BEST MANAGEMENT PRACTICES MANUAL

FOR

CONSTRUCTION SITES IN HONOLULU

Prepared by the

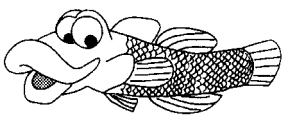
Department of Environmental Services
City and County of Honolulu

in cooperation with

The General Contractors Association of Hawaii

May 1999

Help protect our waters ... for life!



OFFICE OF THE MAYOR
CITY AND COUNTY OF HONOLULU

MAYOR'S MESSAGE

The construction industry contributes greatly to our economy, growth and quality of life. It also has the potential to significantly impact our environment. Using best management practices (BMPs) at construction sites is the most effective way to prevent pollution and protect our environment.

Engineers, contractors and inspectors, who support this idea have all expressed the need for guidance in the planning, building and maintenance of effective pollution control measures. This *Best Management Practices Manual for Construction Sites in Honolulu*, prepared in cooperation with the General Contractors Association of Hawaii, provides a broad range of measures to control erosion and the discharge of sediment and other pollutants into our environment.

Each BMP fact sheet in the manual clearly defines objectives, identifies pollutants and lists implementation requirements. The fact sheets present the principles behind each measure, such as containment, filtration, or simply the need for good housekeeping practices, and give guidance for their effective application.

Please use the best management practices in this manual to keep pollutants out of our waterways. Together, with your kokua, we can meet our responsibilities as stewards entrusted to protect Oahu's streams and coastal waters.

JEREMY HARRIS, Mayor
City and County of Honolulu

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REFERENCES

"California Storm Water Best Management Practice Handbook, Construction Activity," dated March 1993, by Camp Dresser & McKee, Larry Walker Associates, Uribe and Associates, and Resources Planning Associates for the California Storm Water Quality Task Force

"A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii," January 1999, State of Hawaii Department of Business, Economic Development and Tourism, Clean Hawaii Center

"Guidelines for the Design and Construction of Small Embankment Dams," Report R88, June 1992, State of Hawaii Department of Land and Natural Resource, Division of Water and Land Development

"Guidelines for Safety Inspection of Dams," Report R92, December 1992, State of Hawaii Department of Land and Natural Resource, Division of Water and Land Development

"Hawaii Occupational Safety and Health Standards"

"Minimizing Construction & Demolition Waste: A C&D Waste Management Guide," February 1998, First Edition, State of Hawaii Department of Health, Office of Solid Waste Management

"Residential Construction Waste Management: A Builder's Field Guide (How to Save Money and Landfill Space)," 1997, National Association of Home Builders Research Center

"Rules Relating to Soil Erosion Standards and Guidelines," April 1999, City and County of Honolulu Department of Planning and Permitting

"Standard Specifications for Public Works Construction," dated September 1986, Departments of Public Works, County of Kauai, City and County of Honolulu, County of Maui, County of Hawaii, of the State of Hawaii

"Storm Drainage Standards," dated May 1988, Department of Public Works, City and County of Honolulu

"Planning and Design Manual for the Control and Erosion, Sediment, and Stormwater," A Cooperative Effort by: USDA Natural Resources Conservation Service, Mississippi Department of Environmental Quality, and the Mississippi Soil & Water Conservation Commission.

ACRONYMS

BMPs	Best management practices
CA	Contractor Activity: BMPs in Chapter 1 of this manual are from Chapter 5 of the California Best Management Practice Handbook, and are referenced in this manner.
C&D	Construction & Demolition (C&D) Landfill, which for Honolulu at this time is the PVT Landfill in Nanakuli.
DBEDT	Department of Business, Economic Development & Tourism, State of Hawaii
DLNR	Department of Land and Natural Resources, State of Hawaii
DOH	Department of Health, State of Hawaii
DPP	Department of Planning and Permitting, City & County of Honolulu
ENV	Department of Environmental Services, City & County of Honolulu
EPA	United States Environmental Protection Agency
ESC	Erosion and Sedimentation Control: BMPs in Chapter 2 of this manual are from Chapter 5 of the California Best Management Practice Handbook and are referenced in this manner.
HEER	Hazard Evaluation & Emergency Response Office, Department of Health, State of Hawaii
MSW	Municipal Solid Waste (MSW) Landfill, which for Honolulu is the Waiamanalo Gulch Sanitary Landfill (Makakilo).
NAHB	National Association of Home Builders
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service, formerly the Soil Conservation Service.
POTW	Publicly owned treatment plant. For Honolulu, this could be the plants owned by the Federal Government, City of Honolulu, or the Hawaii Kai system.
SWPPP	Storm Water Pollution Prevention Plan
USEPA	United States Environmental Protection Agency

USEFUL PHONE NUMBERS

City and County of Honolulu

Grading Grubbing or Stockpiling Permits	523-4921 or 523-4164
Grading Plan Review/Approval Process	523-4968 or 523-4732
Effluent Discharge Permit to Storm Drains - Construction Dewatering	523-4968
Effluent Discharge Permits to Storm Drains - Hydrotesting, Well Drilling, Other	527-6106
Industrial Discharges to Sanitary Sewer System	527-6759
Environmental Concern Line	527-5091

Hawaii State Department of Health

NPDES Effluent Discharge Permits	586-4309
Construction and Demolition Waste	586-4220
Hazard Evaluation & Emergency Response Office	586-4249

Hawaii State Department of Land and Natural Resources

Stream Channel Alteration Permits	587-0249
Dam Safety	587-0227

Federal Agencies

National Resources Conservation Service	541-2600
U.S. Army Corps of Engineers (Permits)	438-9258
U.S. Coast Guard (to report spills of oil or hazardous materials)	522-8260
U.S. Environmental Protection Agency	541-2710

ACKNOWLEDGMENTS

Appreciation is extended to Dave Brent, Chairman, California Storm Water Quality Task Force for allowing the City & County of Honolulu to use chapters four and five of the "California Best Management Practice Handbook" as the basis for this manual of BMPs for construction sites. Acknowledgment is given to the Environmental Committee, General Contractors Association of Hawaii; the Department of Health Clean Water Branch, Department of Health Office of Solid Waste Management; Department of Land and Natural Resources; and Chester Saito of Hawaiian Dredging Construction Company, and Bill Paik and Dexter Furuhashi of Hawaiian Bitumuls for helping adapt the California BMPs to construction projects in Honolulu.

INTRODUCTION

The purpose of this manual is to provide descriptions of best management practices (BMPs) for use on construction projects in Honolulu. This manual does not replace or supersede any laws, standards, rules, or policies of any City, State or Federal agency in the State of Hawaii. It offers specific guidance for selecting best management practices to reduce the discharge of pollutants during construction. The intended audience includes engineers, contractors, owners/developers, and others in the construction industry.

The BMPs in this manual have been adapted from Chapters 4 and 5 of the "California Best Management Practice Handbook, Construction," dated March 1993, prepared for the California Storm Water Quality Task Force by the following firms: Camp Dresser & McKee, Larry Walker Associates, Uribe and Associates, and Resources Planning. The California Handbook is prefaced with the following disclaimer:

"The statements and conclusions of this Handbook are those of the Grantee and not necessarily those of the State of California. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

"This Handbook was produced and published by the Storm Water Quality Task Force, an advisory body of municipal agencies regulated by the storm water program. This Handbook is not a publication of the State Water Resources Control Board or any Regional Water Quality Control Board, and none of these Boards has specifically endorsed the contents thereof. The purpose of this Handbook is to assist the members of the Task Force and other dischargers subject to storm water permits, in attaining compliance with such permits."

The California Storm Water Quality Task Force has granted permission to the City & County of Honolulu to modify Chapters 4 and 5 of the California BMP Handbook to make it specific for projects in Honolulu.

Modifications to the original BMPs are minimal and, in general, limited to the following items, with additions shown in italics.

- References to the State of Hawaii Department of Agriculture, State Department of Health, State Department of Land and Natural Resources, and City agencies have been added.

- References to BMPs which target preservation of specific California plant species, such as the California Oak, have been deleted.

- References to sizing for sediment traps and sediment basins have been deleted, because the City and County of Honolulu has specific requirements for sizing these in the "Rules for Soil Erosion Standards and Guidelines," April 1999.

- The BMPs for Solid Waste Management (CA20), and Hazardous Waste Management (CA21), have been changed significantly to reflect State Department of Health policies.

- Table 1.2 QUICK REFERENCE - DISPOSAL ALTERNATIVES has been modified to delete references to residential activity and to reflect State Department of Health policies on handling of solid and hazardous wastes.

- Two BMP sheets have been added at the request of the Department of Health: ESC3, Location of Potential Sources of Sediment; and ESC25, Stockpiling.

There are two broad areas of concern on construction sites: first, contractor activities that can cause a discharge of pollutants from the activity itself; and second, those which are related to soil erosion and sediment runoff caused by dust or storm water runoff. Selection of the BMPs for contractor activities should address the specific activity such as dewatering, paving, vehicle and equipment cleaning, etc. The BMP selection for soil erosion and sedimentation should follow the Department of Planning and Permitting's "Rules Relating to Soil Erosion Standards and Guidelines."

Chapter 1, "BMPs for Contractor Activities" addresses dewatering, paving, painting, material management, waste management, vehicle and equipment management, training, etc. The narratives for CA20, Solid Waste Management, and CA21, Hazardous Waste Management, have been revised extensively to reflect comments by the Department of Health's Solid Waste Management Office. References to DOH publications have been added for recycling and waste reduction, minimization of construction and demolition waste, and proper handling and disposal of hazardous waste.

Chapter 2, "BMPs for Erosion and Sediment Control," includes dust control, mulching, silt fences, and other measures to control erosion and runoff of sediment from construction sites. As mentioned earlier, two BMP fact sheets have been added at the request of the Department of Health, Clean Water Branch: ESC3, Location of Potential Sources of Sediment; and ESC25, Stockpiling.

ESC51, Straw Bale Barriers, has not been included in this manual for several reasons. Straw bale barriers are not commonly used in Honolulu. In California, there have been problems with secondary seeds being transported and establishing downstream of construction sites. Other limitations noted in the California BMP Handbook include the following: they lose effectiveness rapidly because of rotting and need constant maintenance; are suitable only for slopes less than two percent; are not recommended for concentrated flow, inlet protection, channel flow, and live streams; and should not be constructed with jute or cotton bindings.

For ESC56, Sediment Basins, the volume should be sized to City of Honolulu criteria or as required as part of the State Department of Health NPDES permit requirements.

1. BMPs FOR CONTRACTOR ACTIVITIES

INTRODUCTION

This chapter describes specific Best Management Practices (BMPs) for common construction activities that may pollute storm water. This chapter provides a list of BMPs that can be used to fit your site's needs.

BMP fact sheets are provided for each of the contractor's activities, noted in the box.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Approach
- Requirements
  - Costs, including capital costs, and operation and maintenance (O&M) costs
  - Maintenance (including administrative and staffing)
- Limitations
- References

The side bar presents information on which BMP objective applies, targeted constituents, and an indication of the level of effort and costs to implement. For some BMPs, further information is provided in additional sheets.

Contractor Activities

Construction Practices
- CA1 Dewatering Operations
- CA2 Paving Operations
- CA3 Structure Construction and Painting

Material Management
- CA10 Material Delivery and Storage
- CA11 Material Use
- CA12 Spill Prevention and Control

Waste Management
- CA20 Solid Waste Management
- CA21 Hazardous Waste Management
- CA22 Contaminated Soil Management
- CA23 Concrete Waste Management
- CA24 Sanitary/Septic Waste Management

Vehicle and Equipment Management
- CA30 Vehicle and Equipment Cleaning
- CA31 Vehicle and Equipment Fueling
- CA32 Vehicle and Equipment Maintenance

Contractor Training
- CA40 Employee/Subcontractor Training

These BMP fact sheets are suitable for inclusion in many storm water pollution prevention plans for typical contractor activities. The BMPs listed are not an exhaustive list, nor will every BMP be appropriate for every situation. Therefore, suggested BMPs which are inappropriate may be deleted and additional BMPs for specific site conditions should be added. In addition, your selection and implementation of BMPs should be reviewed on a regular basis to match the changing conditions at construction sites.

TABLE 1.1 CONTRACTOR ACTIVITIES AND BMP OBJECTIVES

BMP CATEGORY		BMP OBJECTIVES						
		PRACTICE GOOD HOUSE-KEEPING	CONTAIN WASTE	MINIMIZE DISTURBED AREA	STABILIZE DISTURBED AREA	PROTECT SLOPES AND CHANNELS	CONTROL SITE PERIMETER	CONTROL INTERNAL EROSION
	Construction Practices							
CA1	Dewatering Operations	U				U	U	U
CA2	Paving Operations	U						
CA3	Structure Construction and	U			U			
	Material Management							
CA100	Material Delivery and Storage	U						
CA11	Material Use	U						
CA12	Spill Prevention and Control	U						
	Waste Management							
CA20	Solid Waste Management	U	U					
CA21	Hazardous Waste Management		U					
CA22	Contaminated Soil Management		U	U	U			
CA23	Concrete Waste Management		U					
CA24	Sanitary/Septic Waste		U					
	Vehicle and Equipment Management							
CA30	Vehicle and Equipment Cleaning	U					U	U
CA31	Vehicle and Equipment Fueling	U						
CA32	Vehicle and Equipment Maintenance	U						
	Contractor Training							
CA40	Employee/Subcontractor Training	U	U					

ACTIVITY: DEWATERING OPERATIONS

Graphic: City and County of Honolulu, 1999

Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from dewatering operations by using sediment controls and by testing the groundwater for pollution.

APPROACH

There are two general classes of pollutants that may result from dewatering operations; sediment, and toxics and petroleum products. A high sediment content in dewatering discharges is common because of the nature of the operation. On the other hand, toxics and petroleum products are not commonly found in dewatering discharges unless, the surrounding area has been used for light or heavy industrial activities, or the area has history of groundwater contamination. The following steps will help reduce storm water pollution from dewatering discharges:

Sediment

- Use sediment controls to remove sediment from water generated by dewatering (See Sediment Trap (ESC 55) and Sediment Basin (ESC 56) in Chapter 5).
- Use filtration to remove sediment from a sediment trap or basin. Filtration can be achieved with:
  - Sump pit and a perforated or slit standpipe with holes and wrapped in filter fabric. The standpipe is surrounded by stones which filter the water as it collects in the pit before being pumped out. Wrapping the standpipe in filter fabric may require an increased suction inlet area to avoid clogging and unacceptable pump operation.
  - Floating suction hose to allow cleaner surface water to be pumped out.

Toxics and Petroleum Products

- In areas suspected of having groundwater pollution, sample the groundwater near the excavation site and have the water tested for known or suspected pollutants at a Certified laboratory. Check with the *State Department of Health (DOH) and the City Department of Planning and Permitting (DPP)* for their requirements for dewatering, additional water quality tests, and disposal options.
- *With permits from the State DOH and City DPP, (or State Department of Transportation (DOT) if applicable), you may be able to discharge to the storm sewer system. With a permit from the Publicly Owned Treatment Works (POTW), you may be able to treat pumped groundwater and discharge it to the POTW via the sanitary sewer.*
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA1

BEST MANAGEMENT PRACTICES

CONTRACTOR ACTIVITY: DEWATERING OPERATIONS (Continue)

REQUIREMENTS

- Costs (Capital, O&M)
  - Sediment controls are low cost measures.
  - Treatment and/or discharge of polluted groundwater can be quite expensive.
- Maintenance
  - Maintain sediment controls and filters in good working order. (See Chapter 5 for details)
  - Inspect excavated areas daily for signs of contaminated water as evidenced by discoloration, oily sheen, or odors.

LIMITATIONS

- The presence of contaminated water may indicate contaminated soil as well. See CA22 (Contaminated Soil Management) in this chapter for more information.

REFERENCES

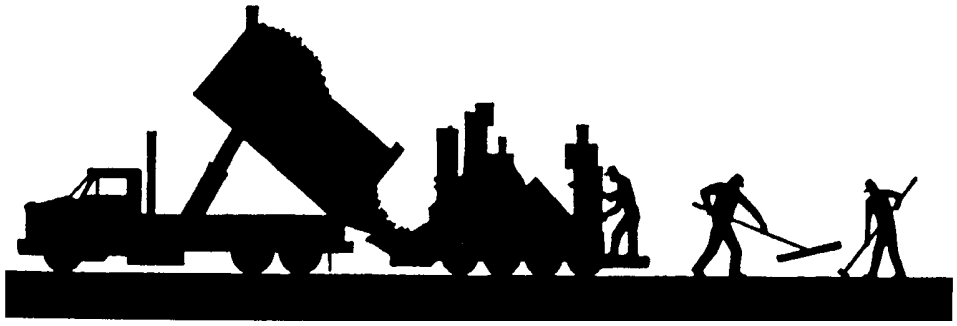
Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA1

ACTIVITY: PAVING OPERATIONS

Graphic: North Central Texas COG, 1993



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

APPROACH

- Avoid paving during wet weather.
- *Use asphalt emulsions as prime coat where possible*.
- Store materials away from drainage courses to prevent storm water runon (see CA10 Material Delivery and Storage).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or trap/filter sediment (see Chapter 5).
- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials rather than burying. See CA32 (Vehicle and Equipment Maintenance) and CA12 (Spill Prevention and Control) in this chapter.
- *Block/protect* catch basins and *cover* manholes when applying seal coat, tack coat, slurry seal, fog seal, etc.
- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- If paving involves portland cement concrete, see CA23 (Concrete Waste Management) in this chapter.
- If paving involves asphaltic concrete, follow these steps:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or *streams* by sweeping. Properly dispose of this waste by referring to CA20 (Solid Waste Management) in this chapter.
  - Old asphalt must be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.
  - If paving involves on-site mixing plant, follow the storm water permitting requirements for industrial activities.
- Train employees and subcontractors.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect employees and subcontractors to ensure that measures are being followed.
  - Keep ample supplies of drip pans or absorbent materials on-site.

LIMITATIONS

- There are no major limitations to this best management practice

Targeted Pollutants

- ◒ Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA2

BEST MANAGEMENT PRACTICES

CONTRACTOR ACTIVITY: PAVING OPERATIONS (Continue)

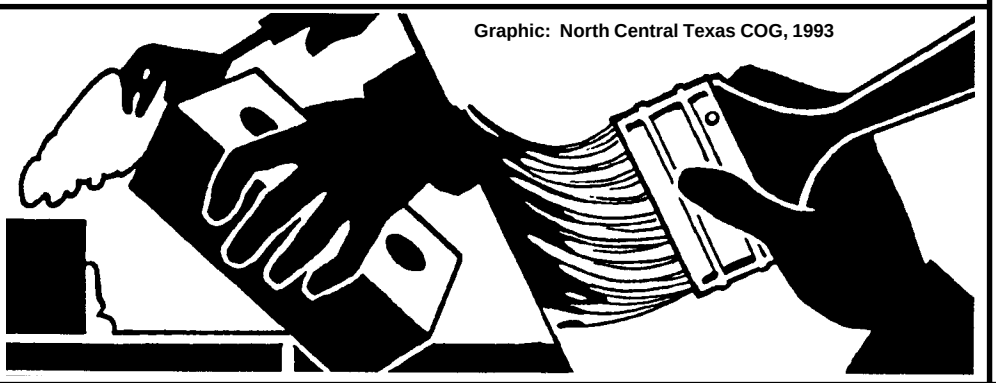
REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Hot-mix Asphalt Paving Handbook. U.S. Army Corps of Engineers, AC 150/5370-14, Appendix 1, July 1991.

CA2

ACTIVITY: STRUCTURE CONSTRUCTION AND PAINTING



Graphic: North Central Texas COG, 1993

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from structure construction and painting by enclosing or covering or berming building material storage areas, using good housekeeping practices, using safer alternative products, and training employees and subcontractors.

APPROACH

- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area.
- Use soil erosion control techniques if bare ground is exposed (See Chapter 2).
- Buy recycled or less hazardous products to the maximum extent practicable.
- Conduct painting operations consistent with local air quality and OSHA regulations.
- Properly store paints and solvents. See CA10 (Material Delivery and Storage) in this chapter.
- Properly store and dispose waste materials generated from the activity. See the waste management BMPs (CA20 to CA24) in this chapter.
- *Recycle/dispose according to applicable laws and regulations* residual paints, solvents, lumber, and other materials to the maximum extent practicable.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.
- Clean the storm drain system in the immediate construction area after construction is completed.
- Educate employees who are doing the work.
  Inform subcontractors of company policy on these matters and include appropriate provisions in their contract to make certain proper housekeeping and disposal practices are implemented.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.
- *Dispose of sand blasted material properly. Chips and dust from marine paints or paints containing lead should be disposed of as hazardous waste. Paint chips and dust from non-hazardous dry stripping and sand blasting may be swept up and disposed of as trash.*

REQUIREMENTS

- Costs (Capital, O&M)
  - These BMPs are generally of low to moderate cost.
- Maintenance
  - Maintenance should be minimal.

LIMITATIONS

- Safer alternative products may not be available, suitable, or effective in every case.
- Hazardous waste that cannot be re-used or recycled must be disposed of by a licensed hazardous waste hauler.

Objectives

- ***Housekeeping Practices***
- ***Contain Waste***
- ***Minimize Disturbed Areas***
- ***Stabilize Disturbed Areas***
- ***Protect Slopes/Channels***
- ***Control Site Perimeter***
- ***Control Internal Erosion***

Targeted Pollutants

- ○ ***Sediment***
- ○ ***Nutrients***
- ◒ ***Toxic Materials***
- ○ ***Oil & Grease***
- ● ***Floatable Materials***
- ● ***Other Construction Waste***

- ● ***Likely to Have Significant Impact***
- ○ ***Probable Low or Unknown Impact***

Implementation Requirements

- ○ ***Capital Costs***
- ○ ***O&M Costs***
- ○ ***Maintenance***
- ◒ ***Training***
- ○ ***Suitability for Slopes >5%***

● ***High*** ○ ***Low***

CA3

BEST MANAGEMENT PRACTICES

- Be certain that actions to help storm water quality are consistent with *State*- and Fed-OSHA and air quality regulations.

Construction and painting activities can generate pollutants that can reach storm water if proper care is not taken. The sources of these contaminants may be solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos insulation. For specific information on some of these wastes see the following BMPs in this chapter
CA20 Solid Waste,
CA21 Hazardous Waste, and
CA23 Concrete Waste.

More specific information on structure construction practices is listed below.

Erosion and Sediment Control
If the work involves exposing large areas of soil or if old buildings are being torn down and not replaced in the near future, employ the appropriate soil erosion and control techniques described in Chapter 2.

Storm/Sanitary Sewer Connections
Carefully install all plumbing and drainage systems. Cross connections between the sanitary and storm drain systems, as well as any other connections into the drainage system from inside a building, are illegal. Color code or flag pipelines on the project site to prevent such connections, and train construction personnel.

Painting
State DOH pollution regulations may specify painting procedures which if properly carried out are usually sufficient to protect storm water quality. These regulations may require that painting operations be properly enclosed or covered to avoid drift. Use temporary scaffolding to hang drop cloths or draperies to prevent drift. Application equipment that minimizes overspray also helps. When using sealants on wood, pavement, roofs, etc, quickly clean up spills. Remove excess liquid with absorbent material or rags.

If painting requires scraping or sand blasting of the existing surface, use a drop cloth to collect most of the chips. Dispose the residue properly. If the paint contains lead or tributyl tin, it is considered a hazardous waste. Refer to the waste management BMPs in this chapter for more information.

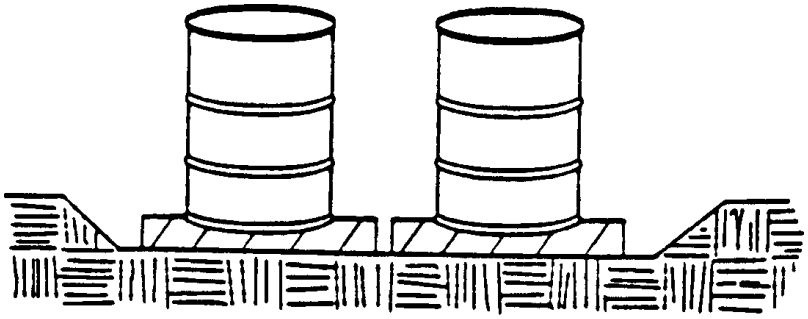
Mix paint indoors, in a containment area, or in a flat unpaved area not subject to significant erosion. Do so even during dry weather because cleanup of a spill will never be 100% effective. Dried paint will erode from sloped surfaces and be washed away by storms. If using water based paints, clean the application equipment in a sink that is connected to the sanitary sewer or in a containment area where the dried paint can be readily removed. Properly store leftover paints if they are to be kept for the next job, or dispose of properly.

Roof work
When working on roofs, if small particles have accumulated in the gutter, either sweep out the gutter or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is lined tight, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck, and clean the catch basin sump where you placed the plug.

REFERENCES
Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

CA3

ACTIVITY: MATERIAL DELIVERY AND STORAGE



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material delivery and storage by minimizing the storage of hazardous materials on-site, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see CA11 (Material Use), or CA12 (Spill Prevention and Control). For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following materials are commonly stored on construction sites:

- Soil,
- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Plaster or other products,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Storage of these materials on-site can pose the following risks:

- Storm water pollution,
- Injury to workers or visitors,
- Groundwater pollution, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:

- Designate areas of the construction site for material delivery and storage.
  - Place near the construction entrances, away from waterways
  - Avoid transport near drainage paths or waterways
  - Surround with earth berms (see ESC30, Earth Dike) *or approved containment device*.
  - Place in an area which *is* paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.
- Keep an accurate, up-to-date inventory of materials delivered and stored on-site.
- Keep your inventory down.
- *Maintain a complete set of material safety data sheets at the project site*.

Targeted Pollutants

- ◒ *Sediment*
- ◒ *Nutrients*
- ◒ *Toxic Materials*
- ◒ *Oil & Grease*
- ◒ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ◒ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA10

BEST MANAGEMENT PRACTICES

- Minimize hazardous materials on-site storage.
- Handle hazardous materials as infrequently as possible.
- During the rainy season, consider storing materials in a covered area. Store materials in secondary containments such as an earthen dike, horse trough; or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids and to reduce corrosion.
- Try to keep chemicals in their original containers, and keep them well labeled.
- Train employees and subcontractors.
- Employees trained in emergency spill cleanup procedures should be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove materials and any contaminated soil (See CA22). If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

REQUIREMENTS

- Cost (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Keep the designated storage area clean and well organized.
  - Conduct routine weekly inspections and check for external corrosion of material containers.
  - Keep an ample supply of spill cleanup materials near the storage area.

LIMITATIONS

- Storage sheds often must meet building and fire code requirements.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

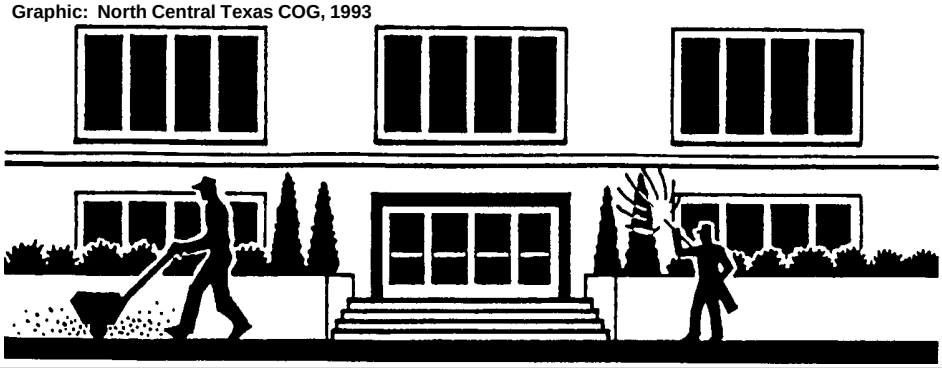
Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA10

ACTIVITY: MATERIAL USE

Graphic: North Central Texas COG, 1993



DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material use by using alternative products, minirnizing hazardous material use on-site, and training employees and subcontractors.

APPROACH

The following materials are commonly used on construction sites:

- Pesticides and herbicides,
- Fertilizers,
- Detergents,
- Plaster and other products,
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Use of these materials on-site can pose the following risks:

- Storm water pollution,
- Injury to workers or visitors,
- Groundwater pollution, and
- Soil contamination.

Therefore, the following steps should be taken to minimize your risk:

- Use less hazardous, alternative materials as much as possible.
- Minimize use of hazardous materials on-site.
- Use materials only where and when needed to complete the construction activity.
- Follow manufacturer's instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Personnel who use pesticides should be trained in their use. The *State Department of Agriculture, Pesticides Branch*, licenses pesticide dealers, certifies pesticide applicators, and conducts on-site inspections.
- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydroseeding. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains.
- Train employees and subcontractors in proper material use.

Objectives

- ***Housekeeping Practices***
- ***Contain Waste***
- ***Minimize Disturbed Areas***
- ***Stabilize Disturbed Areas***
- ***Protect Slopes/Channels***
- ***Control Site Perimeter***
- ***Control Internal Erosion***

Targeted Pollutants

- ○ ***Sediment***
- ◒ ***Nutrients***
- ◒ ***Toxic Materials***
- ◒ ***Oil & Grease***
- ◒ ***Floatable Materials***
- ○ ***Other Construction Waste***

- ● ***Likely to Have Significant Impact***
- ○ ***Probable Low or Unknown Impact***

Implementation Requirements

- ○ ***Capital Costs***
- ○ ***O&M Costs***
- ○ ***Maintenance***
- ◒ ***Training***
- ○ ***Suitability for Slopes >5%***

● ***High*** ○ ***Low***

CA11

BEST MANAGEMENT PRACTICES

REQUIREMENTS
- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Maintenance of this best management practice is minimal.

LIMITATIONS
- Alternative materials may not be available, suitable, or effective in every case.

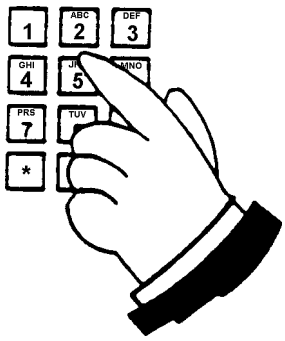
REFERENCES
Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source, Pollution Control Program, 1992.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA11

ACTIVITY: SPILL PREVENTION CONTROL



Objectives

- ***Housekeeping Practices***
- ***Contain Waste***
- ***Minimize Disturbed Areas***
- ***Stabilize Disturbed Areas***
- ***Protect Slopes/Channels***
- ***Control Site Perimeter***
- ***Control Internal Erosion***

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, CA10 (Material Delivery and Storage) and CA11 (Material Use), also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following steps will help reduce the storm water impacts of leaks and spills:

Define "Significant Spill"

- Different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.

General Measures

- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals.
- *Prepare and maintain a spill response plan at the project site*.

Cleanup

- Clean up leaks and spills immediately.
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this chapter for specific information.

Reporting

- Report significant spills to the *U.S. Coast Guard, State HEER Office, and City* agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).

Targeted Pollutants

- ○ ***Sediment***
- ○ ***Nutrients***
- ◒ ***Toxic Materials***
- ◒ ***Oil & Grease***
- ○ ***Floatable Materials***
- ○ ***Other Construction Waste***

- ● ***Likely to Have Significant Impact***
- ○ ***Probable Low or Unknown Impact***

Implementation Requirements

- ○ ***Capital Costs***
- ◒ ***O&M Costs***
- ○ ***Maintenance***
- ◒ ***Training***
- ○ ***Suitability for Slopes >5%***

● ***High*** ○ ***Low***

CA12

BEST MANAGEMENT PRACTICES

ACTIVITY: SPILL PREVENTION AND CONTROL (Continue)

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur on-site, use a designated area and/or a secondary containment, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.
- Oil filters disposed of in trash cans or dumpsters can leak oil and pollute storm water. Place the: oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Discourage "topping-off' of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/leaks.

REQUIREMENTS

- Costs (Capital, O&M)
  - Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil or water can be quite expensive.
- Maintenance
  - Keep ample supplies of spill control and cleanup materials on-site, near storage, unloading, and maintenance areas.
  - Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals on-site.

LIMITATIONS

- If necessary, use a private spill cleanup company.

REFERENCES

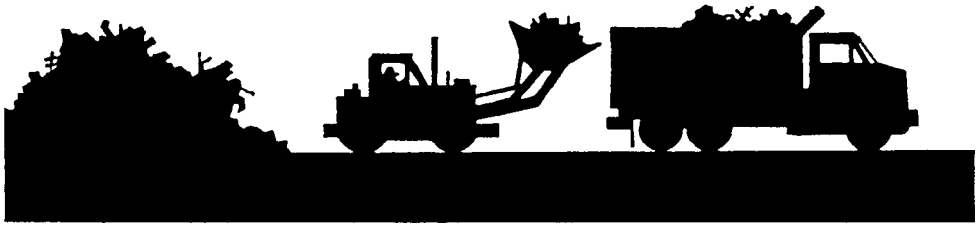
Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA12

ACTIVITY: SOLID WASTE MANAGEMENT

Graphic: North Central Texas COG, 1993



DESCRIPTION

Prevent or reduce discharge of pollutants to the land, groundwater, in storm water from solid waste or construction demolition (C&D) waste by providing designated waste collection areas, separate containers for recyclable waste materials, timing collection of waste and recyclable materials with each stage of the construction or demolition project, and properly training subcontractors and employees.

APPROACH

Solid waste is one of the major pollutants resulting from both construction and demolition activities that also contributes to illegal dumping.

***Construction and demolition (C&D) waste** is defined as solid, largely inert waste, resulting from the demolition or razing of buildings, of roads, or other structures, such as concrete, brick, bituminous concrete, wood, and masonry, composition roofing, and roofing paper, steel, plaster, and minor amounts of other metals such as copper. Cleanup materials contaminated with hazardous substances, friable asbestos, waste paint, solvents, sealers, adhesives, or similar materials are not acceptable at C&D disposal sites.*

One "subset" of C&D waste deserves special mention, because large volumes of these wastes are generated on construction demolition sites. Inert fill materials should not be commingled with other C&D waste, especially if intended for reuse.

***Inert fill material** is defined as earth, soil, rock, rock-like material such as cured asphalt, brick, and clean concrete (with no exposed steel-reinforcing rod) less than eight inches in its greatest dimension, except as specified by a licensed soils engineer. The fill material shall not contain vegetation or organic material, or other solid waste.*

Inert fill materials are wastes that essentially will not decompose or produce leachate or other releases of environmental concern, nor be contaminated with items of concern like asbestos, and lead-based paint (LBP). Place qualifying as inert fill material according to both City & County and State DOH regulations have reuse potential. County and State laws prohibit other types and volumes of solid waste from job-sites from being used as fill material; instead, we must be transported for disposal to a DOH-permitted landfill.

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

Targeted Pollutants

- ◒ *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ● *Floatable Materials*
- ● *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA20

BEST MANAGEMENT PRACTICES

ACTIVITY: SOLID WASTE MANAGEMENT (Continue)

Recycling, Reuse Encouraged Over Disposal
some C&D waste generated on-site should be recycled or reused whenever and wherever possible. These wastes include but are not limited to:

Recycling
asphalt pavement
cardboard
concrete aggregate (no LBP, asbestos-free)
electronic equipment – wiring, fluorescent light ballasts and tubes (also see CA21, Hazardous Waste Management)
excavated rock
excavated soil (uncontaminated)
freon from appliances – air conditioners and refrigerators
glass
green waste – yard and tree trimmings, trunks, limbs
metals, ferrous – steel from appliances, concrete rebar
metals,non-ferrous – aluminum, brass, copper, stainless-steel
used tires
wood and lumber (untreated, no LBP, asbestos-free) – esp. pallets

Reuse (donation to non-profits)
reusable building materials for self-help housing projects
small appliances and other used household items (e.g., fixtures)
used furniture

The State DOH, Office of Solid Waste Management has developed a guide, "Minimizing Construction and Demolition Waste," especially for contractors, architects, builders, and design professionals. The DOH guide features:

- *a checklist on how to start managing C&D waste,*
- *a list of available and DOH-permitted recycling and disposal facilities which can handle or process recyclable and reusable materials, and*
- *a brief regulatory overview of C&D waste, and how important it is to recycle.*

You may obtain free copies of the DOH guide by calling 586-4240.

In addition, the State DBEDT, Clean Hawaii Center has thereafter specialized waste management guide for contractors supervising construction and demolition activities. "A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii" features a Solid Waste Management Checklist offering practical tips on:

- *How to build with used building materials,*
- *What recycled-content materials to consider in the design phase*
- *Deciding where best to use recycled-content materials (e.g., use cold-formed steel framing with a minimum of 25 percent recycle content, and assemble with good quality connectors to prevent corrosion),*
- *Choosing the most helpful suppliers*
- *Training subcontractors to reduce waste*
- *What job-site operations most effectively reduced job-site waste volumes*
- *Specific, environmentally-friendly ways on controlling termites*
- *How to reduce framing waste using advanced-framing techniques*

CA20

ACTIVITY: SOLID WASTE MANAGEMENT (Continue)

The DBEDT manual also offers detailed, helpful tips on managing hazardous wastes (see page 1 – 17) and a "General Practices Checklist" for training subcontractors and employees how to maximize opportunities for on-site waste reduction recycling. For a free copy of the guide, contact DBEDT at 587-3802.

The DBEDT emphasizes recycling and waste reduction as environmentally-responsible job-site waste management practices. And depending upon the type and scale of your project, implementing sound solid waste reduction practices may reduce your overall disposal costs. Other best management practices related to solid waste include: on-site separation of recyclable C&D materials from wastes intended for disposal; minimizing drive-by contamination of recycling bins, and shielding them from the weather; ensuring all refuse is promptly removed; ascertaining waste types generated at various stages of the project, and scheduling timed, specialized pickups for those recyclable materials. These solid waste management practices will mitigate health and safety hazards, enhance the appearance of the construction area, and help reduce waste management costs.

The following steps will help keep a clean site and reduce *pollution to storm water, to the land and protect groundwater resources:*

- Select designated waste collection areas on-site.
- Inform trash hauling contractors that you will accept only water-tight dumpsters for on-site use. Inspect dumpsters for leaks and repair any dumpster that is not water tight.
- Locate containers in a covered area and/or in a secondary containment. Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it's windy.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Erosion and sediment control devices tend to collect litter. Remove this solid waste promptly.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Salvage or recycle any useful material. For example, trees and shrubs from land clearing can be used as a brush barrier (see ESC53), or converted into wood chips, then used as mulch on graded areas (see ESC11).
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- If a container does spill, clean up immediately.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.
- Train employees and subcontractors in proper solid waste management.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
  - *Refer to the DOH and DBEDT BMP guides outlined earlier.*
- Maintenance
  - Collect site trash daily.
  - Arrange for regular waste collection.
  - *Inspect construction waste and recycling areas regularly for signs of contamination.*
  - *Stage collection of recycled materials according to each phase of the construction/demolition project.*
  - *Also, refer to DBEDT's BMP guide outlined in this section.*

LIMITATIONS

- There are no major limitations to this best management practice.

CA20

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity USEPA, 430/9-73-007,1973.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii, DBEDT, January, 1999.

Minimizing Construction and Demolition Waste: A C&D Waste Management Guide, First Edition, DOH, February, 1998.

Residential Construction Waste Management: A Builder's Field Guide (How to Save Money and Landfill Space), NAHB Reseach Center, 1997.

CA20

ACTIVITY: HAZARDOUS WASTE MANAGEMENT

Graphic: North Central Texas COG, 1993

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water *and to the land* from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

APPROACH

Many of the chemicals used on-site can be hazardous materials which become hazardous waste upon disposal. These wastes may include:

- Paints and solvents;
- Petroleum products such as oils, fuels, and grease;
- Herbicides and pesticides;
- Acids for cleaning masonry; and
- Concrete curing compounds.
- *C&D wastes, including clean-up materials, contaminated with hazardous substances (for more information on C&D wastes, see CA20 Solid Waste Management).*

In addition, sites with existing structures may contain wastes which must be disposed of in accordance with Federal, State, and local regulations. These wastes include:

- Sandblasting grit *or chips contaminated* with lead, cadmium, or chromium-based paints;
- Asbestos; and
- PCBs (particularly in older transformers).

To determine if a material or item is potentially hazardous waste:

- *Check label and shipping papers.*
- *Look for words such as hazardous, danger, caustic or corrosive (dissolves skin, metal or other materials); flammable or ignitable (catches fire easily); carcinogenic (causes cancer); and toxic or poisonous (harms people and animals.) A list of hazardous waste and criteria are found in Hawaii Administrative Rules (HAR) Title 11, Chapter 261.*
- *Check the material safety data sheet (MSDS) the manufacturer must prepare for the product. Ask your supplier for a copy.*
- *For questions and additional information including fact sheets and flyers, call the DOH, Hazardous Waste Program Office at 586-4225.*

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

Targeted Pollutants

- ○ *Sediment*
- ○ *Nutrients*
- ◒ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA21

BEST MANAGEMENT PRACTICES

ACTIVITY: HAZARDOUS WASTE MANAGEMENT (Continue)

The following steps will help reduce storm water *and land* pollution *concerns resulting* from hazardous wastes:

Material Use

- Use all of the product before disposing of the container.
- Do not remove the original product label, it contains important safety and disposal information.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with Federal and State regulations.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and re-use thinners and solvents. Dispose of excess oil based paints and sludge as hazardous waste.
- *Consult the "Hazardous Waste Management Checklist" within the State DBEDT's "A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii" for additional tips and BMPs on selecting and purchasing lesser-toxic building products.*

The DBEDT manual also offers detailed, helpful tips on solid waste management (see CA20) and a "General Practices Checklist" for training subcontractors and employees how to maximize opportunities for on-site waste reduction and recycling. For a free copy of the guide, contact DBEDT at 587-3802.

Waste Recycling/Disposal

- Select designated hazardous waste collection areas on-site.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, make recycling impossible, and complicate disposal.
- Recycle any useful material such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g. excess oil-based paint and sludges) is collected, removed, and disposed of only at authorized disposal areas.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.
- *Consult the "Hazardous Waste Management Checklist" within the State DBEDT's "A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii" for additional tips and BMPs on how to reduce hazardous waste volumes, and how to best determine if a material or item is a potentially hazardous waste.*

Training

- Train employees and subcontractors in proper hazardous waste management. *Consult the "Hazardous Waste Management Checklist" within the State DBEDT's "A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii" for tips and other useful resources available to help you train employees and subcontractors.*
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect hazardous waste receptacles and area regularly.
  - Arrange for regular hazardous waste collection.

CA21

LIMITATIONS

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

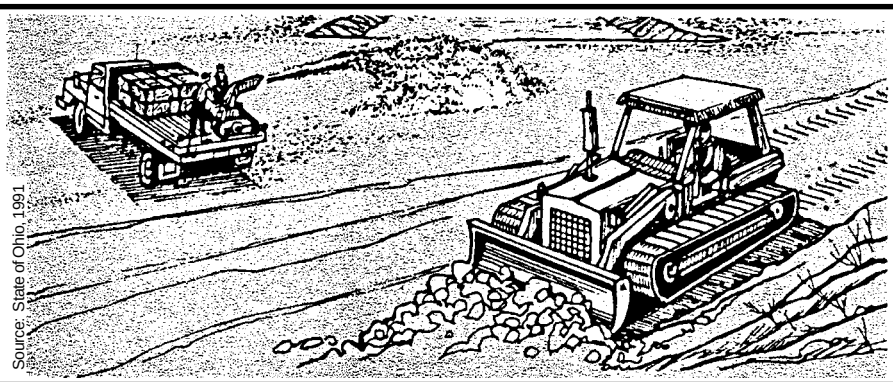
Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/9-73-007, 1973.

A Contractor's Waste Management Guide: Best Management Practices and Tools for Job Site Recycling and Waste Reduction in Hawaii, DBEDT, January, 1999.

Minimizing Construction and Demolition Waste: A C&D Waste Management Guide, First Edition, DOH, February, 1998.

CA21

ACTIVITY: CONTAMINATED SOIL MANAGEMENT


Source: State of Ohio, 1991

Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water *and to the land* from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

APPROACH

Contaminated soils may occur on your site for several reasons including:

- Past site uses and activities;
- Detected or undetected spills and leaks; and
- Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline-forming elements.

Most developers conduct pre-construction environmental assessments as a matter of routine. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil, highlight the need for contractors to confirm that a site assessment is completed before earth moving begins.

The following steps will help reduce storm water *and land* pollution *concerns resulting from hazardous wastes*:

- Conduct thorough site planning including pre-construction geologic surveys.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills to the maximum extent practicable. Contaminated soil can be expensive to treat and/or dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- Test suspected soils at a certified laboratory.
- If the *soil* is contaminated, work with the *State DOH* to develop options for treatment and/or disposal.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.
- *Secure required State DOH permits*.

REQUIREMENTS

- Costs (Capital, O&M)
  - Prevention of leaks and spills is inexpensive. Treatment and/or disposal of contaminated soil can be quite expensive.
- Maintenance
  - Inspect excavated areas daily for signs of contaminated soil.
  - Implement CA 12, Spill Prevention and Control, to prevent leaks and spills as much as possible.

Targeted Pollutants

- ◒ Sediment
- ○ Nutrients
- ● Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training
- ○ Suitability for Slopes >5%

● High ○ Low

CA22

BEST MANAGEMENT PRACTICES

LIMITATIONS

- Contaminated soils must be disposed of at DOH-permitted facilities by DOH-approved transporters. NOTE: If transporting **petroleum-contaminated soil** (PCS) loads off-site to other than permitted remediation facilities, use transporters approved by the DOH, Office of Solid Waste Management (OSWM). Any PCS loads to be taken to DOH-permitted remediation facilities must notify OSWM 48 hours prior (refer to the HRS).
- The presence of contaminated soil may indicate contaminated water as well. See CA1 (Dewatering Operations) in this chapter for more information.

REFERENCES

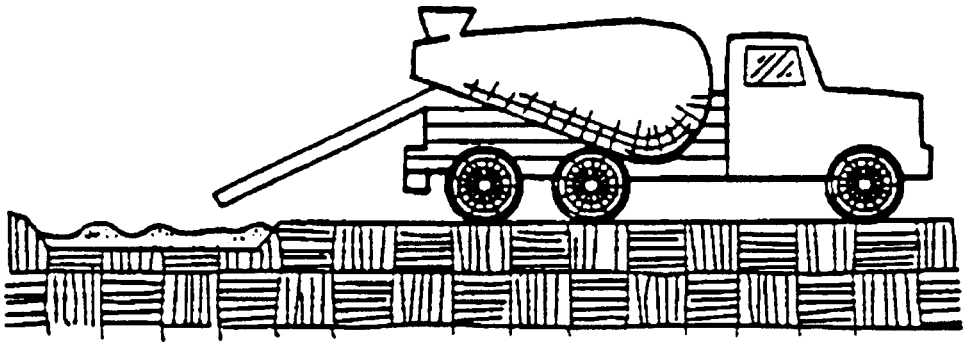
Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity USEPA, 430/9-73-007, 1973.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

CA22

ACTIVITY: CONCRETE WASTE MANAGEMENT



DESCRIPTION
Prevent or reduce the discharge of pollutants to storm water from concrete waste by conducting washout off-site, performing on-site washout in a designated area, and training employees and subcontractors.

APPROACH
The following steps will help reduce storm water pollution from concrete wastes:
- Store dry and wet materials under cover, away from drainage areas.
- Avoid mixing excess amounts of fresh concrete or cement on-site.
- Perform washout of concrete trucks off site or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped on-site, except in designated areas.
- For on-site washout:
  - locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste;
  - wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed of properly.
- When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water to a bermed or level area.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stock pile, or dispose in the trash.
- Train employees and subcontractors in proper concrete waste management.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.

REQUIREMENTS
- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect subcontractors to ensure that concrete wastes are being properly managed.
  - If using a temporary pit, dispose hardened concrete on a regular basis.

LIMITATIONS
- Off-site washout of concrete wastes may not always be possible.

Objectives

Housekeeping Practices
Contain Waste
Minimize Disturbed Areas
Stabilize Disturbed Areas
Protect Slopes/Channels
Control Site Perimeter
Control Internal Erosion

Targeted Pollutants

- ○ *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ◒ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA23

BEST MANAGEMENT PRACTICES

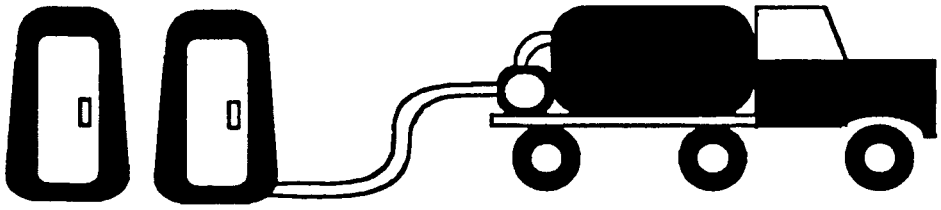
REFERENCES

Best Management Practices and Erosion Control Manual for' Construction Sites; Flood Control District of Maricopa County, AZ, July 1992.

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

ACTIVITY: SANITARY/SEPTIC WASTE MANAGEMENT



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from sanitary/septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

APPROACH

Sanitary or septic wastes should be treated or disposed of in accordance with State, *City or other publicly owned treatment system* requirements. These requirements may include:

- Locate sanitary facilities in a convenient location.
- Untreated raw wastewater should never be discharged *to ground* or buried.
- If using an on-site disposal system (OSDS), such as a septic system, comply with *State Department of Health (DOH) requirements.*
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- If discharging to the sanitary sewer, contact the local wastewater treatment plant for their requirements.
- Sanitary/septic facilities should be maintained in good working order by a licensed service.
- Arrange for regular waste collection by a licensed hauler before facilities overflow.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Inspect facilities regularly.
  - Arrange for regular waste collection.

LIMITATIONS

- There are no major limitations to this best management practice.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Targeted Pollutants

- ○ *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ◒ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA24

BEST MANAGEMENT PRACTICES

ACTIVITY: VEHICLE AND EQUIPMENT CLEANING

Graphic: North Central Texas COG, 1993

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment cleaning by using off-site facilities, washing in designated, contained areas only, eliminating discharges to the storm drain by infiltrating or recycling the wash water, and/or training employees and subcontractors.

APPROACH

- Use off-site commercial washing businesses as much as possible. Washing vehicles and equipment outdoors or in areas where wash water flows onto paved surfaces or into drainage pathways can pollute storm water. If you wash a large number of vehicles or pieces of equipment, consider conducting this work at an off-site commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Performing this work off-site can also be economical by eliminating the need for a separate washing operation at your site.
- If washing must occur on-site, use designated, bermed wash areas to prevent wash water contact with storm water, *streams*, rivers, and other water bodies. The wash area can be sloped for wash water collection and subsequent infiltration into the ground.
- Use as little water as possible to avoid having to install erosion and sediment controls for the wash area.
- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning on-site. Steam cleaning can generate significant pollutant concentrations.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above are low cost measures.
- Maintenance
  - Minimal, some berm repair may be necessary.

LIMITATIONS

- Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades.
- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance).

REFERENCE

Swisher, RD., 1987. Surfactant Biodegradation, Marcel Decker Corporation

Targeted Pollutants

- ○ *Sediment*
- ○ *Nutrients*
- ◒ *Toxic Materials*
- ◒ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

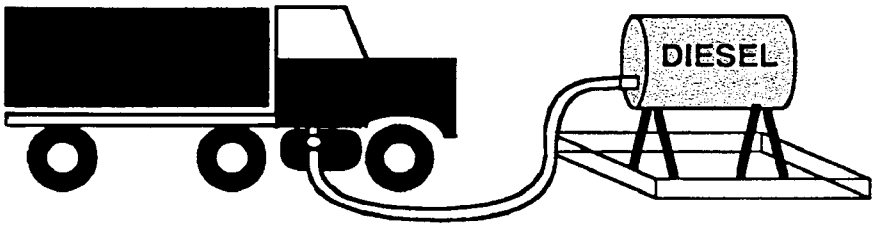
- ◒ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA30

BEST MANAGEMENT PRACTICES

ACTIVITY: VEHICLE AND EQUIPMENT FUELING



Objectives

- ***Housekeeping Practices***
- ***Contain Waste***
- ***Minimize Disturbed Areas***
- ***Stabilize Disturbed Areas***
- ***Protect Slopes/Channels***
- ***Control Site Perimeter***
- ***Control Internal Erosion***

DESCRIPTION

Prevent fuel spills and leaks, and reduce their impacts to storm water by using off-site facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors.

APPROACH

- Use off-site fueling stations as much as possible. Fueling vehicles and equipment outdoors or in areas where fuel may spill/leak onto paved surfaces or into drainage pathways can pollute storm water. If you fuel a large number of vehicles or pieces of equipment, consider using an off-site fueling station. These businesses are better equipped to handle fuel and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Discourage "topping-off of fuel tanks.
- Always use secondary containment, such as a drain pan or drop cloth, when fueling to catch spills/leaks.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Carry out all Federal and State requirements regarding stationary above ground storage tanks.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and perhaps forklifts, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.

REQUIREMENTS

- Costs (Capital, O&M)
  - All of the above measures are low cost, except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.
- Maintenance
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect fueling areas and storage tanks on a regular schedule.

LIMITATIONS

- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance)

Targeted Pollutants

- ○ ***Sediment***
- ○ ***Nutrients***
- ◒ ***Toxic Materials***
- ◒ ***Oil & Grease***
- ○ ***Floatable Materials***
- ○ ***Other Construction Waste***

- ● ***Likely to Have Significant Impact***
- ○ ***Probable Low or Unknown Impact***

Implementation Requirements

- ◒ ***Capital Costs***
- ○ ***O&M Costs***
- ◒ ***Maintenance***
- ◒ ***Training***
- ○ ***Suitability for Slopes >5%***

● ***High*** ○ ***Low***

CA31

BEST MANAGEMENT PRACTICES

ACTIVITY: VEHICLE AND EQUIPMENT MAINTENANCE

Graphic: North Central Texas COG, 1993

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment maintenance by running a "dry site". This involves using off-site facilities, performing work in designated areas only, providing cover for materials stored outside, checking for leaks and spills, containing and cleaning up spills immediately, and training employees and subcontractors.

APPROACH

- Keep vehicles and equipment clean, don't allow excessive build-up of oil and grease.
- Use off-site repair shops as much as possible. Maintaining vehicles and equipment outdoors or in areas where vehicle or equipment fluids may spill or leak onto the ground can pollute stormwater. If you maintain a large number of vehicles or pieces of equipment, consider using an off-site repair shop. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes, see Table 1.2 and CA40, Employee/Subcontractor Training.

REQUIRMENTS

- Costs (Capital, O&M
  - All of the above are low cost measures.
- Maintenance
  - Keep ample supplies of spill cleanup materials on-site.
  - Inspect maintenance areas on a regular schedule.

Targeted Pollutants

- ○ *Sediment*
- ○ *Nutrients*
- ◒ *Toxic Materials*
- ◒ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ◒ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

CA32

BEST MANAGEMENT PRACTICES

LIMITATIONS

- Sending vehicles/equipment off-site should be done in conjunction with ESC24 (Stabilized Construction Entrance).

Outdoor vehicle or equipment maintenance is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service, particularly changing or replacement of fluids, and outdoor equipment storage and parking (dripping engines). For further information on vehicle or equipment servicing, see CA30, Vehicle and Equipment Cleaning, and CA31, Vehicle and Equipment Fueling.

Listed below is further information if you must perform vehicle or equipment maintenance on-site.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane, or methylene chloride. Many of these parts cleaners are harmful and must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents (1,1,1-trichloroethane, methylene chloride, etc.) with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic end less expensive to dispose of properly. Check list of active ingredients to see whether it contains chlorinated solvents. The “chlor” term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling/Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous and non-hazardous wastes separate, do not mix used oil and solvents, and keep chlorinated solvents (like 1,1,1-trichloroethane) separate from nonchlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don’t leave full drip pans or other open containers lying around.

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Place the oil filter in a funnel over a waste oil recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Do not bury used tires.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ, September 1992.

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

CA32

ACTIVITY: EMPLOYEE/SUBCONTRACTOR TRAINING

Graphic: City and County of Honolulu, 1998

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Employee/subcontractor training, like maintenance or a piece of equipment, is not so much a best management practice as it is a method by which to implement BMPs. This fact sheet highlights the importance of training and of integrating the elements of employee/subcontractor training from the individual source controls into a comprehensive training program as part of a company's Storm Water Pollution Prevention Plan (SWPPP).

The specific employee/subcontractor training aspects of each of the source controls are highlighted in the individual fact sheets. The focus of this fact sheet is more general, and includes the overall objectives and approach for assuring employee/subcontractor training in storm water pollution prevention. Accordingly, the organization sheet differs somewhat from the other fact sheets in this chapter.

OBJECTIVES

Employee/subcontractor training should be based on four objectives:

- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water,
- identify solutions (BMPs);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

APPROACH

- Integrate training regarding storm water quality management with existing training programs that may be required for your business by other regulations such as: the *Safety and Health Program (Hawaii Occupational Safety and Health Standards)*, the Hazardous Waste Operations and Emergency Response (HAZWOPER) standard (29 CFR 1910.120), the Spill Prevention Control and Countermeasure (SPCC) Plan (40 CFR 112), and the Hazardous Materials Management Plan (Business Plan).
- Businesses, particularly smaller ones that may not be regulated by Federal, State, or *City* regulations, may use the information in this Handbook to develop a training program to reduce their potential to pollute storm water.
- Use the quick reference on disposal alternatives (Table 1.2) to train employee/subcontractors in proper and consistent methods for disposal.

CA40

BEST MANAGEMENT PRACTICES

ACTIVITY: EMPLOYEE/SUBCONTRACTOR TRAINING (Continue)

- Consider posting the quick reference table around the job site or in the on-site office trailer to reinforce training.
- Train employee/subcontractors in standard operating procedures and spill cleanup techniques described in the fact sheets. Employee/subcontractors trained in spill containment and cleanup should be present during the loading/ unloading and handling of materials.
- Personnel who use pesticides should be trained in their use. The *State Department of Agriculture, Pesticides Branch, licenses* pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employee/ subcontractors can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do on-site.

CA40

TABLE 1.2 QUICK REFERENCE - DISPOSAL ALTERNATIVES
(Adopted from Santa Clara County Nonpoint Source Pollution Control Program - December, 1992)

All of the waste products on this chart are prohibited from discharge to the storm drain system. Use this matrix to decide which alternative disposal strategies to use.
ALTERNATIVES ARE LISTED IN PRIORITY ORDER

KEY: POTW - Publicly Owned Treatment Plant, *which in most areas is the City & County of Honolulu, Department of Environmental Services.*
"Dispose to sanitary sewer" means dispose into sink, toilet, or sanitary sewer clean-out connection.
"Dispose as trash" means dispose in dumpsters or trash containers for pickup and/or eventual disposal in landfill.
"Dispose as hazardous waste" for business/commercial means contract with a hazardous waste hauler to remove and dispose.

DISCHARGE/ACTIVITY	**BUSINESS/COMMERCIAL** **Disposal Priorities**	**Approval**
General Construction and Painting; Street and Utility Maintenance		
Excess Paint (oil- based)	*1. Recycle/reuse.* *2. If volume is too much to dry, solidify with absorbent material, dispose as solid waste.*	
Excess Paint (water-based)	1. *Recycle/reuse.* *2. Dry by leaving cans in open air, dispose as solid waste.* *3. If volume is too much to dry, solidify with absorbent material, dispose as solid waste.*	
Paint cleanup (oil-based)	Wipe paint out of brushes, then: 1. Filter & reuse thinners, solvents. 2. Dispose as hazardous waste	
Paint cleanup (water-based)	Wipe paint out of brushes, then: 1. Rinse to sanitary sewer.	
Empty paint cans (dry)	1. Remove lids, *dispose as solid waste.*	
Paint Stripping (with solvent)	*1. Use it up/give it to someone to use for original intended purpose.* *2. Separate from non-hazardous wastes (to prevent commingling with recyclable materials.)* *3. Dispose as hazardous waste.*	
Building exterior cleaning (high pressure water)	1. Prevent entry into storm drain and remove offsite 2. Wash onto dirt area, spade in 3. Collect (e.g. mop up) and discharge to sanitary sewer	POTW

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval
General Construction and Painting; Street and Utility Maintenance (cont'd)		
Cleaning of building exteriors which have HAZARDOUS MATERIALS (e.g. mercury, lead) in paints	1. Use dry clean methods 2. Contain and dispose washwater as hazardous waste (suggestion: dry material first to reduce volume)	
Non-hazardous paint scraping/sand blasting	1. Dry sweep, dispose as solid waste	*MSW Landfill*
HAZARDOUS paint scraping/sand blasting (e.g. marine paints or paints containing lead or tributyl tin)	1. Dry sweep, dispose as hazardous waste.	*Site permitted to handle HW*
Cleaning streets in construction areas	1. Dry sweep and minimize tracking of mud, *then wash street with water*, filter prior to discharging to storm drain. 2. Use silt ponds, *gravel filters,* and/or similar pollutant reduction techniques when flushing pavement.	
Fresh cement, grout, mortar	*1. Use/reuse excess for original intended purpose.* *2. Dispose separately from recyclable materials as solid waste (take to C&D Landfill.)*	*C&D Landfill*
Washwater from concrete/motor (etc.) cleanup	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	
Aggregate wash from driveway/patio construction	1. Wash onto dirt area, spade in 2. Pump and remove to appropriate disposal facility 3. Settle, pump water to sanitary sewer	POTW

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval
General Construction and Painting; Street and Utility Maintenance (cont'd)		
Rinsewater from concrete trucks	1. Return truck to yard for rinsing into pond or dirt area 2. At construction site, wash into pond or dirt area	
Non-hazardous construction and demolition debris	*1. Separate debris (e.g., pressure-treated lumber, coated or partially-coated with lead-based paint (LBP), adhesives, asbestos) from recyclable materials (e.g., untreated wood, non-ferrous metals), to the extent feasible at each stage of the construction, or demolition process.* *2. Recycle/reuse (e.g., concrete clean of LBP, untreated wood)* *3. Dispose non-recyclables as solid waste (take to C&D Landfill).*	*C&D Landfill*
Hazardous demolition and construction debris (e.g. asbestos)	*1. Separate from recyclable materials (to prevent commingling different waste types) to the extent feasible each stage of the construction, demolition process.* *2. Dispose as hazardous waste*	
Saw-cut slurry	1. Use dry cutting technique and sweep up residue 2. Vacuum slurry and dispose off-site	
Construction dewatering	1. Recycle/reuse 2. Discharge to sanitary sewer 3. As appropriate, treat prior to discharge to storm drain	POTW *DOH, DPP*
Portable toilet waste	1. Leasing company shall dispose to sanitary sewer at POTW	
Leaks from garbage dumpsters	1. Collect, contain leaking material. Eliminate leak, keep covered, return to leasing company for immediate repair. 2. If dumpster is used for liquid waste, use plastic liner	

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval
General Construction and Painting; Street and Utility Maintenance (cont'd)		
Leaks from construction debris bins	1. Insure that bins are used for dry nonhazardous materials only (Suggestion: Fencing, covering help prevent misuse	
Dumpster cleaning water	1. Clean at dumpster's own facility and discharge waste through grease interceptor to sanitary sewer. 2. Clean on site and discharge through grease interceptor to sanitary sewer.	POTW POTW
Cleaning driveways, paved areas (Special Focus = Restaurant alleys, Grocery dumpster areas)	1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, restaurant/grocery alleys, follow this 3-step process: a. Clean up leaks with rags or absorbents. b. Sweep, use granular absorbent material (cat litter). c. Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to sanitary sewer)	
Steam cleaning of sidewalks, plazas	1. Collect all water and pump to sanitary sewer 2. Follow this 3-step process: a. Clean oil leaks with rages or absorbents. b. Sweep, using granular absorbent material (cat litter) c. Mop and dispose of mopwater to sanitary sewer (or collect rinsewater and pump to the sanitary sewer).	
Potable water/line flushing. Hydrant testing	1. Deactivate chlorine by maximizing time water will travel before reaching *streams or the ocean*. 2. Discharge to sanitary sewer. 3. Complete dechlorination required before discharge to storm drain. *Permits are required from the City's Environmental Services Department and the State DOH*	*ENV, SWQ Branch* *DOH*

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval
Landscape/Garden Maintenance		
Pesticides	1. Use up. Rinse containers use rinsewater as product. Dispose rinsed containers as trash 2. Dispose unused pesticide as hazardous waste	
Garden Clippings	*1. Separate from "inert fill material," solid waste and recyclable materials to the extent feasible at each stage of the construction or demolition process.* *2. Take to permitted commercial composters (for recycling)*	
Swimming pool, spa, fountain water (emptying)	1. Do not use metal-based algicides (i.e. Copper Sulfate) 2. Recycle/reuse (e.g. irrigation) 3. *Dechlorinate, check if pH is acceptable, discharge to storm drain (permit required)*	*ENV, SWQ Branch*
Swimming pool, spa filter backwash	1. Reuse for irrigation 2. Dispose on dirt area 3. Settle, dispose to sanitary sewer	

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval
Vehicle Wastes		
Used motor oil	*1. Store in tanks, containers, or other containers that are in good condition and compatible with the oil, send to permitted recycler via a DOH-permitted transporter.*	
Antifreeze	*1. DO NOT MIX with other hazardous wastes (solvents, pesticides. used oil)* *2. Store in tanks, containers, or other containers that are in good condition and compatible with the antifreeze, send to permitted recycler.* *3. Dispose as hazardous waste*	
Other vehicle fluids and solvents	*1. DO NOT MIX with hazardous wastes* *2. Store in tanks, containers, or other containers that are in good condition and compatible with the fluid, send to permitted recycler.*	
Automobile batteries	*1. Send to auto battery recyclers*	
Refrigerant	*1. Send to an EPA-certified technician who uses EPA-approved recycling/recovery equipment.*	
Motor home/construction trailer waste	1. Use holding tank. Dispose to sanitary sewer	
Vehicle Washing	1. Recycle 2. Discharge to sanitary sewer	POTW
Mobile Vehicle Washing	1. Collect washwater and discharge to sanitary sewer	
Vehicle leaks at Vehicle Repair Facilities	Follow this 3-step process: 1. Clean up leaks with rags and absorbents 2. Sweep, using granular absorbent material (cat litter) 3. Mop and dispose of mop water to sanitary sewer	

DISCHARGE/ACTIVITY	BUSINESS/COMMERCIAL Disposal Priorities	Approval
Other Wastes		
Carpet cleaning solutions & other mobile washing services	1. Dispose to sanitary sewer	POTW
Roof Drains	1. If roof is contaminated with industrial waste products, discharge to sanitary sewer. 2. If no contamination is present, discharge to storm drain	
Cooling water, except for once through cooling water	1. Recycle/reuse 2. Discharge to sanitary sewer	 POTW
Pumped groundwater, infiltration/foundation drainage (contaminated)	1. Recycle/reuse (landscaping, etc.) 2. Treat if necessary; discharge to sanitary sewer 3. Treat and discharge to storm drain	 POTW *ENV, SWQ Branch*
Kitchen Grease	1. Provide secondary containment, collect, *and send to DOH-permitted processor or recycler.* *2. NOTE: prior to transport, check with the City and County if POTW is an option, as they may not accept untreated grease.*	POTW
Restaurant cleaning of floor mats, exhaust filters, etc.	1. Clean inside building with discharge through grease trap to sanitary sewer 2. Clean outside in container or bermed area with discharge to sanitary sewer	
Clean-up wastewater from sewer backup	1. Follow this procedure: a. Block storm drain, contain, collect, and return spilled material to the sanitary sewer. b. Block storm drain, rinse remaining material to collection point and pump to sanitary sewer (No rinsewater may flow to storm drain).	

2. BMPs FOR EROSION AND SEDIMENTATION CONTROL

INTRODUCTION

This chapter describes specific Best Management Practices (BMPs) for common construction activities that result in erosion of the construction site and the generation of sediment which impacts waterways and off-site property. This chapter will provide you with the BMPs for *erosion and sediment control* that best fit your site's needs.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Suitable Applications
- Installation/Application Criteria
- Requirements
  - Costs, including capital costs, and operations and maintenance (O&M)
  - Maintenance (including administrative and staffing)
- Limitations

The side bar presents information on which BMP objective applies, targeted constituents, and an indication of the level of effort and costs to implement, The remainder of the fact sheet provides further information on some or all of these topics, and provides references for additional guidelines.

Keep in mind that these controls must also be able to safely contain or convey storms larger than the design storm for erosion and sediment control.

These BMP fact sheets are suitable for inclusion in many SWPPPs for erosion and sedimentation control. They may be used to supplement and provide details for erosion and sedimentation controls shown on the project site map.

BMPs for Erosion and Sedimentation Control

Site Planning Considerations
- ESC1 Scheduling
- ESC2 Preservation of Existing Vegetation
- ESC3 Location of Potential Sources of Sediment

Vegetative Stabilization
- ESC10 Seeding and Planting
- ESC11 Mulching

Physical Stabilization
- ESC20 Geotextiles and Mats
- ESC21 Dust Control
- ESC22 Temporary Stream Crossing
- ESC23 Construction Road Stabilization
- ESC24 Stabilized Construction Entrance
- ESC25 Protection of Stockpiles

Diversion of Runoff
- ESC30 Earth Dike
- ESC31 Temporary Drains and Swales
- ESC32 Slope Drain

Velocity Reduction
- ESC40 Outlet Protection
- ESC41 Check Dams
- ESC42 Slope Roughening/Terracing

Sediment Trapping/Filtering
- ESC50 Silt Fence
- ESC52 Sand Bag Barrier
- ESC53 Brush or Rock Filter
- ESC54 Storm Drain Inlet Protection
- ESC55 Sediment Trap
- ESC56 Sediment Basin

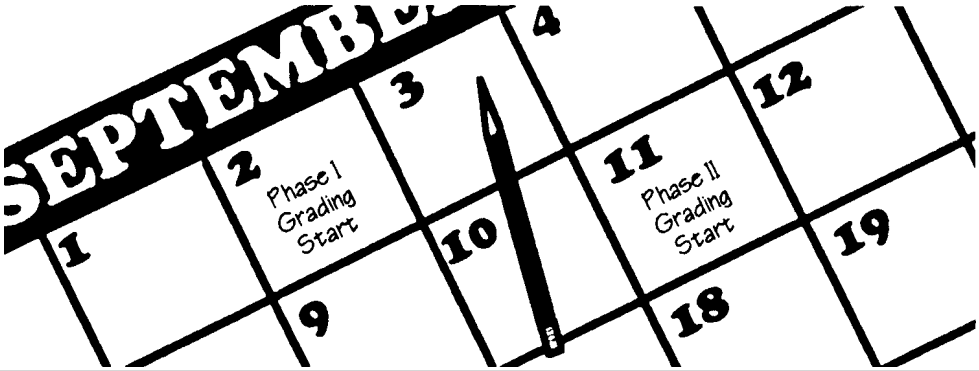
In all cases, however, *State and City* erosion and sedimentation criteria and standards supercede the suggested criteria on these fact sheets. *Refer to the "Rules Relating to Soil Erosion Standards and Guidelines," April 1999, for additional information.*

TABLE 2.1 EROSION AND SEDIMENT CONTROL AND BMP OBJECTIVES

BMP CATEGORY		BMP OBJECTIVES						
		PRACTICE GOOD HOUSE-KEEPING	CONTAIN WASTE	MINIMIZE DISTURBED AREA	STABILIZE DISTURBED AREA	PROTECT SLOPES AND CHANNELS	CONTROL SITE PERIMETER	CONTROL INTERNAL EROSION
	Site Planning Considerations							
ESC1	Scheduling	U	U	U	U	U	U	U
ESC2	Preservation of Existing Vegetation				U	U	U	U
ESC3	Location of Potential Sources of Sediment				U	U		
	Vegetative Stabilization							
ESC10	Seeding and Planting				U	U		
ESC11	Mulching				U	U		
	Physical Stabilization							
ESC20	Geotextiles and Mats				**U**	**U**		
ESC21	Dust Control	U		**U**	**U**		**U**	
ESC22	Temporary Stream Crossing	U		**U**	**U**	**U**		
ESC23	Construction Road Stabilization	**U**		U	**U**	**U**		
ESC24	Stabilized Construction Entrance	U		U	U		**U**	
ESC25	Protection of Stockpiles				U	**U**		
	Diversion Runoff							
ESC30	Earth Dike		U			U	U	U
ESC31	Temporary Drains and Swales					U	U	U
ESC33	Slope Drain					U		
	Velocity Reduction							
ESC40	Outlet Protection					U		
ESC41	Check Dams (see ESC 53 also)					U		
ESC42	Slope Roughening/Terracing				U	U		

BMP CATEGORY		BMP OBJECTIVES						
		PRACTICE GOOD HOUSE-KEEPING	CONTAIN WASTE	MINIMIZE DISTURBED AREA	STABILIZE DISTURBED AREA	PROTECT SLOPES AND CHANNELS	CONTROL SITE PERIMETER	CONTROL INTERNAL EROSION
	Sediment Trapping/Filtering							
ESC50	Silt Fence						U	U
ESC52	Sand Bag Barrier					U	U	**U**
ESC53	Brush or Rock Filter					U	U	**U**
ESC54	Storm Drain Inlet Protection						**U**	**U**
ESC55	Sediment Trap							**U**
ESC56	Sediment Basin							**U**

BMP: SCHEDULING



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

DESCRIPTION

Sequencing the construction project to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

SUITABLE APPLICATIONS

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project. Use of other, more costly yet less effective, erosion and sedimentation controls, may often be reduced through proper construction sequencing.

APPROACH

- Project design considerations: Design project to integrate into existing land contours. Significant regrading of a site will require more costly erosion and sedimentation control measures and may require that on-site drainage facilities be installed.
- Incorporate existing, natural areas: Inventory and evaluate the existing site terrain and vegetation. Disturbance of highly erosive natural areas (e.g., steep, unstable slope areas, watercourses) should be minimized, while protecting other areas may enhance site aesthetics. Construction should not disturb these areas (see ESC2).
- Avoid rainy periods: Schedule major grading operations during dry months. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means (see ESC10 to 24) or to install temporary sediment trapping devices (see ESC50 to 56).
- Practice erosion and sediment control year round: Erosion may be caused during dry seasons by "freak" rainfall, wind and vehicle tracking. Therefore, keep the site stabilized year-round, and retain wet season sediment trapping devices.
- Minimize soil exposed at one time: Schedule projects to disturb only small portions of the site at any one time. Complete grading as soon as possible. Immediately stabilize the disturbed portion before grading the next portion. Practice staged seeding—revegetate cut and fill slopes as the work progresses.
- Trenching: Close and stabilize open trenches as soon as possible. Sequence trenching projects so that most open portions of the trench are closed before new trenching is begun.

REQUIREMENTS

- Cost
  - Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost-effec tiveness of scheduling techniques should be compared with the other, less effective erosion and sedimentation controls to achieve a cost-effective balance.

Targeted Pollutants

- ○ *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC1

BEST MANAGEMENT PRACTICES

LIMITATIONS

There are no significant limitations to the use of this BMP.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona - 1992.

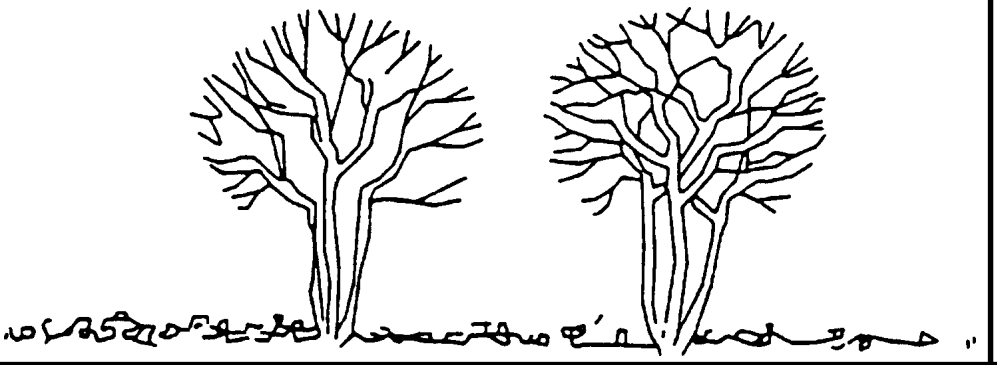
Erosion and Sediment Control Guidelines for Developing Areas in Texas, U.S. Department of Agriculture, Soil Conservation Service, Fort Worth, Texas - 1976.

Storm Water Management for Construction Activites. Developing Pollution Prevention Plans and Best Management Practices, U.S. Environmental Protection Agency, Office of Water (EPA 832-R-92-005) - September, 1992.

Virginia Erosion and Sediment Control Handbook, Third Edition, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation - 1992.

ESC1

BMP: PRESERVATION OF EXISTING VEGETATION



Objectives

- Housekeeping Practices
- Contain Waste
- **Minimize Disturbed Areas**
- **Stabilize Disturbed Areas**
- **Protect Slopes/Channels**
- **Control Site Perimeter**
- Control Internal Erosion

GENERAL DESCRIPTION

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs and/or grasses that serve as erosion controls.

SUITABLE APPLICATIONS

- Areas within site where no construction activity occurs, or occurs at a later date.
- Sensitive areas where natural vegetation exist and should be preserved, such as: steep slopes, watercourses, and building sites in wooded areas.
- Areas where local, state and federal government requires preservation, such as: wetlands, marshes, etc.

INSTALLATION/APPLICATION CRITERIA

- Clearly mark, flag or fence vegetation or areas where vegetation should be preserved.
- Prepare landscaping plans which include as much existing vegetation as possible and state proper care of this vegetation both during and after construction.
- Define and protect with berms, fencing, signs, etc., a setback area from vegetation to be preserved. Setback area size should be based on the location, species, size, age and potential impact of adjacent construction activities or permanent improvements.
- Proposed landscaping plans which do not include plant species that compete with the existing vegetation.
- Do not locate construction traffic routes, spoil piles, etc., where significant adverse impact on existing vegetation may occur.

REQUIREMENTS

- Maintenance
  - Inspection and maintenance requirements for protection of vegetation are low.
  - During construction the limits of grading or disturbance should be clearly marked at all times.
  - Irrigation or maintenance of native trees or vegetation should conform to specifications on the Landscape Plan.
- Cost
  - There is little cost associated with preserving existing vegetation if properly planned during the project design, and may yield aesthetic benefits which enhance property values.

LIMITATIONS

- Requires forward planning by the owner/developer, contractor and design staff.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactorily for the planned development.

Targeted Pollutants

- ● **Sediment**
- ○ **Nutrients**
- ○ **Toxic Materials**
- ○ **Oil & Grease**
- ○ **Floatable Materials**
- ○ **Other Construction Waste**

- ● **Likely to Have Significant Impact**
- ○ **Probable Low or Unknown Impact**

Implementation Requirements

- ○ **Capital Costs**
- ○ **O&M Costs**
- ○ **Maintenance**
- ○ **Training**
- ● **Suitability for Slopes >5%**

● **High** ○ **Low**

ESC2

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: PRESERVATION OF EXISTING VEGETATION

The best way to prevent excessive erosion is to not disturb the land. On a construction site, where extensive land disturbance is necessary, a reasonable BMP would be to not disturb land in sensitive areas of the site which need not be altered for the project to be viable (e.g., natural watercourses, steep slopes), and to design the site to incorporate particularly unique or desirable existing vegetation into the site landscaping plan. Clearly marking and leaving a buffer area around these unique areas will both help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping in naturally vegetated areas.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to insure the survival of desirable vegetation for shade, beautification, and erosion protection. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. Also, vegetation helps to keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

The following criteria may be used for deciding which vegetation will remain on the site:

- Aesthetic values: Consideration should be given to foliage, flowering habits, bark and crown characteristics (for trees).
- Freedom from disease and rot.
- Life span of trees: Short-lived trees need not be preserved.
- Environmental values: Habitat; screening; and buffers.
- Sudden exposure: Save vegetation which grows in direct sunlight and is able to withstand radiated beat from proposed buildings and pavement.
- Space needed: Sufficient space must be provided between the vegetation and any structures, electric and telephone lines, water and sewer lines, driveways and streets. Mark trees and shrubs with bright paint or ribbon so there is no doubt as to which trees and shrubs are to be left and protected from damage during construction.

Saving existing vegetation and mature trees on-site, beautifies the area and may save money by reducing new landscaping requirements. Mature trees also increase property values and satisfy consumer aesthetic needs.

Preserving and protecting existing vegetation can often result in more stable soil conditions during construction. Careful site planning and identification of plantings to preserve can provide erosion and sedimentation controls during construction, and contribute to the aesthetics of the development. Provisions to protect the tree and its root system during construction must be specified in the project plans, and an area must be provided where the soil stability may not be disturbed. No grading or construction storage within the tree drip line is allowed.

Installation/Application

Building sites may be planned to integrate existing vegetation and trees. Construction impacts must be considered. Trench width for pipe construction projects and the location of permanent structures, such as buildings, needs to be considered when preserving existing vegetation, including mature trees and their root system. Native vegetation should be preserved since it is able to adapt to the climate. The USDA National Resources Conservation Service (NRCS) should be contacted about existing vegetation. Mature trees are generally preferable to newly planted trees because of the greater soil stabilization provided by the extensive root system of a mature tree.

ESC2

ADDITIONAL INFORMATION: PRESERVATION OF EXISITING VEGETATION

Methods for protecting existing vegetation and trees:

- Stake off root system limits (drip line of tree). Some counties limit construction within 5 feet of the tree drip line.
- Fence off the area to be preserved or along the tree drip line.
- Flag or mark trees to remain in place.
- Tree wells and retaining walls (permanent) help preserve existing vegetation, but must be large enough to protect the root system (see below).
- Where grading under trees is necessary, excavation and fill should be limited to one foot within the drip lines.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

County of Sacramento Tree Preservation Ordinance - September 1981.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Water Quality Management Plan for the Lake Tahoe Region, Volume II Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC2

BMP: LOCATION OF POTENTIAL SOURCES OF SEDIMENT

Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Proper location of potential sources of sediment can reduce the generation of erosion and sediment from construction sites.

SUITABLE APPLICATIONS

Locating potential sources of sediment so that they minimize the discharge of pollutants should be considered on all projects. This is especially true where runoff goes either directly or indirectly to Class 1 or Class AA waters.

APPROACH

- *Sequence construction so that haul roads and stockpiles are buffered with planted areas prior to discharging offsite.*
- *Separate offsite runoff where possible, so that it flows through the construction site without going through bare ground.*
- *Locate stockpiles away from waterways or low spots.*
- *Maintain swales and natural drainage ways in vegetated condition.*
- *Save trees and other existing vegetation. Vegetation along the perimeter of the site provides an effective buffer against sediment leaving the construction site.*
- *Use naturally level area for parking during construction.*

REQUIREMENTS

- *Maintenance*
  - *Inspect regularly and after rain for damage.*
  - *Provide mulching, grassing other ground cover to reduce bare areas.*

LIMITATIONS

Prevention must be supplemented with mulching, planting and structural controls such as berms, silt fences, and silt basins.

Targeted Pollutants

- ● Sediment
- ◒ Nutrients
- ◒ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ◒ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC3

BEST MANAGEMENT PRACTICES

REFERENCES

Erosion and Sediment Control Guide for Hawaii, March 1981, USDA Soil Conservation Service.

Rules Relating to Soil Erosion Standards and Guidelines, April 1999, Department of Planning and Permitting, City and County of Honolulu.

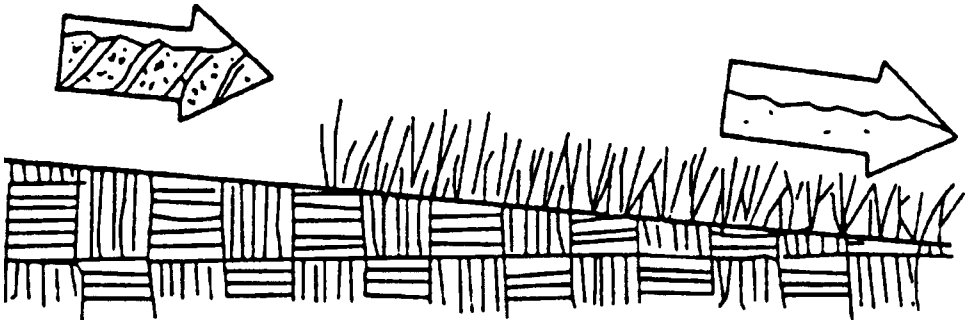
Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices, September 1992, U.S. Environmental Protection Agency.

California Storm Water Best Management Best Management Practice Handbooks, Construction Activity Best Management Practice Handbook, March 1993, Camp Dresser & McKee et. al. For the California Storm Water Quality Task Force.

Planning and Design Manual for the Control and Erosion, Sediment, and Stormwater, A Cooperative Effort by: USDA Natural Resources Conservation Service, Mississippi Department of Environmental Quality, and the Mississippi Soil & Water Conservation Commission.

ESC3

BMP: SEEDING AND PLANTING



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DESCRIPTION

Seeding of grasses and plantings of trees, shrubs, vines and ground covers provide longterm stabilization of soil. In some areas, with suitable climates, grasses can be planted for temporary stabilization.

SUITABLE APPLICATIONS

- Appropriate for site stabilization both during construction and post-construction.
- Any graded/cleared areas where construction activities have ceased.
- Open space cut and fill areas.
- Steep slopes.
- Spoil piles.
- Vegetated swales.
- Landscape corridors.
- Stream banks.

INSTALLATION/APPLICATION CRITERIA

Type of vegetation, site and seedbed preparation, planting time, fertilization and water requirements should be considered for each application.

Grasses:

- Ground preparation: fertilize and mechanically stabilize the soil.
- Tolerant of short-term temperature extremes and waterlogged soil conditions.
- Appropriate soil conditions: shallow soil base, good drainage, slope 2:1 or flatter.
- Develop well and quickly from seeds.
- Mowing, irrigating, and fertilizing are vital for promoting vigorous grass, growth.

Trees and Shrubs:

- Selection Criteria: vigor, species, size, shape & wildlife food source.
- Soil conditions: select species appropriate for soil, drainage & acidity.
- Other Factors: wind/exposure, and irrigation needs.

Vines and Ground Covers:

- Ground preparation: lime and fertilizer preparation.
- Use proper seeding rates.
- Appropriate soil conditions: drainage, acidity, slopes.
- Generally avoid species requiring irrigation.

Targeted Pollutants

- ● *Sediment*
- ◒ *Nutrients*
- ◒ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ◒ *Training*
- ◒ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC10

BEST MANAGEMENT PRACTICES

BMP: PLANTING AND SEEDING (Continue)

REQUIREMENTS

- Maintenance
  - Shrubs and trees must be adequately watered and fertilized and if needed pruned.
  - Grasses may need to be watered and mowed.
- Cost: Average annual cost for installation and maintenance (2- year useful life, source: EPA, 1992)
  - Seeding: $300 per acre, appropriate for flat slopes and stable soils.
  - Seeding with Mulching: $1,100 per acre, appropriate for moderate to steep slopes and/or erosive soils.
  - Trees, shrubs, vines, and ground cover: Cost, applicability based on species used and terrain features.

LIMITATIONS

- Permanent and temporary vegetation may not be appropriate in dry periods without irrigation.
- Fertilizer requirements may have potential to create storm water pollution if improperly applied.

ESC10

ADDITIONAL INFORMATION: SEEDING AND PLANTING

Permanent seeding of grasses, sodding, and planting of trees, shrubs, vines and ground covers can provide long-term stabilization of soil. Permanent seeding and planting contributes to long-term site aesthetics and helps reduce erosion by reducing the velocity of runoff, allowing infiltration to occur, filtering sediments, and by holding soil particles in place.

Seeding and planting should be applied as soon as final grading is done to all graded and cleared areas of the construction site where plant cover is ultimately desired. For example, vegetation may be established along landscaped corridors and buffer zones where they may act as filter strips (see TC6 in Chapter 5 of the *California* Municipal *BMP* Handbook). Additionally, vegetated swales, steep *and/or* arid/or rocky slopes and stream banks can also serve as appropriate areas for seeding and plantings.

Installation/Application Criteria

Application of appropriate vegetation must consider: the seedbed or plantbed, proper seasonal planting times, water requirements fertilizer requirements and availability of the selected vegetation within the project's region. Permanent plantings during the construction stage of projects require careful coordination between the local agency inspectors, project managers, construction managers, and landscape contractor. Protocols for coordination and implementation procedures regarding site access, construction staging, and short- and long-term planting areas should be developed prior to the construction bid process. Where possible, these protocols should be established by and remain the responsibility of the site owner.

Because of the many available types of plants and ground covers and because site conditions and land use vary so widely, a set of general guidelines is included for installation/application of grasses, trees and shrubs, vines and ground covers. However, the National Resources Conservation Service (NRCS), agricultural extension or other resources should be consulted on appropriate species, planting requirements, and maintenance needs for your climate and soils.

Grasses

Grasses, depending on the type, provide short-term soil stabilization during construction or can serve as long- term/ permanent soil stabilization for disturbed areas. In general, grasses provide low maintenance to areas that have been cleared, graded and mechanically stabilized.

Selection:

The selection of the grass type is determined by the climate, irrigation, mowing frequency, maintenance effort and soilbed conditions. Although grasses provide quick germination and rapid growth, they also have a shallow root system and are not as effective in stabilizing deep soils, where trees, shrubs and deep rooted ground covers may be more appropriate. Specific seed mix and/or varieties for each site should be provided by an approved/qualified plant materials specialist.

ESC10

ADDITIONAL INFORMATION: SEEDING AND PLANTING

Planting:
The following steps should be followed to ensure established growth:

1. Select the proper grass for the site.
2. Prepare the seedbed; soil should be fertilized and contain good topsoil or soil at least a 2:1 or flatter slope.
3. Initial irrigation will be required often for most grasses, with follow-up irrigation and fertilization as needed. Mulching may be required in dry climates or during drought years.

Trees & Shrubs

Selection:
Trees and shrubs, when properly selected, are low maintenance plantings that stabilize adjacent soils, moderate the adjacent temperatures, filter air pollutants, and serve as a barrier to wind. Some desirable characteristics to consider in selecting trees and shrubs include: vigor, species, age, size and shape, and use as a wildlife food source and habitat.

Trees and shrubs to be saved should be clearly marked so that no construction activity will take place within the dripline of the plant. The sites for new plantings should be evaluated. Consider the prior use of the land: adverse soil conditions such as poor drainage or acidity; exposure to wind; temperature extremes; location of utilities, paved areas, and security lighting and traffic problems.

Transplanting:
Preparation - Proper digging of a tree/shrub includes the conservation of as much of the root system as possible. Soil adhering to the roots should be damp when the tree is dug, and kept moist until re-planting. The soil ball should be 12 inches in diameter for each inch of diameter of the trunk.

Site preparation - Refer to landscape plans and specifications for site and soil preparation, and for ability to coordinate construction strategy with permanent vegetation.

Supporting the trunk - Many newly planted trees/shrubs need artificial support to prevent excessive swaying.

Watering - Soil around the tree should be thoroughly watered after the tree is set in place. When the soil becomes dry, the tree should be watered deeply, but not often. Mulching around the base of the tree is helpful in preventing roots from drying out.

Vines & Ground Covers

Selection:
Vines, ground covers, and low growing plants, that can quickly spread, come in many types, colors, and growth habits. Some are suitable only as part of a small maintained landscape area, while some can stabilize large areas with little maintenance. Flowers, which provide little long-term erosion control may be planted to add color and varietal appearances.

ESC10

ADDITIONAL INFORMATION: SEEDING AND PLANTING

Caution should be exercised in the non-native vegetation because of impacts to native vegetation on adjacent lands. For example, species that may be planted at the construction site can quickly spread and compete with originally undisturbed vegetation. In addition to stabilizing disturbed soil, vines and ground covers can perform the following functions:

1. Provide attractive cover that does not need mowing.
2. Help to define traffic areas and control pedestrian movement.

Site Preparation:
Ground covers are plants that naturally grow very close together, causing severe competition for space nutrients and water. Sod for ground covers should be well prepared. The entire area should be spaded, disced, or rototilled to a depth of six to eight inches. Two to three inches of organic material, such as good topsoil or peat, should be spread over the entire area.

Planting:
The following steps will help ensure good plant growth.

1. Make the plantings following the contours of the land.
2. Dig the holes 1/3 larger than the plant root ball.
3. Know what depth to place the plants.
4. Use good topsoil or soil mixture with a lot of organic matter.
5. Fill hole 1/3 to 1/2 full, shake plants to settle soil among roots, then water.
6. Leave saucer-shaped depression around the plant to hold water.
7. Water thoroughly and regularly.
8. Space plants according to the type of plant and the extent of covering desired.

Materials:
There are many different species of vines and ground covers from which to choose, but care must be taken in their selection. It is essential to select planting materials suited to both the intended use and specific site characteristics. Additional information can be obtained from local nurserymen, landscape architects, and extension agents. An approved low water use plant list may be obtained from the *Board of Water Supply (BWS)*, or Natural Resources Conservation Service.

Requirements
Maintenance

General requirements include:
- Grass maintenance should be minimal to none. Irrigation and regular fertilizing may be required for some types of grasses. Mowing is only required in areas where aesthetics or fire hazards are a concern.
- Young trees should receive an inch of water each week for the first two years after planting. The tree should be watered deeply, but not more often than once per week
- Transplanted trees, should be fertilized on an annual basis.
- Proper pruning, watering, and application of fertilizer is necessary to maintain healthy and vigorous shrubs. A heavy layer of mulch applied around the shrubs reduces weeds and retains moisture.
- Trim old growth as needed to improve the appearance of ground covers. Most covers need once-trimming to promote growth.

ESC10

Limitations

- Construction activities are likely to injure or kill trees unless adequate protective measures are taken. Direct contact by equipment is the most obvious problem, but damage is also caused by root stress from filling, excavation, or compacting too close to trees.
- Temporary seeding can only be viable when adequate time is available for plants to grow and establish.
- Over fertilizing of plants may cause pollution of storm water runoff.
- Irrigation source and supply may be limiting.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, September 1992.

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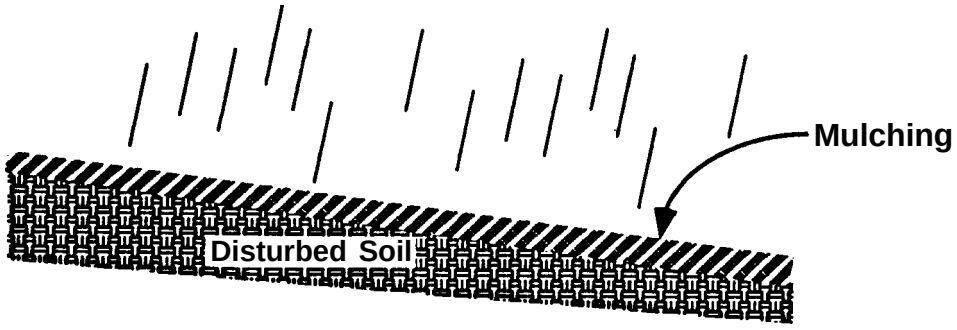
ESC10

BMP: MULCHING



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DESCRIPTION

Mulching is used to temporarily and permanently stabilize cleared or freshly seeded areas. Types of mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite, and gravel.

SUITABLE APPLICATIONS

- Temporary stabilization of freshly seeded and planted areas.
- Temporary stabilization during periods unsuitable for growing vegetation.
- Temporary stabilization of areas that cannot be seeded or planted (e.g., insufficient rain, steep slope).

INSTALLATION/APPLICATION CRITERIA

Mulch prevents erosion by protecting the soil surface and fostering growth of new seedings that do not stabilize by themselves.

- May be used with netting to supplement soil stabilization.
- Apply to planting areas where slopes are 2:1 or greater.
- Binders may be required for steep areas, or if wind and runoff is a problem.
- Type of mulch, binders, and application rates should be recommended by manufacturer/contractor.

REQUIREMENTS

- Maintenance
  - Must be inspected weekly and after rain for damage or deterioration.
- Cost: Average annual cost for installation and maintenance (3-4 month useful life, source: EPA, 1992)
  - Straw Mulch: $7,500 per acre.
  - Wood Fiber Mulch: $3,500 per acre.
  - JuteNetting: $12,500 per acre.

LIMITATIONS

- Organic mulches are not permanent erosion control measures.
- Mulches tend to lower the soil surface temperature, and may delay germination of some seeds.

Targeted Pollutants

- ● *Sediment*
- ◒ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ● *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC11

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: MULCHING

Mulching protects the soil from rainfall impact; increases infiltration; conserves moisture around trees, shrubs and seedings; prevents compaction and cracking of soil; and aids plant growth for seedings and plantings by holding the seeds, fertilizers and topsoil in place until growth occurs. Mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite and gravel. A variety of nettings or mats of organic or non-organic materials and chemical sod stabilization are practices that may be used conjunctively with mulching.

Mulching may be applied to all graded and cleared areas of the construction site:

- Areas which have been permanently seeded to assist in retaining moisture, and to hold seedings;
- Areas which need temporary soil surface protection because seeding cannot occur due to the season;
- Areas between trees, shrubs and certain ground covers;
- Areas where climatic conditions require a soil moisture retention aid to avoid cracking of the soil and associated compaction, and require soil temperature modification.

Installation/Application Criteria

Only a set of general guidelines is included for application and installation of mulching on disturbed lands because of the various climates, soil conditions and land uses in California. Installation of mulch consists of furnishing all materials, preparing the soil surface and applying the mulch to all soil surface areas designated on the project plans or established by the site engineer.

Materials

Organic mulch materials, such as straw, wood chips, bark and wood fiber, have been found to be most effective where re-vegetation will be provided by reseeding. The choice of mulch should be based on the size of the area, site slopes, surface conditions such as hardness and moisture; weed growth and availability of mulch materials.

Wood Fiber Mulches: Wood fiber mulches consist of specially prepared wood fiber processed to contain no growth germination inhibiting factors. The mulch should be from virgin wood, and be manufactured and processed so the fibers will remain in uniform suspension in water under agitation to form a homogenous slurry. The fiber lengths should be as long as possible to increase the effectiveness for erosion control. Wood fiber mulching should not be used in areas of extremely hot summer and late fan seasons because of fire danger. When used as a tackifier with straw mulch, wood fiber mulches are good for steep slopes and severe climates. The California Office of the Natural Resources Conservation Service (NRCS) recommends a non-toxic mulch green dye be used to provide a visual aid in metering applications.

Wood Chips and Bark Chips: Wood and bark chips are suitable for application in landscaped areas that will not be closely mowed. Wood chips do not require tacking, but do require nitrogen treatment (12 pounds/ton) to prevent nutrient deficiency. Bark chips do not require additional nitrogen fertilizer. When the wood source is near the project site, wood and bark chips can be very inexpensive. Caution must be used in areas of steep slopes, since both wood and bark chips tend to wash down slopes exceeding 6 percent.

Straw Mulch: Straw mulch is a good short-term protection most commonly used with seeding. The mulch should be from the current season's crop. A letter of certification from the supplier should be required to show that the straw was baled less than 12 months from the delivery date. Wheat or oat straw is recommended.

Emulsified Asphalt: Asphalt is used to adhere the mulch to the ground surface, preventing the mulch from blowing or washing off. The type and quantity of asphalt used should not result in a storm water pollution problem.

Binder: Binder should be free flowing, noncorrosive powder produced from natural plant gum such as those marketed under M-Binder, M145 Binder, or AZ-TAC. Synthetic, spray-on materials are not recommended since they tend to create an impervious surface, and may enter the stormwater sewer system via discharge runoff.

ESC11

ADDITIONAL INFORMATION: MULCHING

Preparations/Methods and Equipment

Straw Mulch: Should be applied in an even, uniform manner, either by hand or by mulch blowing equipment. Straw mulches must be anchored to prevent the mulch from being blown or washed off the site. Anchoring is achieved in two ways:

- Crimping: The mulch is anchored by running a heavy disc with flat, dull, serrated, closely-spaced blades over the mulched soil. Effective crimping embeds the mulch about 2 inches into the soil without completely covering it. The disc should be run once or twice across the soil. About 2 1/2 tons of straw mulch per acre should be applied if the mulch is anchored by crimping.
- Tacking: Achieved using a emulsified asphalt or binder either independently or followed by crimping. If tacked, straw mulch may be applied at a rate of 13/4 ton per acre, and tacked with emulsified asphalt at a rate of 500 gallons per acre.

Wood Fiber Mulch: Typically applied with a hydroseeder at a rate of about 1000 to 1500 pounds per acre, or as a slurry consisting of at least 150 pounds of binder, 400 pounds of wood fiber mulch, and 200 gallons of water per acre.

Requirements

Maintenance: Mulched areas require frequent inspection for damage and deterioration. Requirements will vary greatly based on the type of mulch used and the type of vegetation to be established. Vegetative mulches are usually not intended to be permanent; but are extended only as a base for re-seeding or re-vegetation. Where a permanent anchor for vegetation is required, along steep slopes or areas of higher velocity flows, then a geotextile mat or net is recommended (see ESC20).

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Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, September 1992.

Controlling Erosion of Construction Sites, U.S. Department of Agriculture, Soil Conservation Service, Agriculture Information # 347.

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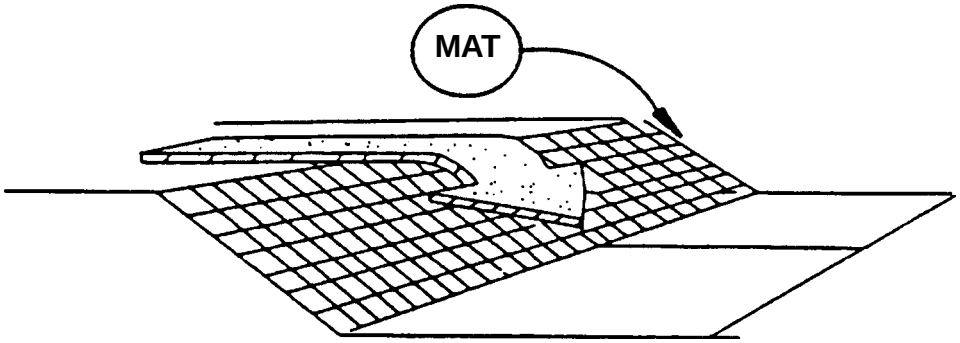
ESC11

BMP: GEOTEXTILES AND MATS



GENERAL DESCRIPTION
Mattings made of natural or synthetic material which are used to temporarily or permanently stabilize soil.

SUITABLE APPLICATIONS
Typically suited for post-construction site stabilization, but may be used for temporary stabilization of highly erosive soils.
- Channels and streams.
- Steep slopes.

INSTALLATION/APPLICATION CRITERIA
Mattings may be applied to disturbed soils and where existing vegetation has been removed. The following organic matting materials provide temporary protection until permanent vegetation is established, or when seasonal circumstances dictate the need for temporary stabilization until weather or construction delays are resolved.
- Jute mattings.
- Straw mattings.

The following synthetic mattings may be used for either temporary or post-construction stabilization, both with and without vegetation
- Excelsior matting.
- Glass fiber matting.
- Staples.
- Mulch nettings.

REQUIREMENTS
- Maintenance
  - Inspect monthly and after significant rainfall.
  - Re-anchor loosened matting and replace missing matting and staples as required.
- Cost
  - Relatively high compared to other BMPs.

LIMITATIONS
- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs arc ineffective (e.g., channels, steep slopes).
- May delay seed germination, due to reduction in soil temperature.
- Installation requires experienced contractor to ensure soil stabilization and erosion protection.

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
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- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ● *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ● *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC20

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: GEOTEXTILES AND MATS

Mattings are used to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, mattings may be used to stabilize soils until vegetation is established. This practice may be used alone or with a mulch during the establishment of protective cover on critical slopes (see ESC11, Mulching).

Suitable applications

Mattings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks where moving water at velocities between 3 fps and 6 fps is likely to wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. Matting may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). Erosion control matting should be considered when the soils are fine grained and potentially erosive.

The following natural or synthetic mattings are commonly used:

Jute Mat - should be cloth of a uniform plain weave of undyed and unbleached single jute yarn, 48" in width, and weighing an average of 1.2 pounds per linear yard of cloth with a tolerance of plus or minus five (5) percent, with approximately 78 warp ends per width of cloth and 41 weft ends per linear yard of cloth. The yarn should be of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than its normal diameter.

Straw Mat - should be a machine produced mat consisting of 70% (±3%) agricultural straw and 30% (±3%) coconut fiber. The blanket should be of consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat. The blanket should be covered on the top side with polypropylene netting having an approximate 5/8" x 5/8" mesh containing ultraviolet additives to resist breakdown, and on the bottom with a polypropylene netting with an approximate " x " mesh. The blanket should be sewn together with cotton thread.

Excelsior Mat - should be wood excelsior, 48 inches in width plus or minus one inch and weighing 0.8 pound per square yard plus or minus ten percent. The excelsior material should be covered with a netting to facilitate handling and to increase strength.

Glass Fiber Matting - should be of bonded textile glass fibers with an average fiber diameter of eight to twelve microns, two to four inch strands of fiber bonded with phenol formaldehyde resin. Mat should be roll type, water permeable, minimum thickness inch, maximum thickness inch, density not less than three pounds per cubic foot.

Staples for anchoring soil stabilizing materials should be Number 11 gauge wire or heavier. Their length should be six to ten inches, with longer staples used in loose, unstable soils.

Other Mulch Netting - such as paper, plastic, cotton or fiber glass matting should be installed according to the manufacturer's recommendations.

Installation/Application Criteria

Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness and moisture; weed growth and availability of materials. Matting strengths and uses vary, therefore, manufacturer's specifications must be followed. Proper installation of mattings is critical in order to obtain firm continuous contact with the soil.

ESC20

ADDITIONAL INFORMATION: GEOTEXTILES AND MATS

Site Preparation: After the site has been shaped and graded to the approved design, prepare a friable seed bed relatively free from clods and rocks more than 1 inch in diameter and any foreign material that will prevent contact of the protective mat with the soil surface.

Planting: Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Erosion Stops: Erosion stops are made of glass fiber strips, excelsior matting strips or tight-folded jute matting blanket or strips for use on steep, highly erodible watercourses. The stops are placed in narrow trenches six to twelve inches deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Laying and Securing Matting: Before laying the matting, all erosion stops should be installed and the friable seed bed made free from clods, rocks, and roots. The surface upon which the separation fabric will be placed should be compacted and finished according to the requirements of the manufacturer's recommendations.

Most matting comes with the manufacturer's recommendations for installation. Most channels will require multiple widths of matting, and the matting should be unrolled starting at the upper end of the channel, allowing a four inch overlap of mattings along the center of the channel. To secure, bury the top ends of the matting in a narrow trench, a minimum of six inches deep. Backfill trench and tamp firmly to conform to channel cross section. Secure with a row of staples about four inches down slope from the trench with staples twelve inches apart.

Where matting crosses erosion stops, reinforce with a double row of staples at six inch spacing, using a staggered pattern on either side of the erosion stop. When the matting is overlapped, the discharge end of the matting liner should be similarly secured with a double row of staples.

Mechanical or manual laydown equipment should be capable of handling full rolls of fabric and laying the fabric smoothly, without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Final Check: Check the following after the matting is installed:

- Make sure matting is uniformly in contact with the soil.
- All lap joints are secure.
- All staples are flush with the ground.
- All disturbed areas seeded.

Limitations

Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.

Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs, otherwise the material will not stabilize the soil and erosion will occur beneath the material. Ultraviolet protection may be required on some geotextiles. Matting strengths and uses vary; the manufacturer's specifications should be followed.

ESC20

ADDITIONAL INFORMATION: GEOTEXTILES AND MATS

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, September 1992.

Guides for Erosion and Sediment Controls in California, USDA Soils Conservation Service - January 1991.

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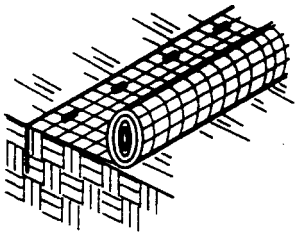
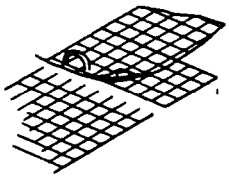
ESC20

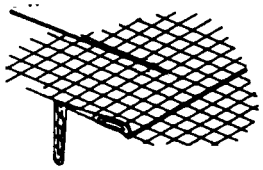
ADDITIONAL INFORMATION: GEOTEXTILES AND MATS



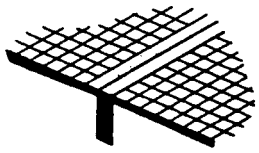
ANCHOR SLOT: BURY THE UP-CHANNEL END OF THE NET IN A 12" DEEP TRENCH. TAMP THE SOIL FIRMLY. STAPLE AT 12" INTERVALS ACROSS THE NET.



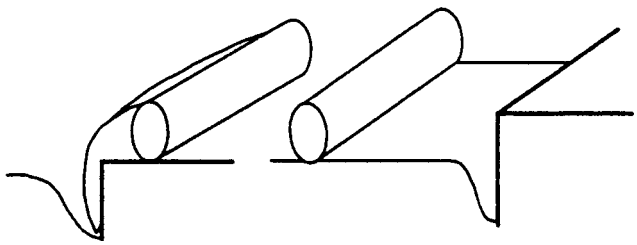
OVERLAP: OVERLAP EDGES OF THE STRIPS AT LEAST 4". STAPLE EVERY 12" DOWN THE CENTER OF THE STRIP.



JOINING STRIPS: INSERT THE NEW ROLL OR NET IN A TRENCH, AS WITH THE ANCHOR SLOT. OVERLAP THE UP-CHANNEL END OF THE PREVIOUS ROLL 18" AND TURN THE END OF THE PREVIOUS ROLL JUST BELOW THE ANCHOR SLOT LEAVING A 6" OVERLAP.



CHECK SLOTS: ON ERODIBLE SOILS OR STEEP SLOPES, CHECK SLOTS SHOULD BE MADE EVERY 15 FEET. INSERT A FOLD OF THE NET INTO A 6" TRENCH AND TAMP FIRMLY. STAPLE AT 12" INTERVALS ACROSS THE NET. LAY THE NET SMOOTHLY ON THE SURFACE OF THE SOIL - DO NOT STRETCH THE NET, AND DO NOT ALLOW WRINKLES.



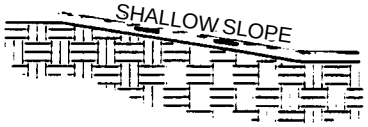
ANCHORING ENDS AT STRUCTURES: PLACE THE END OF THE NET IN A 12" SLOT ON THE UP-CHANNEL SIDE OF THE STRUCTURE. FILL THE TRENCH AND TAMP FIRMLY. ROLL THE NET UP THE CHANNEL. PLACE STAPLES AT 12" INTERVALS ALONG THE ANCHOR END OF THE NET.

INSTALLATION OF NETTING AND MATTING

ESC20

ADDITIONAL INFORMATION: GEOTEXTILES AND MATS

ON SHALLOW SLOPES, STRIPS OF NETTING MAY BE APPLIED ACROSS THE SLOPE.



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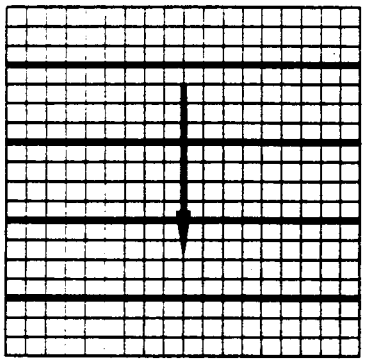
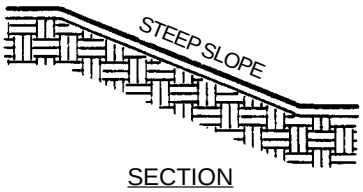


(SHALLOW SLOPE)
PLAN

ON STEEP SLOPES, APPLY STRIPS OF NETTING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURLY.



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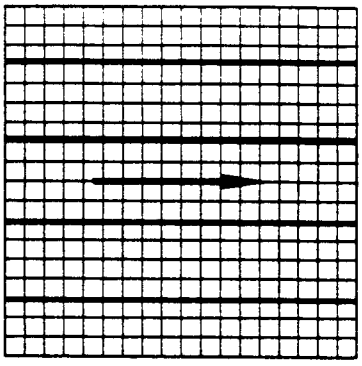
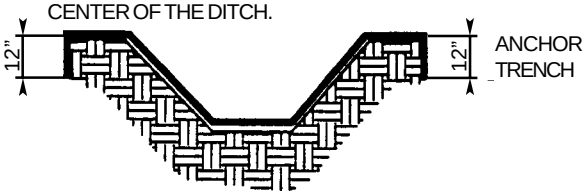


(STEEP SLOPE)
PLAN

IN DITCHES, APPLY NETTING PARALLEL TO THE DIRECTION OF FLOW. USE CHECK SLOTS EVERY 15 FEET. DO NOT JOIN STRIPS IN THE CENTER OF THE DITCH.



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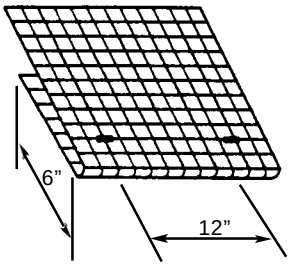
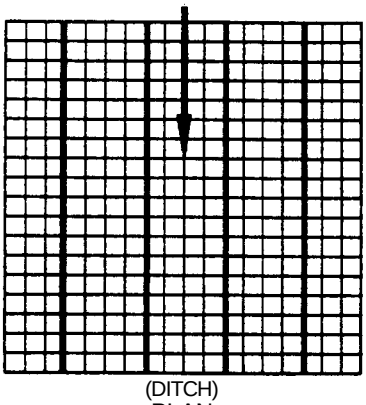


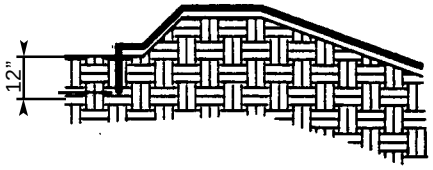
FLOW



(DITCH)
PLAN

BRING NETTING DOWN TO A LEVEL BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 6" AND STAPLE AT 12" INTERVALS.

BERM

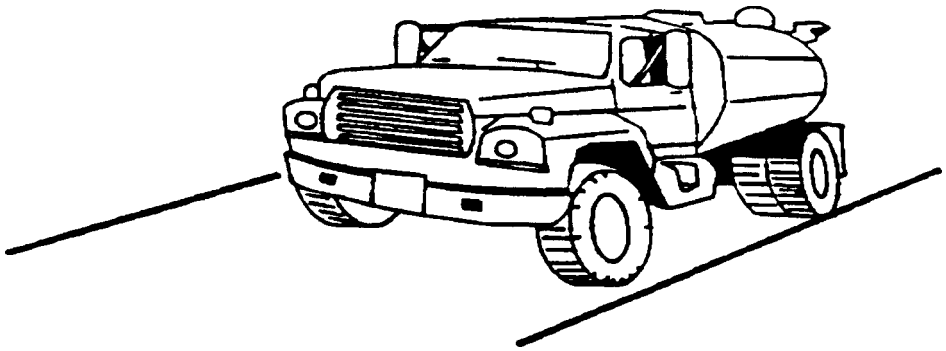


WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE MATTING OVER THE BERM WITH A 12" ANCHOR TRENCH.

ORIENTATION OF NETTING AND MATTING

ESC20

BMP: DUST CONTROLS



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Dust control measures are used to stabilize soil from wind erosion, and reduce dust generated by construction activities.

SUITABLE APPLICATIONS

- Clearing and grading activities.
- Construction vehicle traffic on unpaved roads.
- Drilling and blasting activities.
- Sediment tracking onto paved roads.
- Soil and debris storage piles.
- Batch drop from front end loaders.
- Areas with unstabilized soil.
- Final grading/site stabilization usually is sufficient to control post-construction dust sources.

INSTALLATION/APPLICATION CRITERIA

- Schedule construction activities to minimize exposed area (See ESC1).
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering (See ESC10 and 11).
- Identify and stabilize key access points prior to commencement of construction (See ESC24).
- Minimizing the impact of dust by anticipating the direction of prevailing winds.
- Direct most construction traffic to stabilized roadways within the project site (See ESC23).
- *Comply with the State DOH requirements for dust control.*

REQUIREMENTS

- Maintenance
  - Most dust control measures require frequent, often daily, attention.
- Cost
  - Installation costs for water/chemical dust suppression are low, but annual costs may be quite high since these measures are effective for only a few hours to a few days.

LIMITATIONS

- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective.
- Overwatering may cause erosion.
- Oil should not be used for dust control because the oil may migrate into drainageway and/or seep into the soil.
- Certain chemically-treated subgrades may make soil water repellant, increasing runoff.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ○ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

ESC21

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: DUST CONTROLS

Dust Control Practices

Dust control BMP's generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. Table ESC21.1 shows which Dust Control BMPs apply to site conditions which cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel or asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching and sand fences can be employed for areas of occasional or no construction traffic. Preventive measures would include minimizing surface areas to be disturbed, limiting on-site vehicle traffic to 15 miles per hour, and controlling the number and activity of vehicles on a site at any given time.

Many of the reasonably available control measures for controlling dust from construction sites can also be implemented as BMPs for storm water pollution prevention. Those BMPs include:

- Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for wet suppression or chemical stabilization of exposed soils.
- Provide for rapid clean-up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas.
- Stabilize unpaved haul roads, parking and staging areas. Reduce speed and trips on unpaved roads.
- Implement dust control measures for material stockpiles.
- Prevent drainage of sediment laden storm water onto paved surfaces.
- Stabilize abandoned construction sites using vegetation or chemical stabilization methods.
- Limit the amount of areas disturbed by clearing and earth moving operations by scheduling these activities in phases.

For the chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stock-piles. The types of chemicals available and recommendations for their use are tabulated in Table ESC21.2, Commonly Used Chemicals for Dust Control.

ESC21

ADDITIONAL INFORMATION: DUST CONTROLS

In addition, there are many other BMPs identified in this handbook that provide dust control including:

- Seeding and Plantings (ESC10)
- Mulching (ESC11)
- Construction Road Stabilization (ESC23)
- Stabilized Construction Entrances (ESC24)

Limitations

- Oil treated subgrades should not be used because the oil may migrate into drainageways and/or seep into the soil.
- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration, and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- Asphalt, as a mulch tack or chemical mulch, requires a 24 hour curing time to avoid adherence to equipment, worker shoes, etc. Application should be limited because asphalt surfacing may eventually migrate into the drainage system.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

California Air Pollution Control Laws, California Air Resources Board. 1992.

CalTrans, Standard Specifications, Sections 10, “Dust Control Section 17, “Watering”; and Section 18, “Dust Palliative”.

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Sacramento County, Winterization Ordinance & Dust Control Ordinance (example).

USDA Soil Conservation Service, “Guides for Erosion and Sediment Control”.

ESC21

TABLE ESC 21.1 DUST CONTROL BMPs FOR GIVEN SITE CONDITIONS

SITE CONDITION	DUST CONTROL BMPS								
	Permanent Vegetation	**Mulching**	**Wet Suppression (Watering)**	**Chemical Dust Suppression**	**Gravel or Asphalt Surfacing**	**Sand Fences**	**Temporary Gravel Construction Entrances/Equipment Wash Down**	**Haul Truck Covers**	**Minimize Extent of Area Disturbed**
Disturbed Areas not Subject to Traffic	U	U	U	U	U				U
Disturbed Areas Subject to Traffic			U	U	U				U
Material Stock Pile Stabilization			U	U		U			U
Demolition			U				U	U	
Clearing/Excavation			U	U					U
Truck Traffic on Unpaved Roads			U	U	U				
Mud/Dirt Carry-Out					U		U		

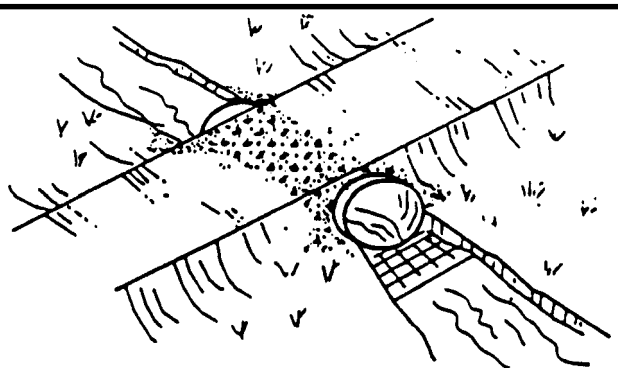
TABLE ESC 21.2 COMMONLY USED CHEMICALS FOR DUST CONTROL

	SALTS	ORGANIC, NON PETROLEUM BASED	PETROLEUM BASED PRODUCTS[1]
CHEMICAL TYPES	C Calcium Chloride[2] C Magnesium Chloride C Natural Brines	C Calcium Lignosulfonate C Sodium Lignosulfonate C Ammonium Lignosulfonate	C Bunker Oil C Asphalt Primer C Emusified Asphalt
LIMITATIONS	Can lose effectiveness in dry periods with low humidity. Leaches from road in heavy rain. Not recommended for gravel road surfaces with low fines. Recommended 10-20% fines.	Not affected by dry weather and low humidity. Leached from road in heavy rain if not sufficiently cured Best performance on gravel roads with high surface fines (10-30%) and dense compact surface with loose gravel.	Generally effective regardless of climatic conditions; may pothole in wet weather. Best performance on gravel roads with 5-10% fines.
COMMENTS	Calcium Chloride is popular. May become slippery when wet on gravel surfaces with high fines.	Ineffective on gravel surfaces low in fines. May become slippery when wet on gravel surfaces with high fines content.	Creates a hardened crust.

[1] Motor oils and oil treatments are not recommended due to adverse effects on plant life and groundwater.

[2] Not Recommended due to adverse effects on plant life.

BMP: TEMPORARY STREAM CROSSING



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

A temporary access stream crossing is a temporary culvert, ford or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to be used to maintain traffic for the general public.

SUITABLE APPLICATIONS

Temporary stream crossings should be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels which may be significantly eroded by construction traffic.

INSTALLATION/APPLICATION CRITERIA

Requires knowledge of stream flows and soil strength and should be designed under the direction of a *Hawaii* registered engineer with knowledge of both hydraulics and construction loading requirements for structures.

REQUIREMENTS

• Maintenance
  - Inspect weekly and after each significant rainfall, including assessment of foundations.
  - Periodically remove silt from crossings.
  - Replace lost aggregate from inlets and outlets of culverts.

LIMITATIONS

- May be an expensive for a temporary improvement.
- Requires other BMPs to minimize soil disturbance during installation and removal.
- Fords should only be used in dry weather.
- *Liability for damage resulting from the culvert is with the design engineer/contractor. It should be designed so it will not create flooding problems.*

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

ESC22

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: TEMPORARY STREAM CROSSING

A temporary access stream crossing is a culvert, ford, or bridge placed across a waterway to provide access for construction for a period of less than one year. Temporary access crossings are not intended to be used for general public traffic.

The purpose of this BMP is to provide a safe, erosion-free access across a stream for construction equipment. Minimum standards and specifications for the design, construction, maintenance, and removal of the structure should be established by an engineer registered in *Hawaii*. Temporary stream crossings may be necessary to prevent construction equipment from causing erosion of the stream and tracking sediment and other pollutants into the stream.

Temporary stream crossings are used as access points to construction sites when other detour routes may be too long or burdensome for the construction equipment. Often heavy construction equipment must cross streams or creeks, and detour routes may impose too many constraints such as being too narrow or poor soil strength for the equipment loadings. Additionally, the contractor may find a temporary stream crossing more economical for light-duty vehicles to use for frequent crossings, and may have less environmental impact than construction of a temporary access road.

Installation/Application

Temporary access stream crossings should be sized and installed according to the drainage design criteria of the local municipality. Design criteria should be based on standard engineering practices for culvert design with provisions for minimizing impacts on disturbed crossing areas. Three types of temporary access stream crossings may be considered:

Temporary Access Culvert: A temporary access culvert is effective in controlling erosion but will cause erosion during installation and removal. A temporary culvert can be easily constructed and allows for heavy equipment loads.

Temporary Access Ford: A temporary access ford provides little sediment and erosion control and is ineffective in controlling erosion in the stream channel. A temporary ford is the least expensive stream crossing and allows for maximum load limits. It also offers very low maintenance. Fords are more appropriate during the dry season and in arid areas.

Temporary Access Bridge: With the appropriate materials and designs, a temporary access bridge causes the least erosion of the stream channel crossing during its installation and removal.

During the summer, rainfall is infrequent and many streams are dry. Under these conditions, a temporary access ford may be sufficient. A ford is not appropriate if construction will continue through the winter rainy season, if summer thunderstorms are likely, or if the stream flows during most of the year. Temporary access culverts and bridges should then be considered and, if used, should be sized to pass a significant design storm (i.e., at least a 10-year storm). The temporary stream crossing should be protected against erosion, both to prevent excessive sedimentation in the stream and to prevent washout of the crossing (and, consequently, costly construction delays).

Limitations

Special care must be taken when crossing an environmentally sensitive waterway. Oils or other potentially hazardous materials shall not be used for surface treatments. Street runoff should not be allowed to spill down crossing sideslopes. Construction in watercourses should be at or near the natural elevation of the stream bed to prevent any potential flooding upstream of the crossing. In addition, the following limitations may apply:

ESC22

- May be expensive temporary cost
- Increased soil disturbance upon installation and removal
- Temporary culverts need regular maintenance and can cause erosion if the culvert becomes clogged.
- A temporary ford offers little if any erosion control in flowing streams and can often make erosion worse. Fords should only be used in the dry season on dry streams.

Construction in waterways is subject to additional permit requirements. Contact the *US Army Corps of Engineers and State Department of Land and Natural Resources* for additional information.

REFERENCES

Bank and Shore Protection, CalTrans - November 1970.

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September, 1992.

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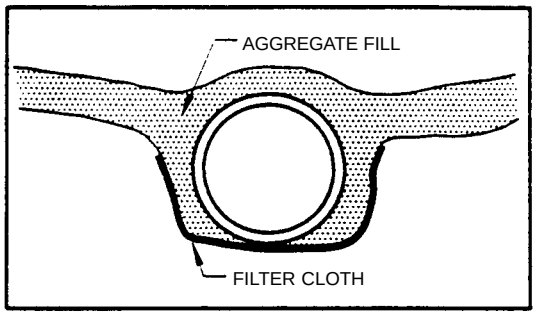
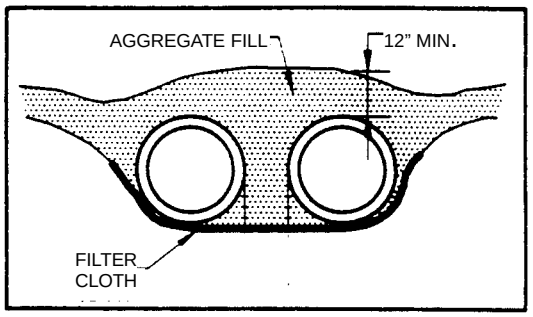
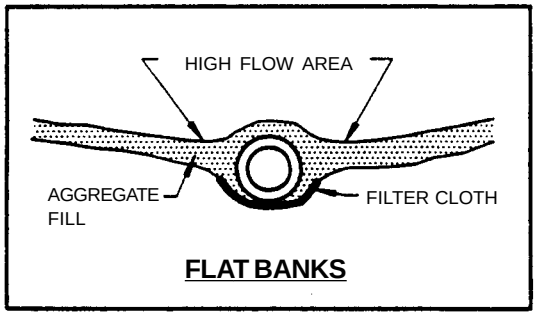
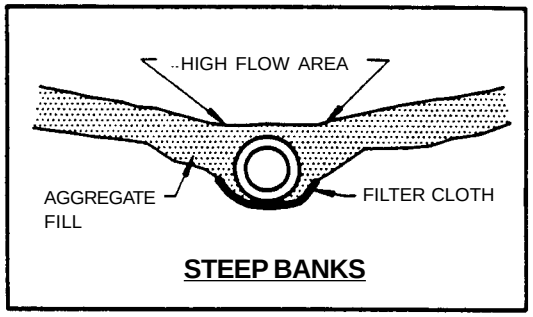


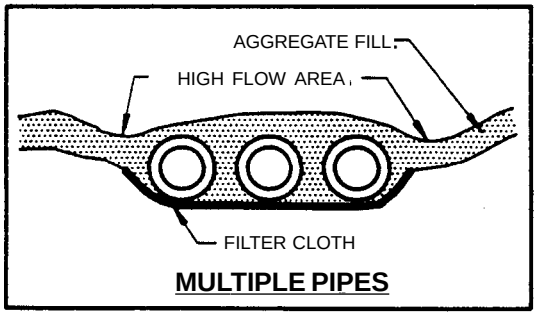




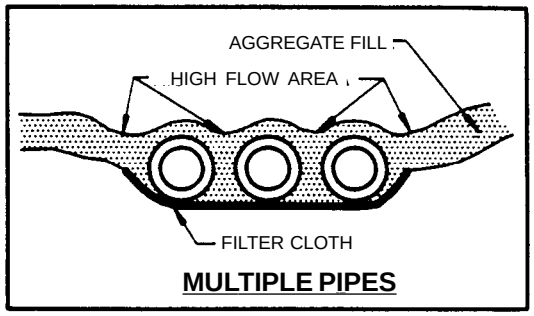
FLAT BANKS



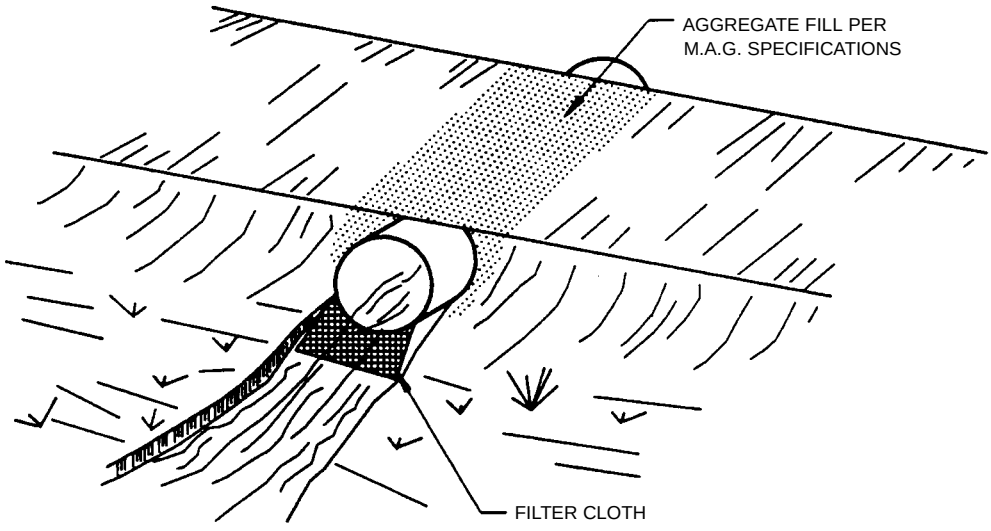
STEEP BANKS



MULTIPLE PIPES



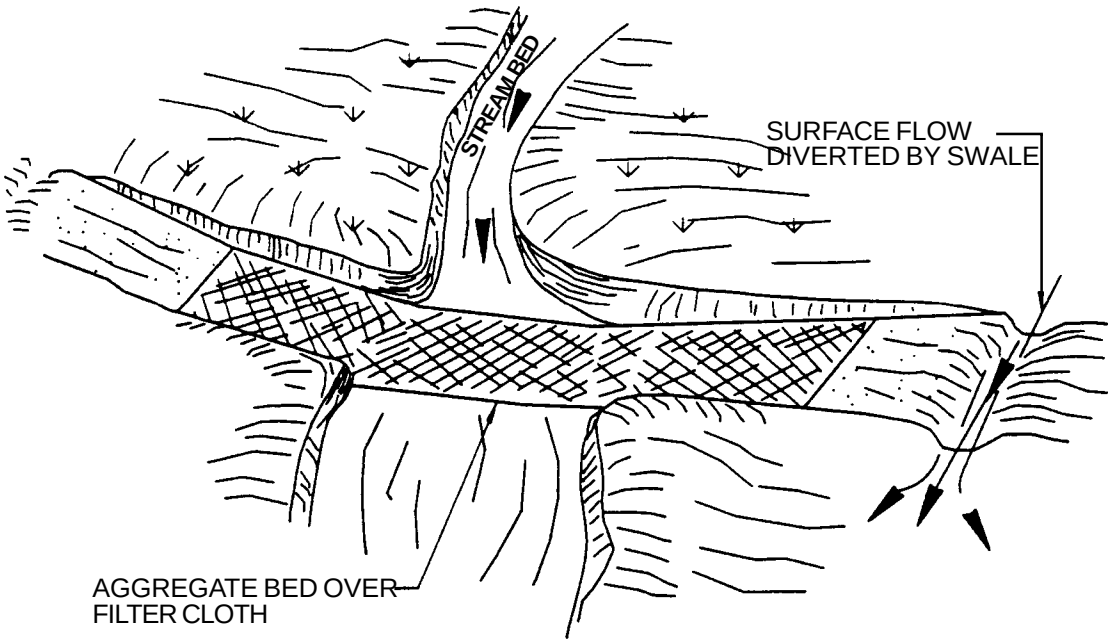
MULTIPLE PIPES



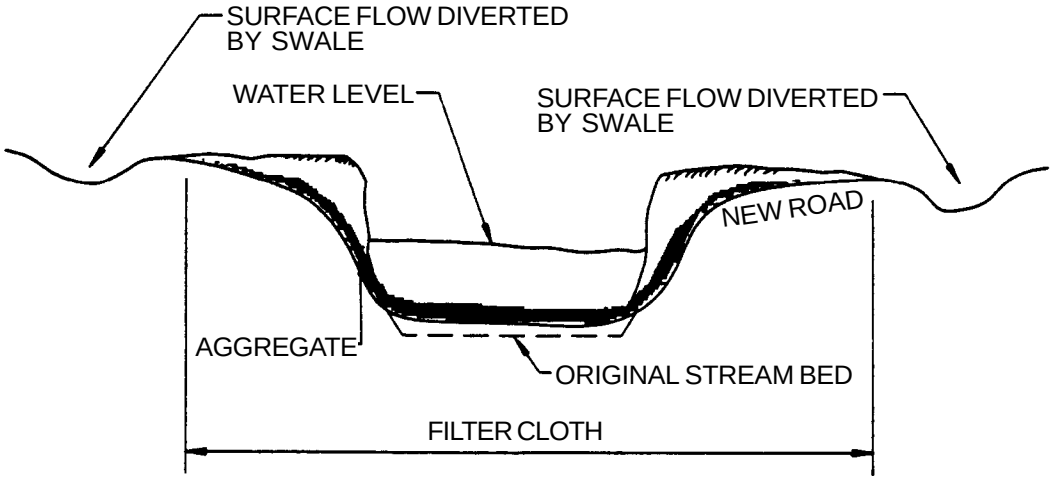
TEMPORARY ACCESS CULVERT

ESC22

ADDITIONAL INFORMATION: TEMPORARY STREAM CROSSING



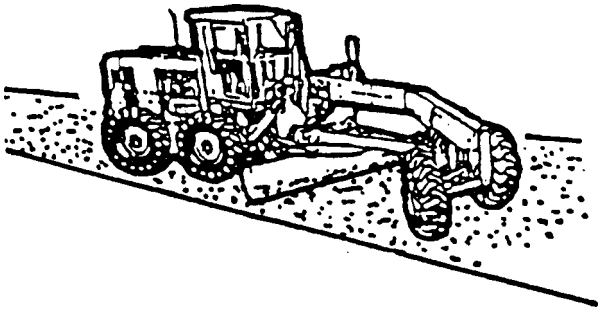
AGGREGATE APPROACH
5:1 MAXIMUM, SLOPE ON ROAD



TEMPORARY ACCESS FORD

ESC22

BMP: CONSTRUCTION ROAD STABILIZATION



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

Access roads, subdivision roads, parking areas, and other on-site vehicle transportation routes should be stabilized immediately after grading and frequently maintained to prevent erosion and control dust.

SUITABLE APPLICATIONS

- Temporary construction traffic.
- Phased construction projects and off-site road access.
- Detour roads.
- Construction during wet weather.

INSTALLATION/APPLICATION CRITERIA

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15 percent.
- Gravel roads should be a minimum 4-inch thick, 2-3 inch coarse aggregate base applied immediately after grading, or as recommended by soils engineer.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (see Dust Control ESC21).

REQUIREMENTS

- Maintenance
  - Periodically apply additional aggregate on gravel roads.
  - Active dirt construction roads are commonly watered three or more times per day during the dry season.
  - Inspect weekly, and after each rain.
  - Repair any eroded areas immediately.
- Cost
  - Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay.
  - No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

LIMITATIONS

- The roadway must be removed or paved when construction is complete.
- Certain chemical stabilization methods may cause storm water or soil pollution and should not be used (see Dust Control ESC21).
- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ○ Toxic Materials
- ○ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ◒ O&M Costs
- ◒ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC23

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: CONSTRUCTION ROAD STABILIZATION

Areas which are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires which generate significant quantities of sediment that may pollute nearby streams or be transported off-site on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces on-site erosion but can significantly speed on-site work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather.

Installation/Application Criteria

Where feasible, alternative routes should be made for construction traffic; one for use in dry condition, the other for wet conditions which incorporate the measures listed for this BMP. Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and/or on slopes greater than 5 percent.

When gravel road is needed, apply a minimum 4-inch course of 2 to 4-inch crushed rock. gravel base, or crushed surfacing base course immediately after grading or the completion of utility installation within the right-of-way. Chemical stabilization may also be used upon compacted native sub-grade (see the Dust Control BMP ESC21). These chemical controls should be applied per the manufacturer's directions.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15 percent. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section, or one side in the case of super-elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment-laden water from entering the storm sewer system (see "Storm Drain Inlet Protection" ESC54).

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

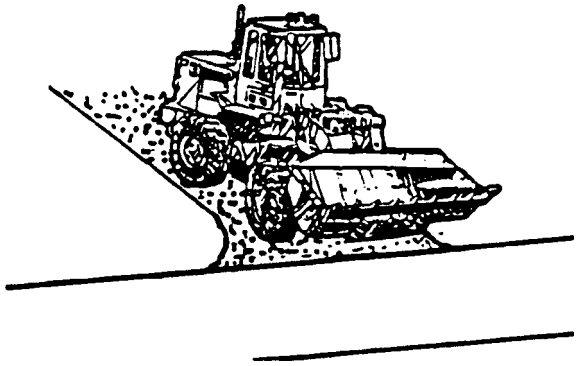
Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual February 1992, Publication # 91-75.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC23

BMP: STABILIZED CONTRUCTION ENTRANCE



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

The construction entrance practice is a stabilized pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area. Stabilizing the construction entrance significantly reduces the amount of sediment (dust, mud) tracked off-site, especially if a washrack is incorporated for removing caked on sediment.

SUITABLE APPLICATIONS

- All points of construction ingress and egress.
- Unpaved areas where sediment tracking occurs from site onto paved roads.

INSTALLATION/APPLICATION CRITERIA

- Construct on level ground where possible.
- Stones should be 1-3 inches.
- Minimum depth of stones should be 6 inches or as recommended by soils engineer.
- Length should be 50-foot minimum, and 30-foot minimum width.
- Provide ample turning radii as part of entrance.

REQUIREMENTS

- Maintenance
  - Inspect monthly and after each rainfall.
  - Replace gravel material when surface voids are visible.
  - Remove all sediment deposited on paved roadways within 24 hours.
  - Remove gravel and filter fabric at completion of construction
- Cost: Average annual cost for installation and maintenance (Source: EPA, 1992)
  - Without Wash Rock: $1500 each.
  - With Wash Rock: $2200 each.

LIMITATIONS

- Requires periodic top dressing with additional stones.
- Should be used in conjunction with street sweeping on adjacent public right-of-way.

Targeted Pollutants

- ◒ Sediment
- ◒ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ○ Other Construction Waste

- ● Likely to Have Significant Impact
- ○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ○ Maintenance
- ○ Training
- ○ Suitability for Slopes >5%

● High ○ Low

ESC24

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: STABILIZED CONSTRUCTION ENTRANCE

A stabilized construction entrance is a pad of aggregate underlaid with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights-of-way or streets. Reducing trackout of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving, a stabilized construction entrance should be used at all points of construction ingress and egress. NPDES permits require that appropriate measures be implemented to prevent trackout of sediments onto paved roadways, which is a significant source of sediments derived from mud and dirt carryout from the unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be build on the level ground. Advantages of the Stabilized Construction Entrance is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance.

See the City and County of Honolulu's "Rules Relating to Soil Erosion Standards and Guidelines," for additional information.

The entrance must be properly graded to prevent runoff from leaving the construction site. When wash areas are provided, washing is done on a reinforced concrete pad (if significant washing is necessary) or in an area stabilized with crushed stone which drains into a properly constructed sediment trap or basin (ESC55 and 56). Sediment barriers are provided to prevent sediments from entering into the stormwater sewer system, ditch, or waterway.

Limitations

- Construct on level ground.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.
- Requires periodic top dressing with additional stones.
- Should be used in conjunction with street sweeping on adjacent public right-of-way.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April, 1992.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual February 1992, Publication # 91-75.

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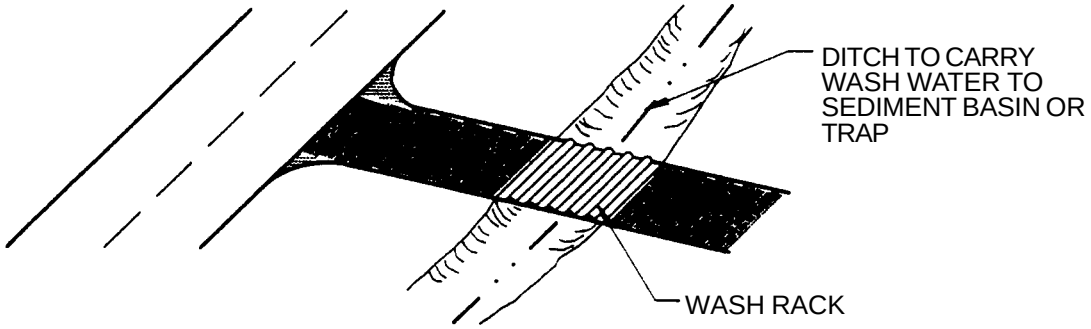
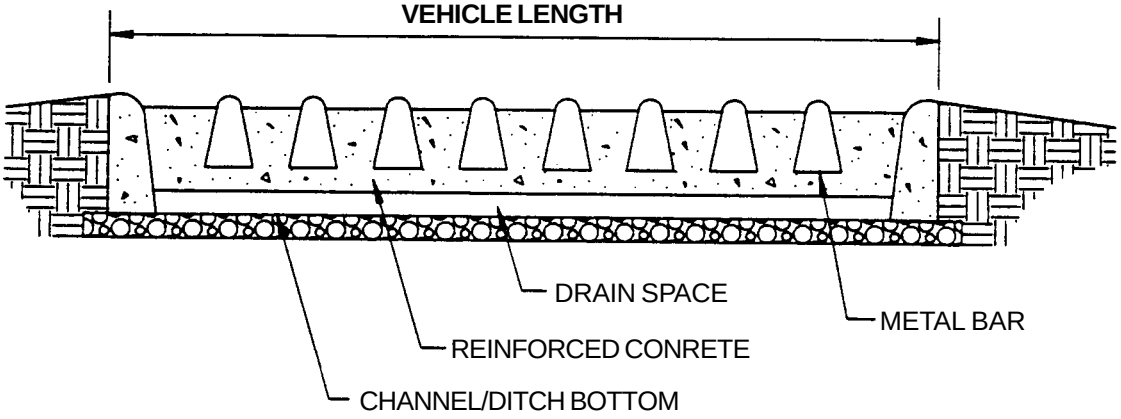
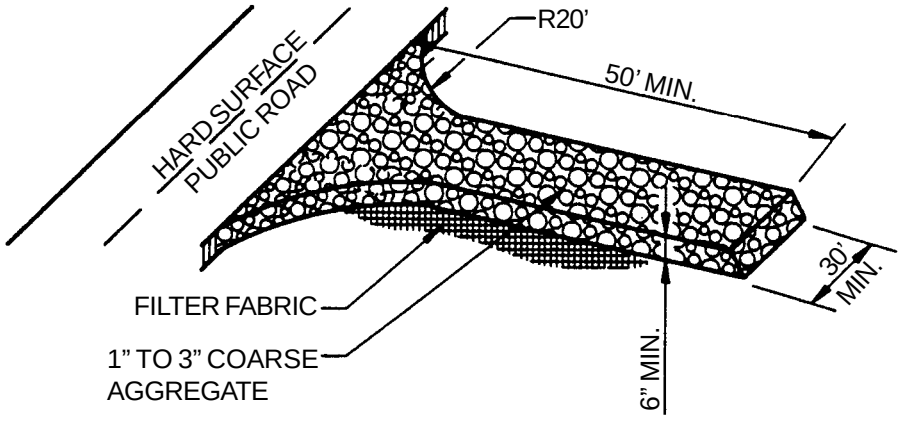




WASH RACK (SCHEMATIC)



ESC24

STABILIZED CONSTRUCTION ENTRANCE

BMP: PROTECTION OF STOCKPILES

Graphic by City & County of Honolulu, 1999

GENERAL DESCRIPTION

Stockpiles can be a significant source of erosion and sediment, and measures should be take to mitigate the potential for nonpoint source pollution. Information to be provided to the City and County of Honolulu, Department of Planning and Permitting, when applying for a stockpiling permit include "a plot plan showing the property lines, easements and setbacks, topography, and the location of the proposed stockpile, quantities, height of stockpile, life of stockpile and source of the material to be stockpiled," and other information as may be required to "control the emission of air-borne dust, drainage runoff or erosion problems."

SUITABLE APPLICATIONS

- *Stockpiles for gravel, topsoil in roadway areas.*
- *Stockpiles for excavated material to be moved to off-site locations.*
- *Stockpiles of imported material.*
- *Stockpiles for surcharging to stabilize or consolidate an area.*

INSTALLATION/APPLICATION CRITERIAL

- *Provide adequate setback from waterways.*
- *Provide earth dikes or other diversion to keep runoff away from stockpiles.*
- *Provide silt fences at the toe of the stockpile to mitigate runoff during rain events.*
- *Cover, grass or provide other stabilization measures.*
- *Provide adequate setback distance from lot lines.*
- *Provide silt basins where required.*

REQUIREMENTS

- *Maintenance*
  - *Inspect periodically and after every significant rainfall; repair as necessary.*

LIMITATIONS

Stockpiles are for temporary storage of material only. Provisions should be made for permanent movement of stockpiled material. Failure to contain stockpiled material may cause downstream erosion or flood damage. Stockpiles not properly stabilized may cause fugitive dust problems.

Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

Targeted Pollutants

- ● *Sediment*
- ◒ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC25

BEST MANAGEMENT PRACTICES

REFERENCES

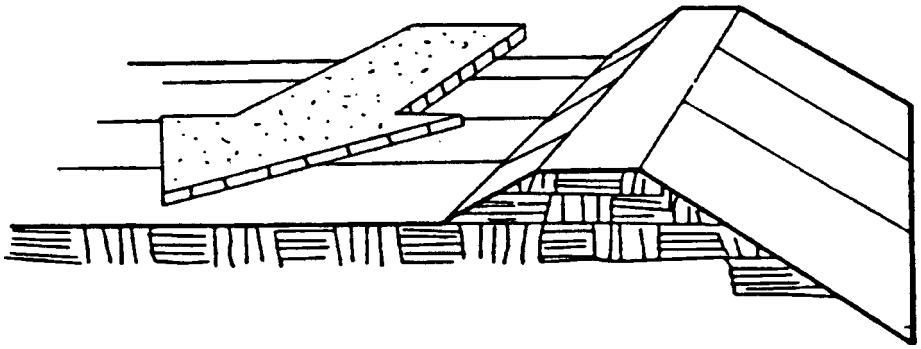
"Rules Relating to Erosion Control Standards and Guidelines," April 1999, Department of Planning and Permitting, City and County of Honolulu.

Chapter 14, Article 14. Permits, Bonds and Inspection for Grading, Soil Erosion and Sediment Control, Revised Ordinances of Honolulu, 1990 as amended.

California Storm Water Best Management Best Management Practice Handbooks, Construction Activity Best Management Practice Handbook, March 1993, Camp Dresser & McKee et. al. For the California Storm Water Quality Task Force.

ESC25

BMP: EARTH DIKE



Objectives

- Housekeeping Practices
- Contain Waste
- Minimize Disturbed Areas
- Stabilize Disturbed Areas
- Protect Slopes/Channels
- Control Site Perimeter
- Control Internal Erosion

GENERAL DESCRIPTION

The temporary earth dike is a temporary berm or ridge of compacted soil, used to divert runoff or channel water to a desired location.

SUITABLE APPLICATIONS

Earth dikes are typically used to divert concentrated runoff through disturbed areas into another BMP (e.g., sediment basins), to divert runoff away from disturbed or unstable slopes, to divert runoff from off-site and undisturbed areas around disturbed areas, and as a containment for construction materials and wastes. The dikes should remain in place until the disturbed areas are permanently stabilized. The dikes must be on-site and must safely convey anticipated flood flows.

INSTALLATION/APPLICATION CRITERIA

- All dikes should be compacted by earth-moving equipment.
- All dikes should have positive drainage to a stabilized outlet.
- Top width may be wider and side slopes may be flatter at crossings for construction traffic.
- Dikes should direct sediment-laden runoff into a sediment trapping device.
- Dikes should be stabilized with vegetation, chemicals, or physical devices.

REQUIREMENTS

- Maintenance
  - Inspect periodically and after every significant rainfall; repair as necessary.
- Cost
  - Cost ranges from $15 to $55 per foot for both earthwork and stabilization and depends on availability of material, site location, and access.

LIMITATIONS

Dikes should not be used for drainage areas greater than 10 acres, or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately, which adds cost and maintenance concerns.
- Diverted storm water may cause downstream flood damage.
- Dikes should not be constructed of soils which may be easily eroded.
- Regrading the site to remove the dike may add additional cost.

Targeted Pollutants

- ● Sediment
- ○ Nutrients
- ◒ Toxic Materials
- ◒ Oil & Grease
- ○ Floatable Materials
- ◒ Other Construction Waste

● Likely to Have Significant Impact
○ Probable Low or Unknown Impact

Implementation Requirements

- ◒ Capital Costs
- ○ O&M Costs
- ◒ Maintenance
- ○ Training
- ◒ Suitability for Slopes >5%

● High ○ Low

ESC30

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: EARTH DIKE

The temporary earth dike is a berm or ridge of compacted *soil*, located in such a manner as to divert storm water to a sediment trapping device or stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off-site and from undisturbed areas away from disturbed areas, and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff; a dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

- The advantages of the temporary earth dike include the ability to handle flows from large drainage areas.
- Once stabilized, earth dikes require relatively little maintenance. Additionally, the earth dikes are relatively inexpensive to install since the soil material required for construction may be available on-site, and can be constructed as part of the initial grading operations, while the equipment is on-site.
- Uses on-site materials.

Installation/Application Criteria

Temporary earth dikes are a practical, inexpensive BMP used to divert storm water runoff. Temporary diversion dikes should be installed in the following manner:

1. All dikes should be compacted by earth-moving equipment.
2. All dikes should have positive drainage to an outlet.
3. All dikes should have 2:1 side slopes, 18 inches minimum height, and a minimum top width of 24 inches. Top width may be wider and side slopes may be flatter at crossings for construction traffic.
4. The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a sediment trap (ESC55) or sediment basin (ESC56) when either the dike channel or the drainage area above the dike are not adequately stabilized.
5. Temporary stabilization may be achieved using seed and mulching for slopes less than 5%, and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain.
6. If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

CHANNEL GRADE	RIPRAP STABILIZATION
0.5-1.0%	4" Rock
1.1-2.0%	6" Rock
2.1- 4.0%	8" Rock
4.1-5.0%	8-12" Riprap

7. The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment.
8. Filter cloth may be used to cover dikes in use for long periods.
9. Construction activity on the earth dike should be kept to a minimum.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices, U.S.E.P.A., April, 1990.

ESC30

ADDITIONAL INFORMATION: EARTH DIKE

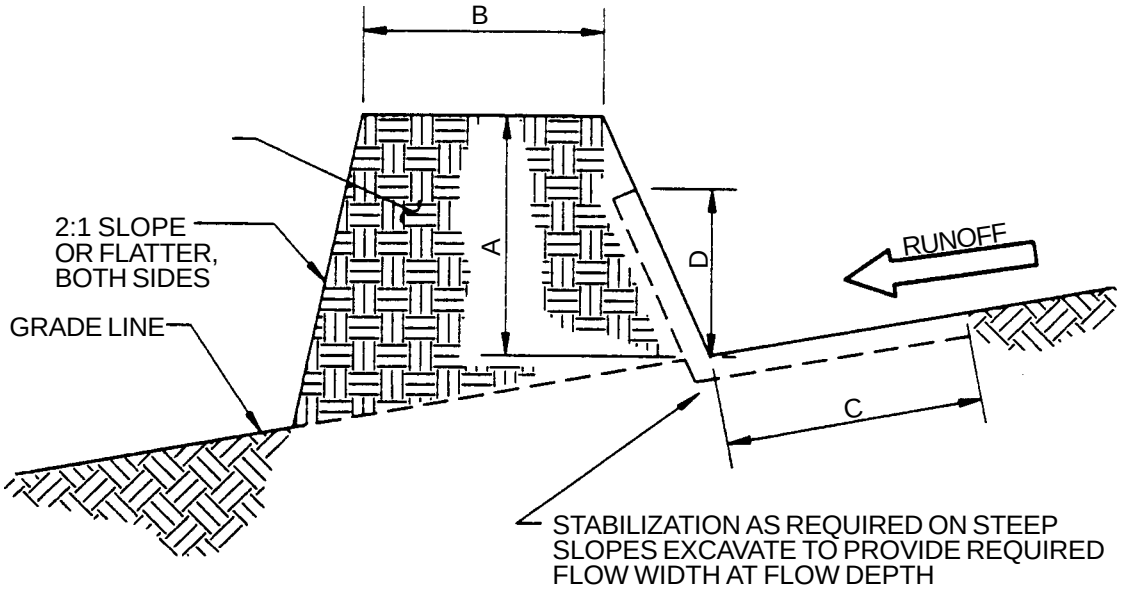
Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursetynsky, P.E., McGraw Hill Book Company.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC30

ADDITIONAL INFORMATION: EARTH DIKE



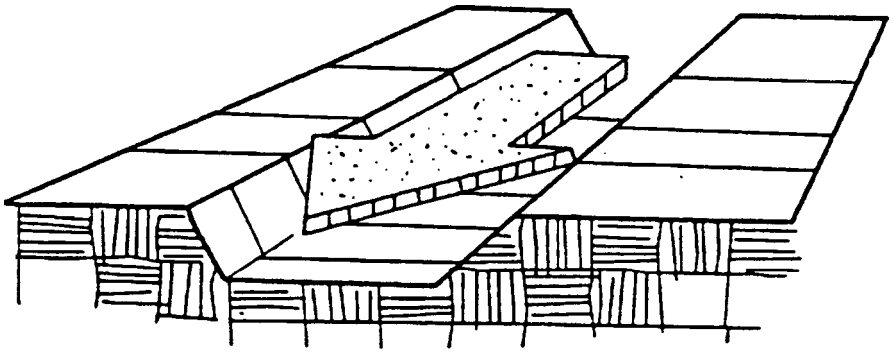
REQUIREMENTS BASED ON UPSTREAM DRAINAGE AREA

	DIKE 1 (5 ACRES OR LESS)	DIKE 1 (5-10 ACRES)
A-DIKE HEIGHT	18”	36”
B-DIKE WIDTH	24”	36”
C-FLOW WIDTH	4’	6’
D-FLOW DEPTH	8”	15”

TEMPORARY DIVERSION DIKE

ESC30

BMP: TEMPORARY DRAINS AND SWALES



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DESCRIPTION

Temporary drains and swales are used to divert off-site runoff around the construction site, divert runoff from stabilized areas around disturbed areas, and direct runoff into sediment basins or traps.

SUITABLE APPLICATIONS

Temporary drains and swales are appropriate for diverting any upslope runoff around unstabilized or disturbed areas of the construction site:

- Prevent slope failures.
- Prevent damage to adjacent property.
- Prevents erosion and transport of sediments into water ways.
- Increases the potential for infiltration.
- Diverts sediment-laden runoff into sediment basins or traps.

INSTALLATION/APPLICATION CRITERIA

Temporary drainage swales will effectively convey runoff and avoid erosion if built properly: Size temporary drainage swales using local drainage design criteria. A permanent drainage channel must be designed by a professional engineer (see the local drainage design criteria for proper design).

- At a minimum, the drain/swale should conform to predevelopment drainage patterns and capacities.
- Construct the drain/swale with an uninterrupted, positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the drain or swale can reach an erosive velocity.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rain.
  - Repair any erosion immediately.
  - Remove sediment which builds up in the swale and restricts its flow capacity.
- Cost
  - The cost of a drainage swale increases with drainage area and slope. Typically, swales for controlling internal erosion are inexpensive.

LIMITATIONS

- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales must conform to local flood plain management requirements.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ◒ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC31

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: TEMPORARY DRAINS AND SWALES

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike (see ESC30) at the top of a slope can safely divert runoff to a location where it can safely be brought to the bottom of the slope (see Pipe Slope Drain ESC32). 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. Diversion structures should be installed when the site is initially graded, and remain in place until post-construction BMPs are installed and/or the slopes are stabilized.

Diversion practices concentrate the volume of surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale must be directed onto a stabilized area or into a grade stabilization structure. A swale should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization, if significant erosion will occur. Any drain or swale which conveys sediment-laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

Installation/Application Criteria

Diversion drains or swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost-effective diversion.

Standard engineering design criteria for small open channel and closed conveyance systems should be used *(see the City and County of Honolulu's "Storm Drainage Standards.")* Unless *the City and County of Honolulu* drainage design criteria state otherwise, drains or swales should be designed as follows:

- No more than 5 acres may drain to a temporary drain or swale
- Place the drain or swale above, not on, a cut and fill slope
- Swale bottom width should be at least 2 ft
- Depth of the swale should be at least 18 inches
- Side slopes should be 2:1 or flatter
- Drain or swale should be layed at a grade of at least 1 percent, but not more than 15 percent
- The swale must not be overtopped by the 10-year, 24-hour storm, irrespective of the design criteria stated above
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built
- Compact any fill material along the path of the swale
- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- The cost of swales and other diversion devices is generally included in the earthwork cost, as a separate item under the grading budget of the project construction contract.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Water Quality Management Plan for the Lake Tahoe Region, Volume II , Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

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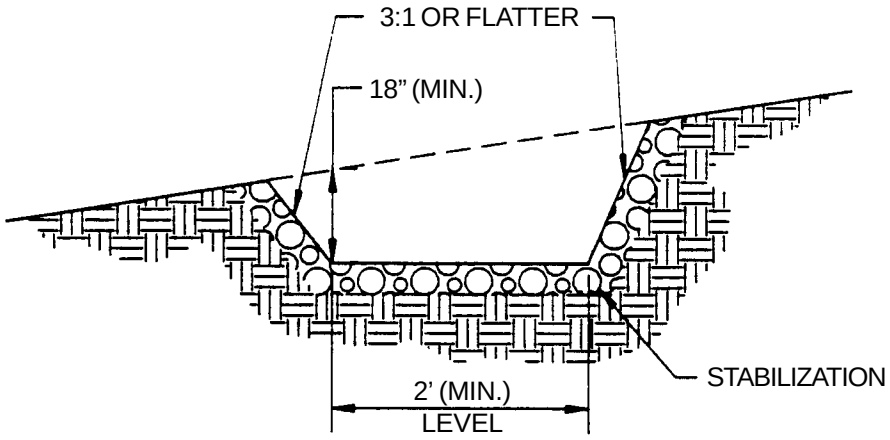
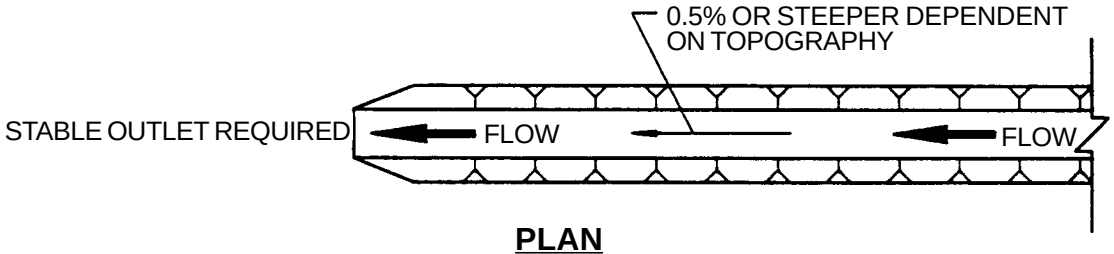


CROSS SECTION

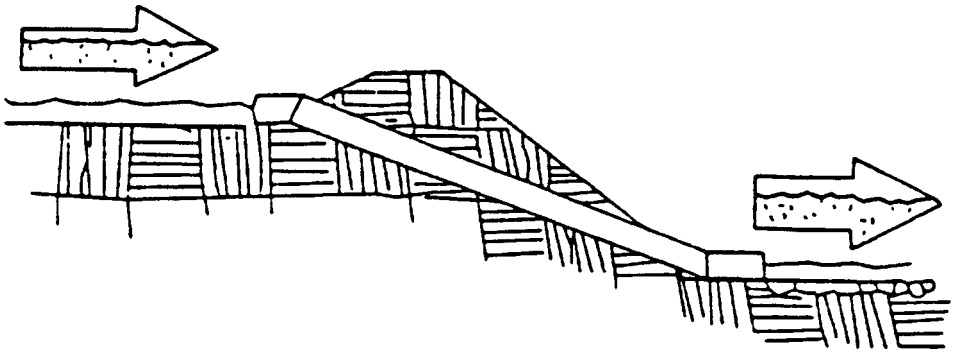


PLAN

TEMPORARY DRAINAGE SWALE

ESC31

BMP: SLOPE DRAIN



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels* (●)
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DESCRIPTION

A temporary pipe or lined channel to drain the top of a slope to a stable discharge point at the bottom of a slope without causing erosion.

SUITABLE APPLICATIONS

- Where concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion.
- Drainage for top of slope diversion dikes or swales.
- Emergency spillway for a sediment basin.
- Drainage for top of cut/fill slopes where water can accumulate.

The types of slope drain can include:

- Pipe drops.
- Flexible downdrains.
- Sectional downdrains.
- Lined terrace drains.

INSTALLATION/APPLICATION CRITERIA

- Secure inlet and surround with dikes to prevent gully erosion, and anchor pipe to slope.
- Size to convey at least the peak of a 10-year, 24-hour storm (See local flood control agency for requirements).
- Stabilize outlet.

REQUIREMENTS

- Maintenance
  - Structure must be inspected regularly and after storms.
  - Inlet must be free of undercutting and no water should circumvent the entry.
  - Outlet should not produce erosion; velocity dissipators must be maintained.
  - Pipe anchors must be checked to ensure that the pipe remains anchored to the slope.

LIMITATIONS

- Maximum drainage area per slope drain is 5 acres. (For large areas use a paved chute, rock lined channel or additional pipes.)
- Clogged slope drains will force water around the pipe and cause slope erosion.
- Dissipation of high flow velocities at the pipe outlet is required to avoid downstream erosion.
- Failure can result in flooding and severe erosion.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ◒ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC32

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: SLOPE DRAIN

The slope drain may be a rigid pipe, such as corrugated metal, a flexible conduit, or a lined terrace drain with the inlet placed on the top of a slope. The drain conveys concentrated runoff down to the bottom of the slope. The BMP typically is used in combination with a diversion control, such as a temporary dike or swale, at the top of the slope, and serves as a temporary BMP to reduce or eliminate slope erosion until permanent BMPs are installed and the slope is stabilized.

The slope drain is applicable for any construction site where concentrated surface runoff can accumulate and must be conveyed down the slope in order to prevent erosion. The slope drain is effective because it prevents the stormwater from flowing directly down the slope by confining all the runoff into an enclosed pipe or channel. Due to the time lag between grading slopes and installation of permanent storm water collection systems and slope stabilization measures, temporary provisions to intercept runoff are sometimes necessary. Particularly in steep terrain, slope drains can protect unstabilized areas from erosion. Typical uses include:

- Emergency spillway for a sediment basin.
- Drainage for top of cut/fill slopes where storm water can accumulate and must be conveyed down the slope.

Installation/Application Criteria

Temporary slope drains are highly effective in eliminating slope erosion. Installation and maintenance requirements are small, especially when flexible pipe is used. General criteria:

- Gully erosion is the major problem with slope drains. Inlet structures must be securely entrenched and compacted to avoid severe gully erosion.
- The drain must be securely anchored to the slope and must be adequately sized to carry the capacity of the design storm and associated forces.
- The outlet must be stabilized with rip-rap, concrete or other type of energy dissipator, or directed into a stable sediment trap or basin.
- A debris rack is recommended at the inlet. and should be encouraged for larger pipes and at the outlet as a safety device to prevent small children from entering the pipe.

Materials:

Material selection and criteria for the pipe slope drain *should conform to the City and County of Honolulu criteria.* Soil type, rainfall patterns, construction schedule, and available supply are some of the factors to be considered. The following types of slope drains are commonly used:

- Rigid Pipe: This type of slope drain is also known as a pipe drop. The pipe usually consists of corrugated metal pipe or rigid plastic pipe. The pipe is placed on undisturbed or compacted soil and secured into the slope. One foot minimum cover is required on the pipe, and concrete thrust blocks must be used when required by the municipality or warranted by the calculated thrust forces. Collars should be properly installed and secured with metal strappings or watertight collars.
- Flexible Pipe: The flexible pipe slope drain consists of a flexible conduit of heavy duty material. The conduit material is securely anchored into the slope and connections are watertight. The conduit should be securely fastened to the metal inlet and outlet conduit sections with metal strappings or water tight collars.
- Sectional Downdrains: The sectional downdrain consists of pre-fabricated sectional conduit of half-round or third-round material. The sectional downdrain performs similar to a flume or chute. The pipe must be placed on undisturbed or compacted soil and secured into the slope.
- Concrete-lined Terrace Drain: This is a concrete channel for draining water from a terrace on a slope to the next level. These drains are after permanent structures which should be designed according to the *City and County of Honolulu's drainage design criteria.*

ESC32

ADDITIONAL INFORMATION: SLOPE DRAIN

Design:
Unless specified by the local municipality, the capacity for temporary drains should be sufficient to handle the peak runoff from a 10-year, 24-hour rainfall event. The pipe size may be computed using the Rational Method or a method established by the *City and County of Honolulu*. Higher flows must be safely stored or routed to prevent any offsite concentration of flow, and any erosion of the slope.

As a guide, temporary pipe slope drains should not be sized smaller than shown in the following table:

MINIMUM PIPE DIAMETER	MAXIMUM DRAINAGE AREA (ACRES)
12"	0.5
18"	1.5
21"	2.5
24"	3.5
30"	5.0

Permanent improvements must be designed and installed if the drainage area is greater than 5 acres.

The following additional design criteria should be considered:
- Construct the pipe slope drain entrance of a standard flared end section with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance is usually at least 3 percent.
- Thoroughly compact the soil around and under the pipe and entrance section.
- Securely fasten the slope drain sections together, have gasketed watertight fittings, and securely anchored into the soil.
- Secure the flared inlet section to the slope drain and have watertight connecting bands.
- Use interceptor dikes to direct runoff into a slope drain. The height of the dike should be at least 1 foot higher at all points than the top of the inlet pipe.
- If the pipe slope drain is conveying sediment-laden water, direct all flows into a sediment trap (ESC55) or sediment basin (ESC56).
- Unless the pipe directly enters a sediment trap/basin, stabilize the area below the outlet with a riprap apron.

Limitations
Installation is critical for effective use of the pipe slope drain to minimize potential gully erosion. Maximum drainage area per pipe slope drain is 5 acres. For larger areas use a paved chute, rock lined channel or additional pipes. (See the local municipality for drainage requirements)

- During large storms, pipe slope drains may become clogged or overcharged, forcing water around the pipe and causing extreme slope erosion.
- Structures for dissipation of high flow velocities at the pipe outlet must be constructed to avoid downstream erosion.
- Failure of this type of temporary structure may result in flooding and severe erosion.
- If the sectional downdrain is not sized correctly, the runoff can spill over the drain sides causing gully erosion, and potential failure of the structure.

ESC32

ADDITIONAL INFORMATION: SLOPE DRAIN

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.

Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

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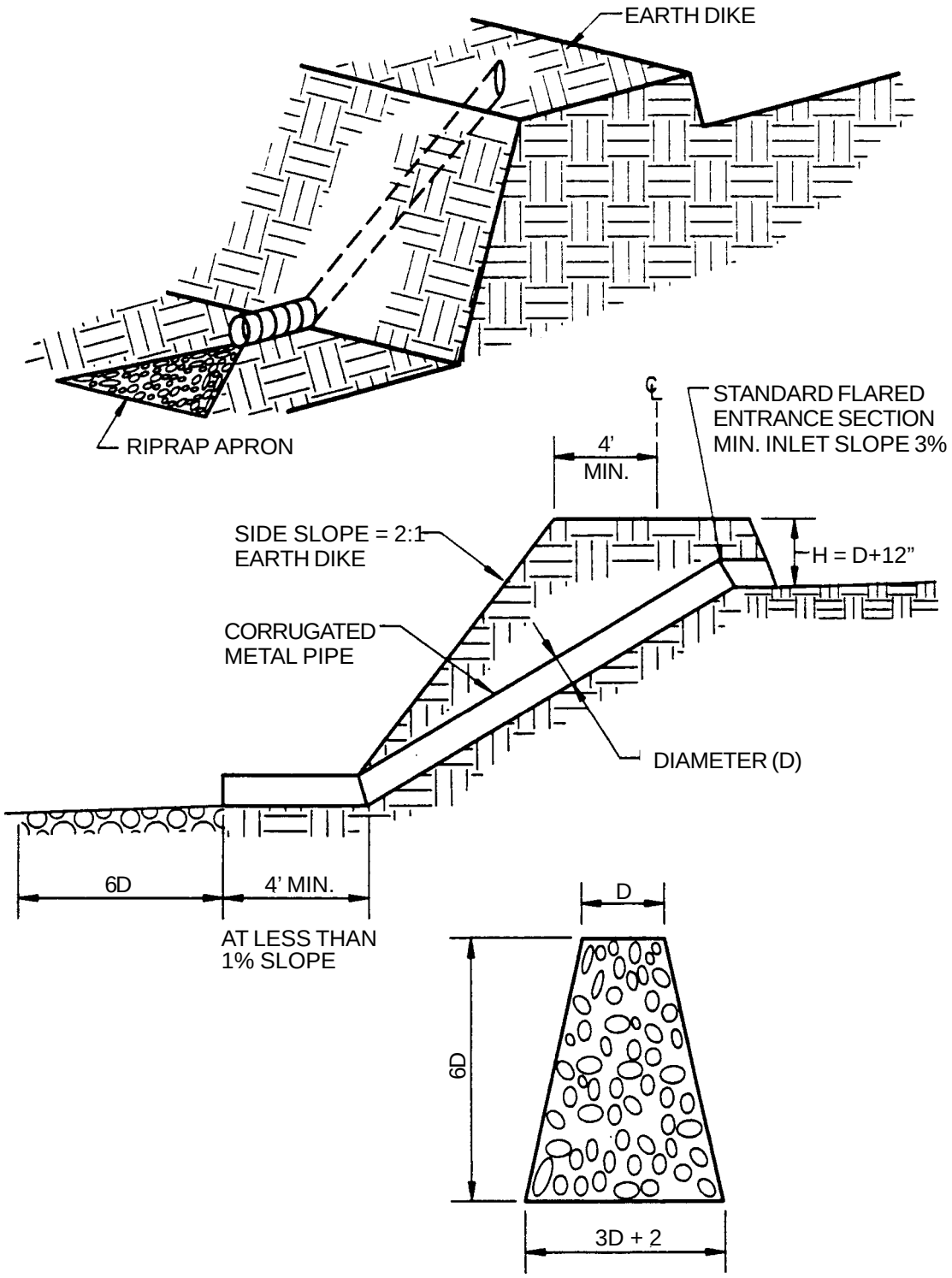
ADDITIONAL INFORMATION: SLOPE DRAIN

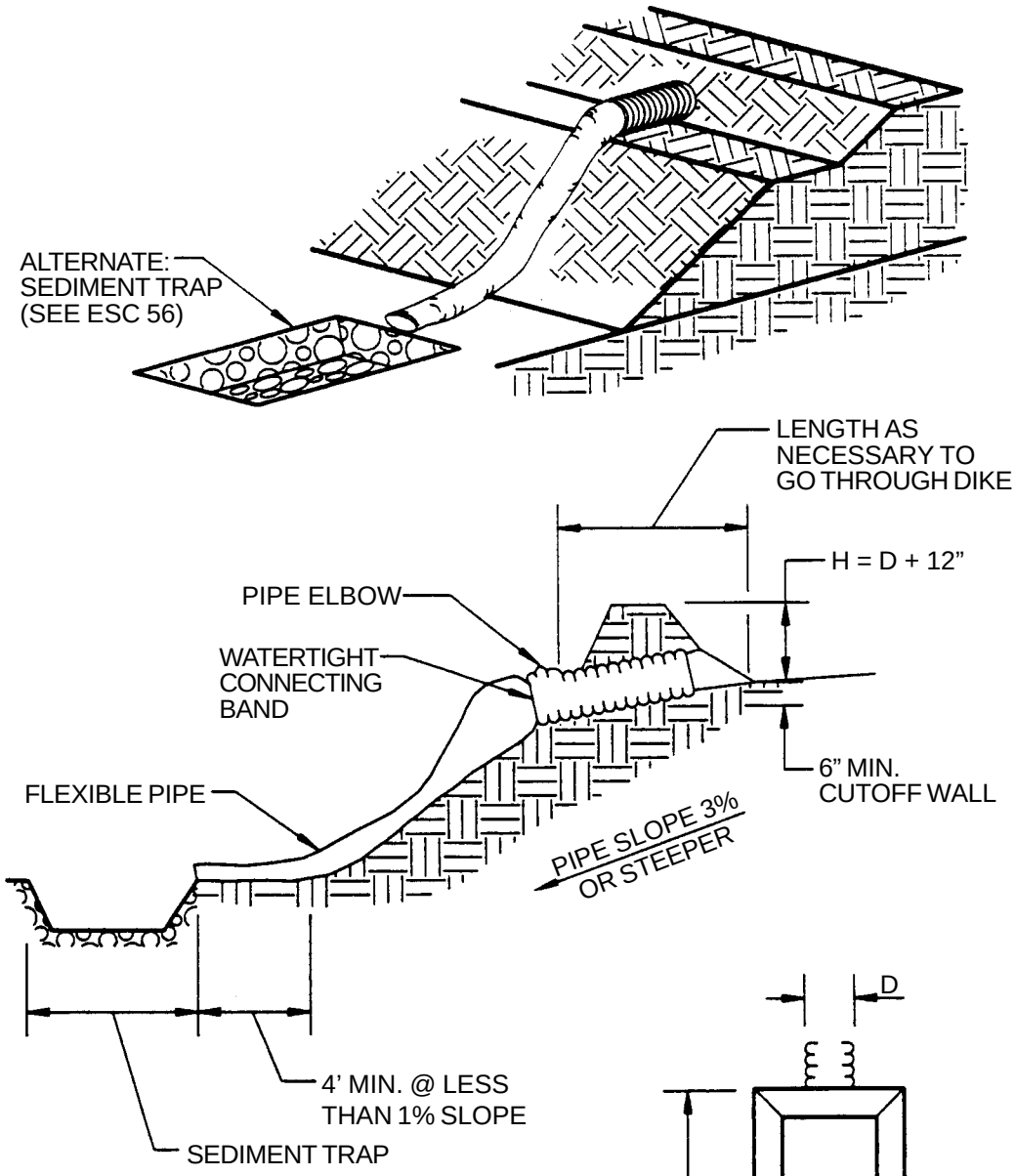


RIPRAP SHOULD CONSIST OF 6" DIAMETER STONE PLACED AS SHOWN AND SHOULD BE A MINIMUM OF 12" IN THICKNESS.

ESC32

PIPE SLOPE DRAIN (RIGID)

ADDITIONAL INFORMATION: SLOPE DRAIN



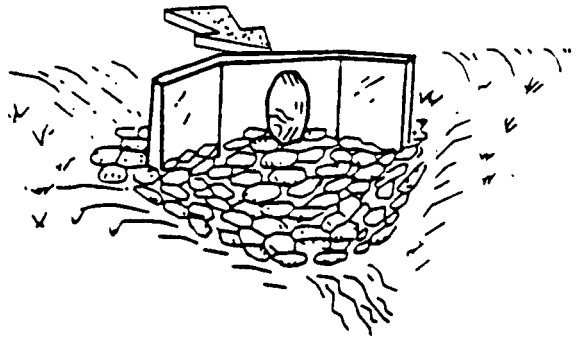
RIPRAP SHOULD CONSIST OF 6" DIA. STONE PLACED AS SHOWN. DEPTH OF APRON SHOULD EQUAL THE PIPE DIA. AND RIPRAP SHALL BE A MINIMUM OF 12" IN THICKNESS

ALTERNATIVE SEDIMENT TRAP: RIPRAP PLAN

ESC32

PIPE SLOPE DRAIN (FLEXIBLE)

BMP: OUTLET PROTECTION



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels* (●)
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DESCRIPTION

Rock outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble which is placed at the outlet of a pipe to prevent scour of the soil caused by high pipe flow velocities, and to absorb flow energy to produce non-erosive velocities.

SUITABLE APPLICATIONS

- Wherever discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the next downstream reach.
- Rock outlet protection is best suited for temporary use during construction because it is usually less expensive and easier to install than concrete aprons or energy dissipators.
- A sediment trap below the pipe outlet is recommended if runoff is sediment laden.
- Permanent rock riprap protection should be designed and sized by the engineer as part of the culvert, conduit or channel design.

INSTALLATION/APPLICATION CRITERIA

Rock outlet protection is effective when the rock is sized and placed properly. When this is accomplished, rock outlets do much to limit erosion at pipe outlets. Rock size should be increased for high velocity flows. General recommendations for rock size and length of outlet protection mat are presented in the additional information sheet. Best results are obtained when sound, durable, angular rock is used. Refer to the *"Standard Specifications for Public Works Construction," and "Storm Drainage Standards,"* for additional specifications for constructing outlet protection devices.

REQUIREMENTS

- Maintenance
  - Inspect after each significant rain for erosion and/or disruption of the rock, and repair immediately.
  - Grouted or wire-tied rock riprap can minimize maintenance requirements.

LIMITATIONS

- Large storms often wash away the rock outlet protection and leave the area susceptible to erosion.
- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Outlet protection may negatively impact the channel habitat.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC40

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: OUTLET PROTECTION

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the inlet or outlet from developing small eroded pools (plunge pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipators. It also serves to trap sediment and reduce flow velocities.

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate and velocity should be considered in the outlet design. Compliance to *City* and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat is shown in the rock outlet protection figure. Best results are obtained when sound, durable, angular rock is used. Rock depth and outlet protection length are governed by the discharge pipe size, but hydraulic calculations and velocities should be used to determine length.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Mariposa County, Arizona, September 1992.

County of Sacramento Improvement Standards, Sacramento County - May 1989.

Environmental Criteria Manual, City of Austin, TX, 1989.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

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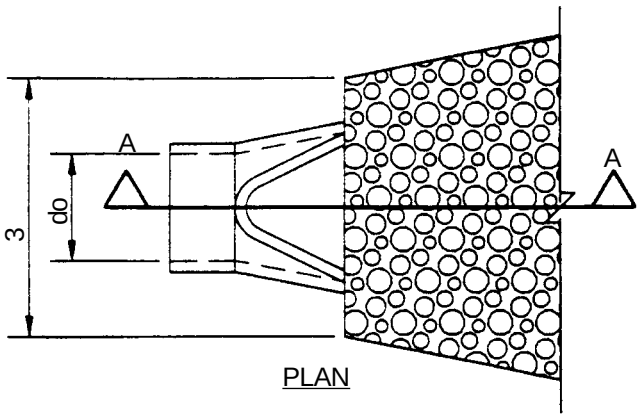
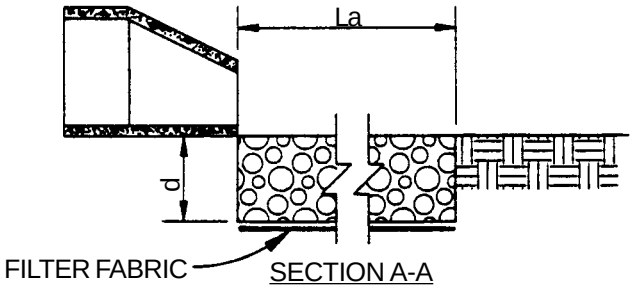
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC40

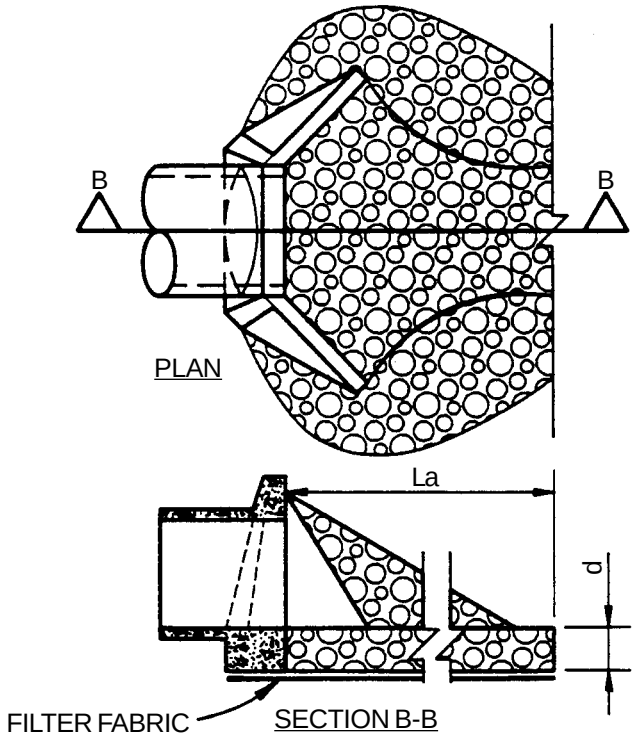


La = LENGTH OF APRON
do = INSIDE PIPE DIAMETER
w = APRON WIDTH
d = APRON THICKNESS



NOTES

1. APRON LINING MAY BE RIPRAP, GROUTED RIPRAP, OR CONCRETE.
2. PIPE DIAMETER, APRON DIMENSIONS, AND AVERAGE ROCK SIZE FOR RIPRAP ARE BASED ON THE DESIGN FLOW RATE AND VELOCITY. La AND ROCK SIZE MUST BE SET TO SLOW THE FLOW TO NON-EROSIVE VELOCITIES (e.g. LESS THAN 10 fps). SEE *CITY* DESIGN CRITERIA FOR APPROPRIATE SIZING CRITERIA.
3. d = 1.5 TIMES THE MAXIMUM ROCK SIZE DIAMETER BUT NOT LESS THAN 6 INCHES.

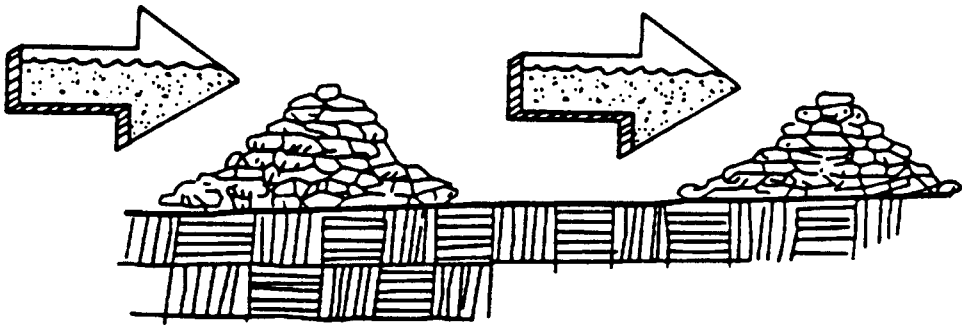


PIPE OUTLET TO WELL-DEFINED CHANNEL

PIPE OUTLET CONDITIONS

ESC40

BMP: CHECK DAMS



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels* (●)
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DESCRIPTION

Small temporary dams constructed across a swale or drainage ditch. Check dams reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch, and promoting sedimentation behind the dam. If properly anchored, brush or rock filter berms (ESC53) may be used for check dams.

SUITABLE APPLICATIONS

- Used to prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- May also promote sedimentation behind the dam, but should not be considered to be a primary sediment trapping device because subsequent storms will scour and resuspend much of the trapped sediment.

INSTALLATION/APPLICATION CRITERIA

- Check dams should be placed at a distance and height to allow small pools to form between each one.
- Backwater from a downstream check dam should reach the toe of the upstream check dam.
- Major floods (2 year storm or larger) should safely flow over the check dam without an increase in upstream flooding or destruction of the checkdam.
- Primarily used in small, steep channels where velocities exceed 2 fps.
- Used in steep terrain where velocity reduction is required.
- A deep sump may be provided immediately upstream of the check dam to capture excessive sediment.
- Check dams may be built of rocks or logs, which are secured against damage during significant floods.

REQUIREMENTS

- Maintenance
  - Inspect for sediment buildup behind the check dam and signs of erosion around the check dam after each rain.
  - Remove accumulated sediment whenever it reaches one-half the sump depth.

LIMITATIONS

- Use only in small open channels which drain 10 acres of less.
- Not to be used in live streams.
- Do not install in lined or vegetated channels.

Targeted Pollutants

- (●) *Sediment*
- ( ) *Nutrients*
- ( ) *Toxic Materials*
- ( ) *Oil & Grease*
- ( ) *Floatable Materials*
- ( ) *Other Construction Waste*

- (●) *Likely to Have Significant Impact*
- ( ) *Probable Low or Unknown Impact*

Implementation Requirements

- (◒) *Capital Costs*
- ( ) *O&M Costs*
- (◒) *Maintenance*
- ( ) *Training*
- ( ) *Suitability for Slopes >5%*

(●) *High* ( ) *Low*

ESC41

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: CHECK DAMS

Check dams create small pools in swales and ditches which drain 10 acres or less. These pools reduce the velocity of storm water flows, thus reducing erosion of the swale/ditch. Sedimentation also occurs in these small pools, but probably results in little net sediment removal because of the small detention time and probable scour during longer storms. A sediment trap (ESC55) may be placed immediately upstream of the check dam to increase sediment removal efficiency (but never in a natural stream or channel). Check dams should not be placed in swales/ditches with a base flow during some or all of the year.

Installation/Application Criteria

Check dams must be sized and constructed correctly and maintained properly, or they will be either washed out or cause flooding. Check dams can be constructed of either rock or logs. Use of other natural materials available on-site that can withstand the stormwater flow velocities is acceptable, such as pea-gravel filled in sand bags. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

A sediment trap (ESC55) may be installed immediately upstream of the check dam, but may be of limited effectiveness if channel flows are large enough to scour the trap during moderate to large storms. Maximum velocity reduction is achieved if the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center section of the dam should be lower than the edge sections so that the check dam will act like a weir during major floods.

Rock check dams are usually constructed of appropriately 8” to 12" rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam must completely span the ditch or swale to prevent washout. The rock used must be large enough to stay in place given the expected design flow through the channel.

Log check dams are usually constructed of 4 to 6-inch diameter logs. The logs should be embedded into the soil at least 18 inches.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swale is greater than 4 percent).

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Mariposa County, Arizona, September 1992.

“Draft - Sedimentation and Erosion Control, An Inventory of Current Practices”, U.S.E.P.A., April, 1990.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

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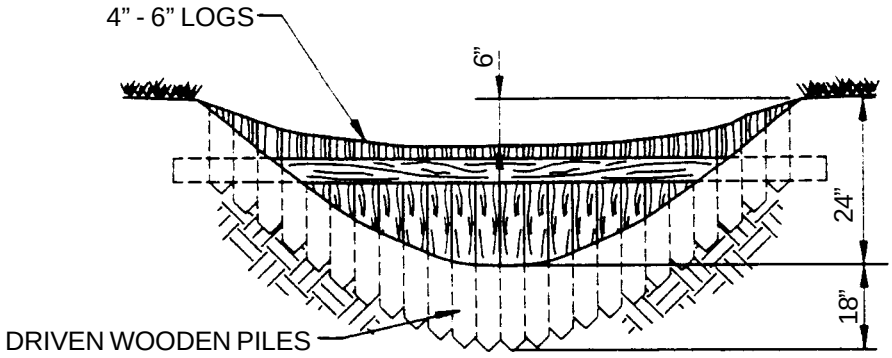
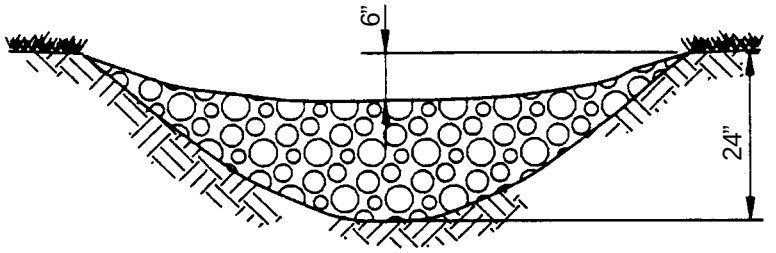
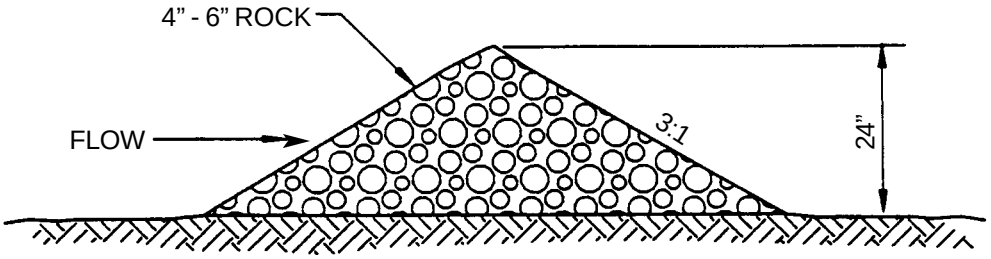
ADDITIONAL INFORMATION: CHECK DAMS



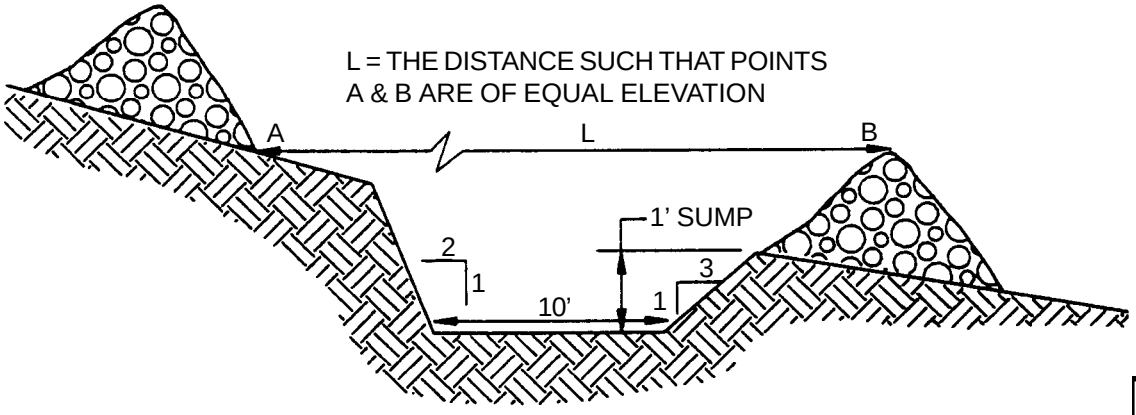
LOG CHECK DAM



ROCK CHECK DAM



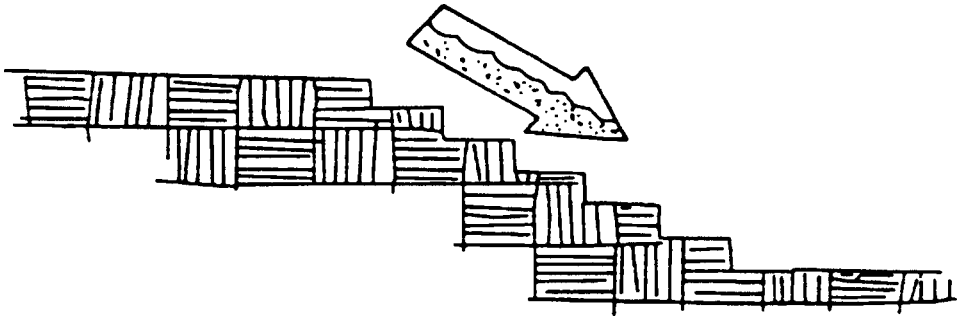
ROCK CHECK DAM CROSS-SECTION



SPACING BETWEEN CHECK DAMS

ESC41

BMP: SLOPE ROUGHENING/TERRACING



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas* (●)
- *Protect Slopes/Channels* (●)
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DEFINITION

Slope roughening/terracing creates microclimates for establishing vegetation, reduces runoff velocity, increases infiltration, and provides small depressions for trapping sediment.

SUITABLE APPLICATIONS

- Any cleared area prior to seeding and planting.
- Required for cleared, erodible slopes steeper than 3:1 and higher than 5 feet prior to seeding and planting.

INSTALLATION/APPLICATION CRITERIA

Slope roughening/terracing is performed in several ways:

- Stair-step grading.
- Grooving.
- Furrowing.
- Tracking.
- Rough grading.
- No grading.

REQUIREMENTS

- Maintenance
  - Inspect roughened slopes weekly and after rainfall for excessive erosion.
  - Revegetate as quickly as possible.
- Cost: (source: EPA, 1992)
  - Surface Roughening: Performed at no (e.g., rough grading) to low (e.g., tracking) cost.
  - Terracing: Average annual cost is $4 per linear foot (2 year useful life).

LIMITATIONS

- Roughening is of limited effectiveness on its own, but is used to speed revegetation.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ● *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC42

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: SLOPE ROUGHENING/TERRACING

Slope roughening/terracing creates uneven depressions, steps or grooves on the soil surface to aid in establishment of vegetation, reduce runoff velocity, increase infiltration, and provide for sediment trapping.

Surface roughening may be applied to all slopes steeper than 3:1, and greater than 5 vertical feet, providing some instant erosion protection on bare soil while vegetative cover is being established. It is an inexpensive, simple and short-term erosion control measure for roadway cut slopes.

Terracing usually is a more permanent measure used to stabilize a steep slope. Terraces should be designed by a registered professional engineer and included in the project construction plans. Local design criteria should be used.

Installation/Application

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but they encourage water infiltration, speed the establishment of vegetation, and decreased runoff velocity. Rough, loose soil surfaces give lime, fertilizer, and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.
2. Graded areas steeper than 3:1 should be stair-stepped with benches (See figure at end of fact sheet). The stair stepping will help vegetation become attached and also trap soil eroded from the slopes above. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment.
3. Areas which will be mowed (there areas should have slopes less than 3:1) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the *soil* surface is severely compacted and runoff is increased. Tracking can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, in leaving a pattern of cleat imprints parallel to slope contours.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

Handbook of Steel, Drainage & Highway Construction, American Iron and Steel Institute, 1983.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April, 1992.

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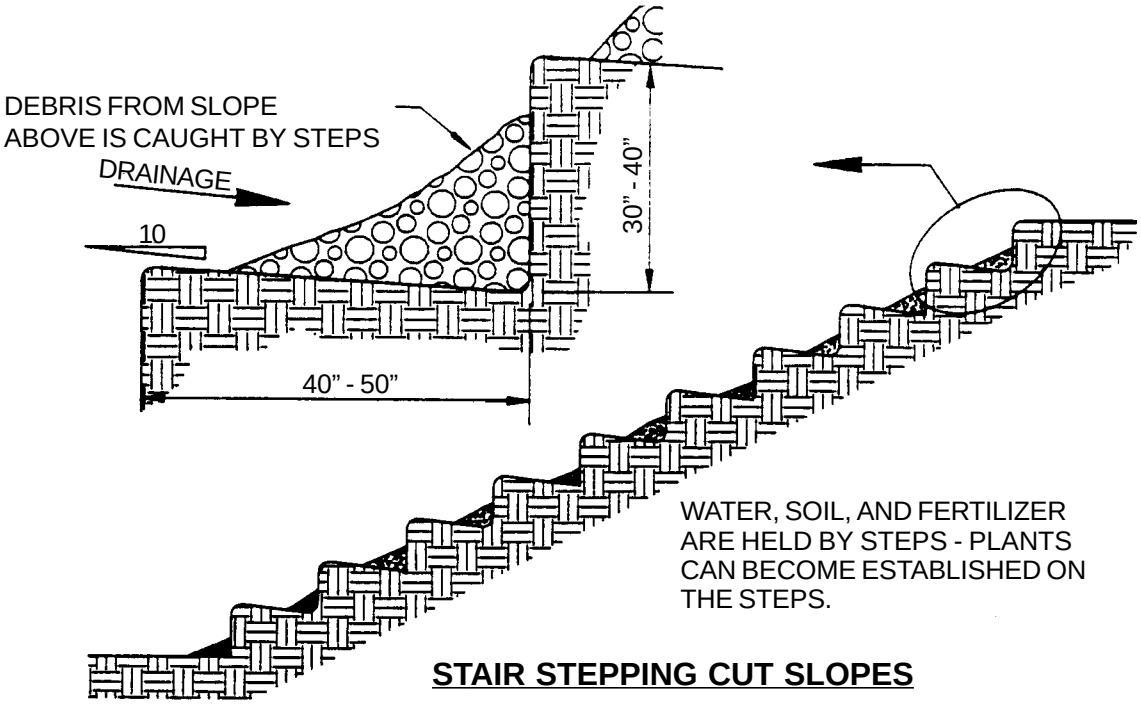
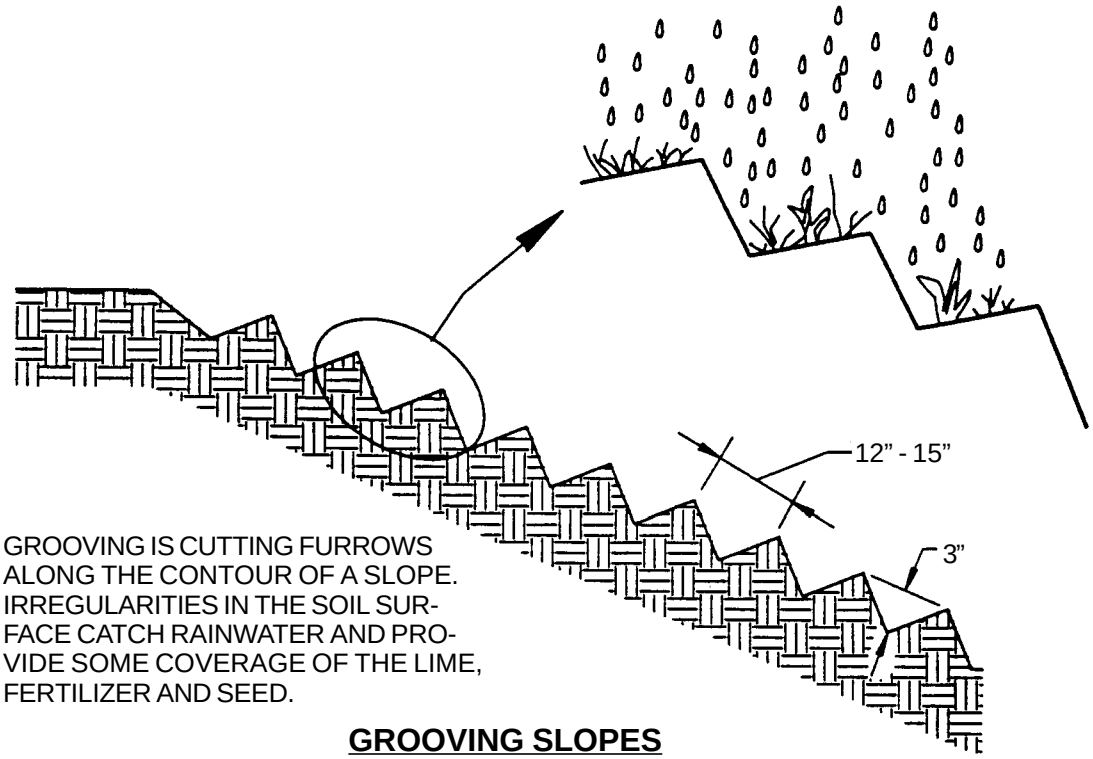
ESC42

ADDITIONAL INFORMATION: SLOPE ROUGHENING/TERRACING



STAIR STEPPING CUT SLOPES

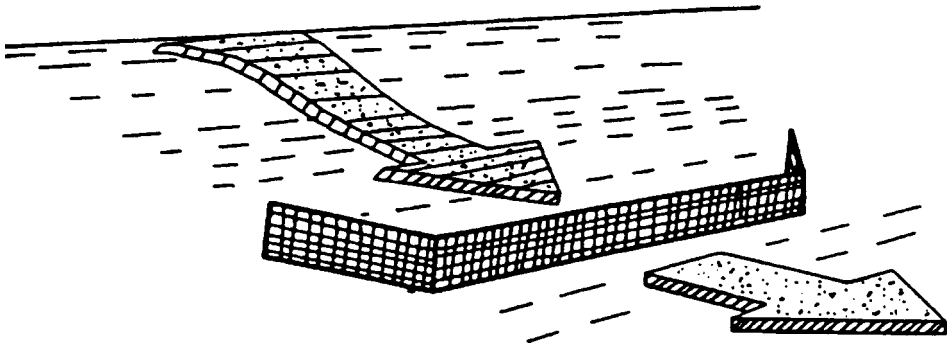


GROOVING SLOPES

ESC42

STAIR-STEPPING CUT SLOPES AND GROOVING SLOPES

BMP: SILT FENCE



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter* (●)
- *Control Internal Erosion* (●)

GENERAL DESCRIPTION

A silt fence is made of a filter fabric which has been entrenched, attached to supporting poles, and sometimes backed by a wire fence for support. The silt fence detains sediment laden water, promoting sedimentation behind the fence.

SUITABLE APPLICATIONS

- Along the perimeter of the site.
- Below the toe of a cleared slope.
- Along streams and channels.
- Around temporary spoil areas.
- Across swales with catchments less than 1 acre.
- Below other small cleared areas.

INSTALLATION/APPLICATION

- Use principally in areas where sheet flow occurs.
- Install along a level contour so water does not pond more than 1.5 feet at any point.
- No more than 1 acre, 100 ft, or 0.5 cfs of concentrated flow should drain to any point along the silt fence.
- Turn ends of fence uphill.
- Provide area behind the fence for runoff to pond and sediment to settle (approx. 1200 sq. ft. per acre draining to the silt fence).
- Select filter fabric which retains 85% of the soil, by weight, based on sieve analysis, but is not finer than an equivalent opening size of 70.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rainfall.
  - Repair wherever fence is damaged.
  - Remove sediment when it reaches 1/3 the height of the fence.
- Cost (source: EPA, 1992)
  - Average annual cost for installation and maintenance (assumes 6 month useful life): $7 per lineal foot ($850 per drainage acre)

LIMITATIONS

- Do not use where 85% of the soil, by weight, passes through a No. 200 sieve because the filter fabric will clog.
- Do not place fence on a slope, or across any contour line.
- Do not use in streams, channels or anywhere flow has concentrated.
- Do not use in locations where ponded water may cause flooding.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

● *Likely to Have Significant Impact*
○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ◒ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC50

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: SILT FENCE

A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of the fabric used, supported with wire fence. Silt fences trap sediment in two ways: (1) by intercepting and detaining small amounts of sediment from disturbed areas during construction operations, in order to promote sedimentation behind the fence; and (2) by decreasing the velocity of low flows (up to 0.5 cfs) in swales.

Silt fences may be used for perimeter control, placed upstream of the point(s) of discharge of sheet flow from a site. They may also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion, and perpendicular to minor swales or ditch lines for up to one acre contributing drainage areas. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows.

Installation/Application

Planning:

Silt fences are generally most effective when the following placement criteria are followed:

- Limit the upstream drainage area to 1 acre or less when used alone or in combination with sediment basin in a larger site.
- The maximum slope perpendicular to the fence line should be 1:1.
- Limit the maximum sheet or overland flow path length to any point along the fence to 100 feet.
- Limit the concentrated flows reaching the fence to 0.5 cfs.

Silt fences are preferable to straw barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw barriers, there are many instances where silt fences have been improperly installed. The following installation methods can improve performance and should be followed:

- Construct the silt fence along a level contour.
- Silt fences should remain in place until the disturbed area is permanently stabilized.
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 sq. ft. of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent storm water from flowing around the fence.
- Leave an undisturbed or stabilized area immediately downslope from the fence.
- Do not place in live streams or intermittently flowing channels.

Design:

Selection of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer should specify a filter fabric that retains the soil found on the construction site yet will have openings large enough to permit drainage and prevent clogging. The following criteria is recommended for selection of the equivalent opening size:

1. If 50 percent or less of the soil, by weight, will pass the U.S. standard sieve No. 200, select the EOS to retain 85 percent of the soil. The EOS should not be finer than EOS 70.
2. For all other soil types, the EOS should be no larger than the openings in the U.S. Standard Sieve No. 70 [0.0083 in. (0.21 mm.)] except where direct discharge to a stream, lake, or wetland will occur, then the EOS should be no larger than Standard Sieve No. 100.

ESC50

ADDITIONAL INFORMATION: SILT FENCE

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100 [0.0059 in. (0. 15 mm.)]. If 85 percent or more of a soil, by weight, passes through the openings in a No. 200 sieve [0.0029 in. (0.074 mm.)], filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large, and they would clog the fabric quickly if the EOS was small enough to capture the soil.

The fence should be supported by a wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0º F. to 120º F.

Installation Guidelines:
Filter fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- Posts should be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 30 inches.
- A trench should be excavated approximately 8 inches wide and 12 inches deep along the line of posts and upslope from the barrier.
- When standard strength filter fabric is used, a wire mesh support fence should be fastened securely to the upslope side of the posts using heavy-duty wire staples at least 1 inch long, tie wires or hog rings. The wire should extend into the trench a minimum of 4 inches.
- The standard strength filter fabric should be stapled or wired to the fence, and 40 inches of the fabric should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the wire mesh support fence may be eliminated and the filter fabric stapled or wired directly to the posts.
- Avoid the use of joints. The filter fabric should be purchased in a continuous roll, then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 inch overlap, and both ends securely fastened to the post
- The trench should be backfilled with compacted native material.

Requirements
Maintenance:

Inspect monthly during dry periods and immediately after each rainfall. Repair as necessary. Sediment must be removed when it reaches approximately one third the height of the fence, especially if heavy rains are expected.

Filter fences should not be removed until the upslope area has been permanently stabilized.

Limitations
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Filter fences are not practical where large flows of water are involved, hence the need to restrict their use to drainage areas of one acre or less, and flow rates of less than 0.5 cfs.
- Problems may arise from incorrect selection of pore size and/or improper installation.
- Do not allow water depth to exceed 1.5 ft. at any point.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.

ESC50

ADDITIONAL INFORMATION: SILT FENCE

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

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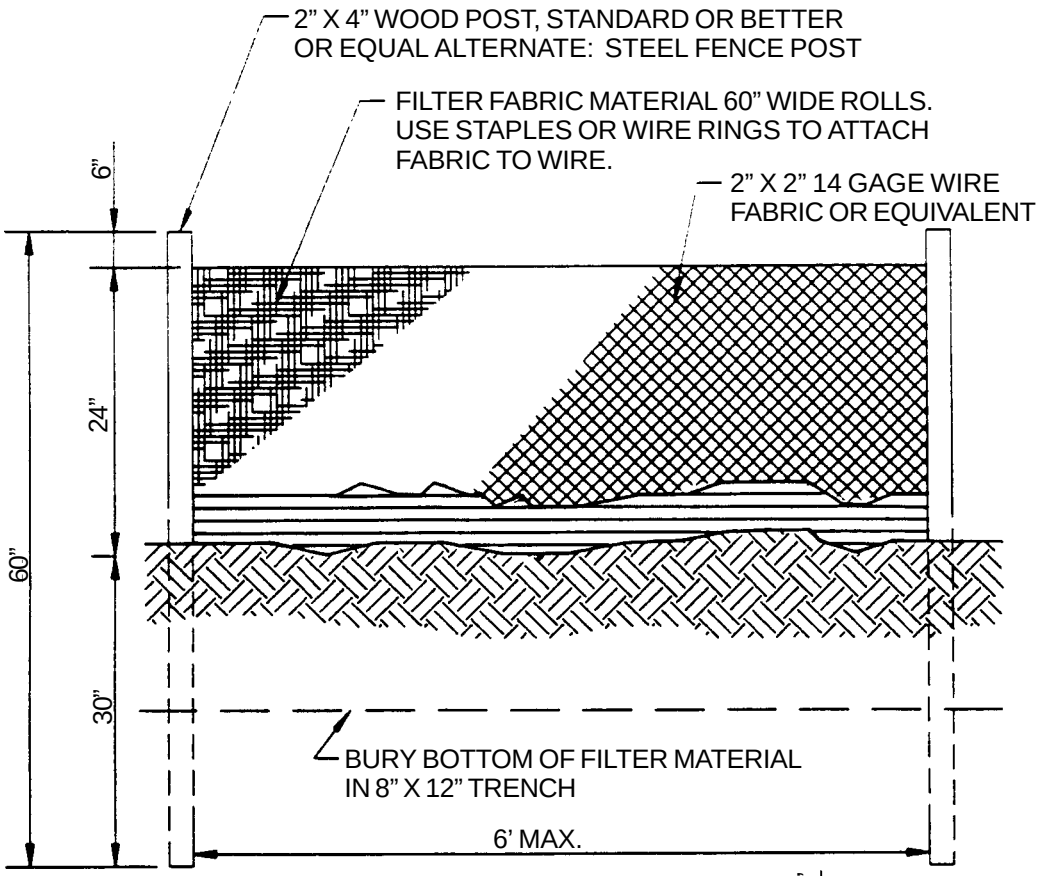
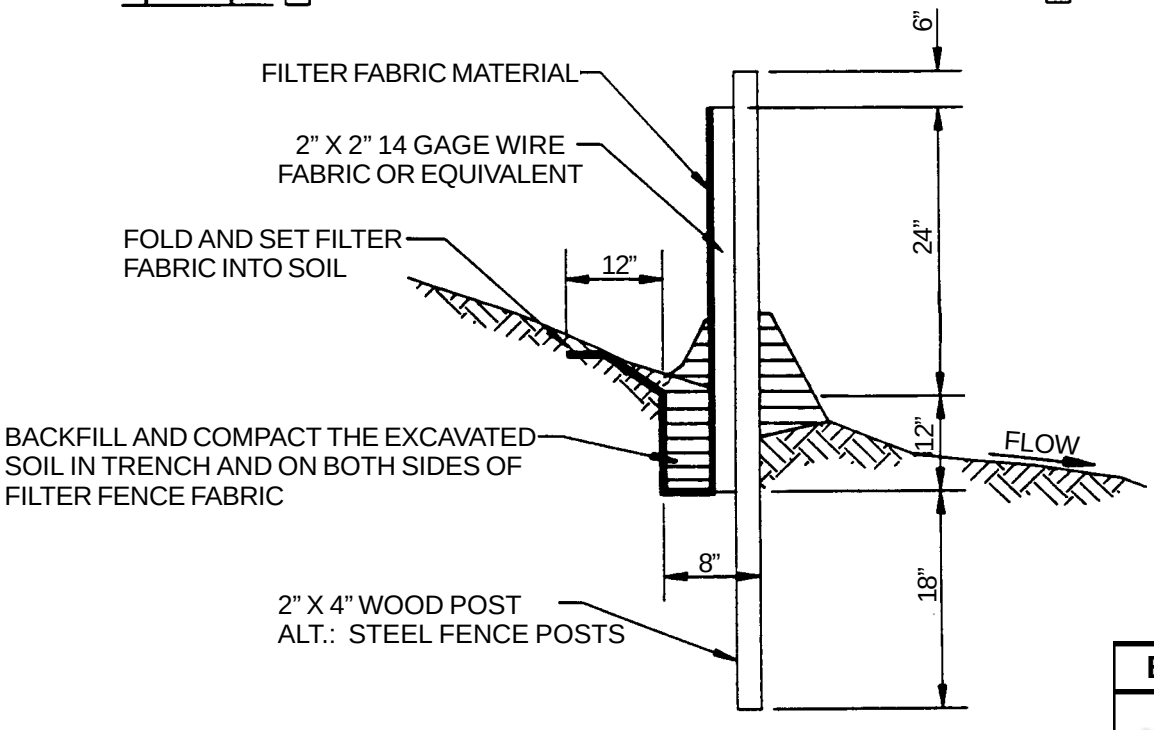
ADDITIONAL INFORMATION: SILT FENCE





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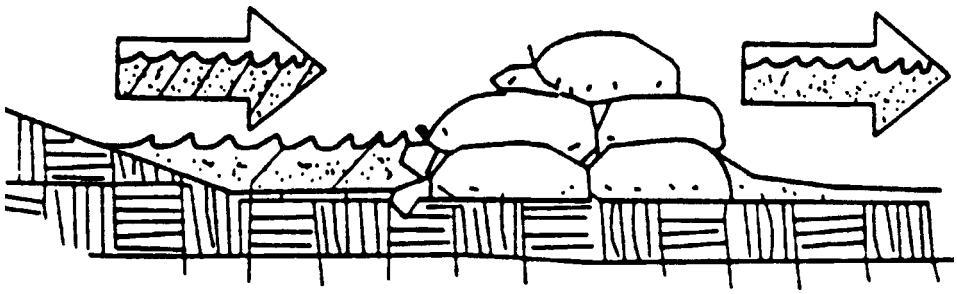
SILT FENCE

BMP: SAND BAG BARRIER



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DEFINITION

Stacking sand bags along a level contour creates a barrier which detains sediment-laden water, ponding water upstream of the barrier and promoting sedimentation.

SUITABLE APPLICATIONS

- Along the perimeter of the site.
- Check dams across streams and channels.
- Along streams and channels.
- Barrier for utility trenches in a channel.
- Across swales with small catchments.
- Division dike or berm.
- Below the toe of a cleared slope.
- Create a temporary sediment trap.
- Around temporary spoil areas.
- Below other small cleared areas.

INSTALLATION/APPLICATION CRITERIA

- May be used in drainage areas up to 5 acres.
- Install along a level contour.
- Base of sand bag barrier should be at least 48 inches wide.
- Height of sand bag barrier should be at least 18 inches high.
- 4 inch PVC pipe may be installed between the top layer of sand bags to drain large flood flows.
- Provide area behind barrier for runoff to pond and sediment to settle, size according to sediment trap BMP criteria (ESC55).
- Place <u>below</u> the toe of a slope.
- Use sand bags large enough and sturdy enough to withstand major flooding.

REQUIREMENTS

- Maintenance
  - Inspect after each rain.
  - Reshape or replace damaged sand bags immediately.
  - Remove sediment when it reaches six inches in depth.
- Cost
  - Sand bag barriers are more costly, but typically have a longer useful life than other barriers.

LIMITATIONS

- Sand bags are more expensive than other barriers, but also more durable.
- Burlap should not be used for sand bags.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ● *Capital Costs*
- ○ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ◒ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC52

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: SAND BAG BARRIER

Suitable Applications

Sand bag berms may be used during construction activities in stream beds and utility construction in channels, temporary channel crossing for construction equipment, etc. Sand bag berms may also be installed parallel to roadway construction. Sand bag berms may also be used to create temporary sediment traps, retention basins and in place of straw bales or silt fences. Examples of applications include:

- Check dams across stream channels.
- Barriers for utility trenches or other construction in a stream channel.
- At temporary channel crossings.
- May be used on a slope where straw bales and silt fences are not appropriate.
- As a diversion dike.
- Embankment for a temporary sediment basin or retention basin.
- Sediment barriers near the toe of slopes.
- At construction perimeter.
- *Permits may be required from the US Army Corps of Engineers and Department of Land and Natural Resources.*

Advantages

- Provides a semi-permeable barrier in potentially wet areas.
- More permanent than silt fences or straw bales.
- Allows for easy relocation on site to meet changing needs during construction.

Installation/Application

Sand bag barriers my be used for sediment trapping in locations where silt fences and straw bale barriers are not strong enough. In addition, sand bag barriers are appropriate to use when construction of check dams or sumps in a stream is undesirable. The sand bag berms can provide the same function as a check dam without disturbing the stream or vegetation. The sand bag berm will also allow a small sediment retention area to be created prior to construction of final detention basins. For installation of a sand bag berm, the following criteria should be observed:

- Drainage Area - Up to five (5) acres.
- Height of Berm - 18 inches minimum height, measured from the top of the existing ground at the upslope toe to the top of the barrier.
- Width of Berm - 48 inches minimum width measured at the bottom of the barrier, 18 inches at the top.
- Sand bag Size - Length 24 to 30 inches, width 16 to 18 inches and thickness six (6) to eight (8) inches. Weight 90 to 125 pounds.
- Sand bag Material - Polypropylene, polyethylene or polyamide woven fabric, minimum unit weight four (4) ounces per square yard, mullen burst strength exceeding 300 psi and ultraviolet stability exceeding 70 percent.
- Use of burlap is discouraged since it rots and deteriorates easily.
- Grade of Sand - Coarse sand, gravel.
- Runoff water should be allowed to flow over the tops of the sand bags or through four (4) inch polyvinyl chloride pipes embedded below the top layer of bags.
- Area behind the sand bag barrier should be established according to sizing criteria for sediment trap BMP (ESC55).

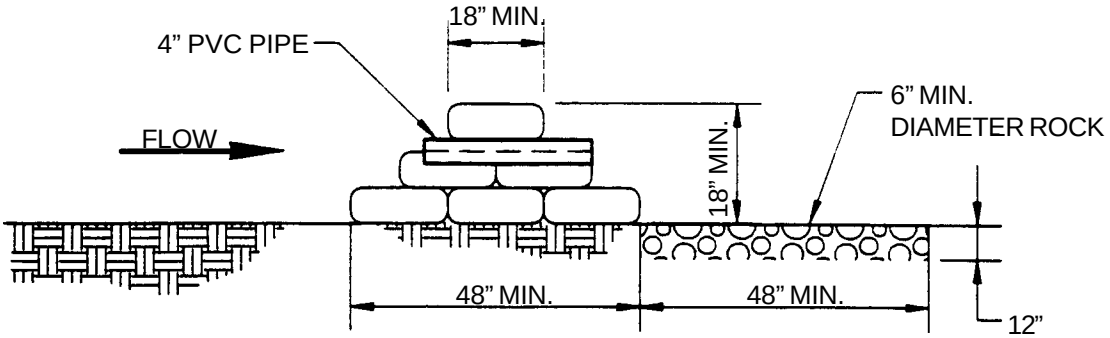
REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona. September 1992.

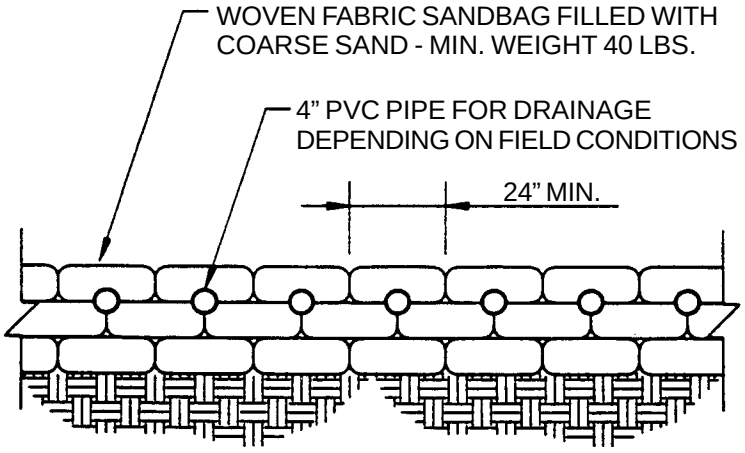
Water Quality Management Plan for the Late Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC52

ADDITIONAL INFORMATION: SAND BAG BARRIER



CROSS SECTION

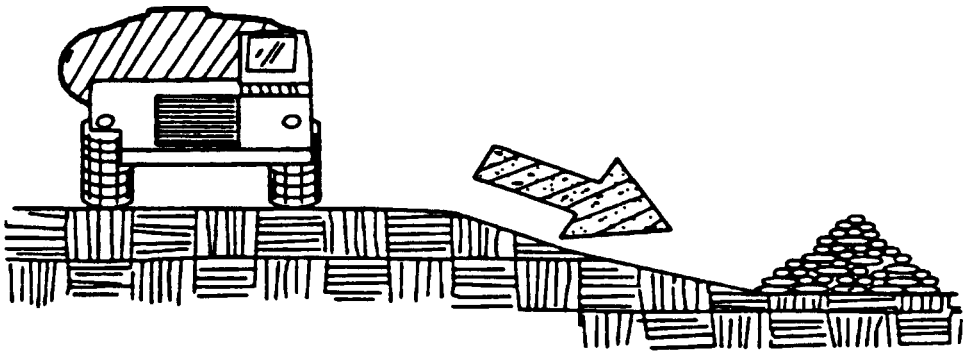


FRONT VIEW

SAND BAG BERM

ESC52

BMP: BRUSH OR ROCK FILTER



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DEFINITION

A rock filter berm is made of rock 3/4 to 3 inches in diameter and placed along a level contour where sheet flow may be detained and ponded, promoting sedimentation. A brush barrier is composed of brush (usually obtained during the site clearing) wrapped in filter cloth and anchored to the toe of the slope. If properly anchored brush or rock filters may be used for sediment trapping and velocity reduction. See Check Dam BMP (ESC41) for more information.

SUITABLE APPLICATIONS

As check dams across mildly sloped construction roads. Below the toe of slopes. Along the site perimeter. Along streams and channels. Around temporary spoil areas. Below other small cleared areas. At sediment traps at culvert/pipe outlets.

INSTALLATION/APPLICATION CRITERIA

- Use principally in areas where sheet or rill flow occurs.
- For rock filter, use larger rock and place in a staked, woven wire sheathing if placed where concentrated flows occur.
- Install along a level contour.
- Leave area behind berm where runoff can pond and sediment can settle.
- Drainage area should not exceed 5 acres.

REQUIREMENTS

- Maintenance
  - Inspect monthly and after each rainfall.
  - If berm damaged, reshape and replace lost/dislodged rock.
  - Remove sediments when depth reaches 1/3 of berm height, or 1 ft.
- Cost
  - Brush filter: Low to moderate cost if debris from on-site clearing and grubbing is used.
  - Rock filter: Expensive, since off-site materials, hand construction and demolition/ removal are usually required.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ◒ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ◒ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC53

BEST MANAGEMENT PRACTICES

BMP: BRUSH OR ROCK FILTER (Continue)

LIMITATIONS

- Rock berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Not appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the filter, possibly causing flooding if sufficient space does not exist.

ESC53

ADDITIONAL INFORMATION: BRUSH OR ROCK FILTER

Rock Filter

A rock filter consists of open graded rock installed at the toe of a slope, along the perimeter of a developing or disturbed area, and as a checkdam across construction roads. Their purpose is to intercept sediment laden runoff from disturbed areas of the site, allow the runoff to pond, promote sedimentation behind the filter, and slowly release the water as sheet flow.

Rock filters are appropriate where a temporary measure is needed to prevent sediments from entering right-of-ways of traffic areas such as near the toe of slopes, incorporated into temporary stabilized construction entrances (ESC26), or at other locations along the construction site perimeter. Rock filters may also be used as check dams across one or more lanes of construction traffic temporary roads, or unsurfaced rights of way subject to construction traffic.

Advantages of the rock filters are that they may be less costly than other temporary barriers, and are relatively efficient at sediment removal.

Installation/Application

Planning:

- Rock filters should be placed along a level contour to intercept sheet flow.
- Allow ample room for ponding, sedimentation, and access by sediment removal equipment between the berm and the toes of slopes.
- Flow through the filter should occur as sheet flow into an undisturbed or stabilized area.
- Installation in stream beds requires large rock, staking of woven wire sheathing, and daily inspection.

Design & Sizing Criteria.

The following design criteria are commonly used to construct filters:

- In Non-Traffic Areas:
  - Maximum flow-through rate per square foot of filter = 60 gpm
  - Height = 18 inches minimum
  - Top width = 24 inches minimum
  - Side slopes = 2:1 or flatter
  - Woven wire sheathing (poultry netting) is recommended in areas of concentrated flow. The wire should be 1 inch diameter hexagonal mesh, galvanized 20 gauge.
  - Build the filter along on a level contour.
  - Rock: 3/4 to 3 inches open graded for sheet flow, 3 to 5 inches open graded for concentrated flow.

- In Construction Traffic Areas:
  - Height = 12" maximum
  - Provide multiple filters in series, spaced as shown.
    Every 300 ft on slopes less than 5 percent
    Every 200 ft on slopes 5 to 10 percent
    Every 100 ft on slopes greater than 10 percent.

Brush Filter

Brush filters trap and filter sediments in a manner similar to other barriers in this handbook (e.g., silt fence, straw bale barrier, rock filter), but have the advantage of being constructed from brush cleared from the site and usually disposed off-site at a cost.

ESC53

ADDITIONAL INFORMATION: BRUSH OR ROCK FILTER

Steps in Construction of a Brush Filter:

1. Stack the brush at the toe of a slope or along the perimeter of the site just outside the limits of clearing and grabbing. The brush may be stacked up to 15 ft. high and 15 ft. wide.
2. Construct a trench 1 to 3 ft. deep immediately upslope from the brush.
3. Place filter fabric over the brush filter and in the trench, extending 1 to 2 ft upslope of the trench.
4. Backfill the trench with aggregate or compacted soil. The trench should be deep enough and backfill material sufficient to hold the barrier in place during a storm.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September, 1992.

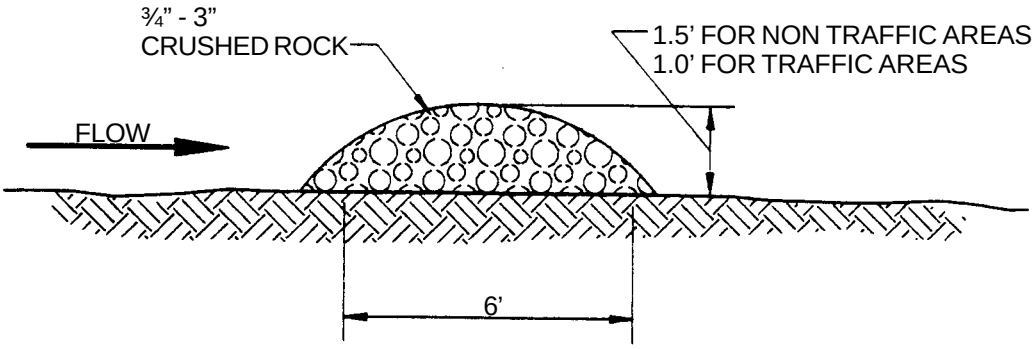
Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

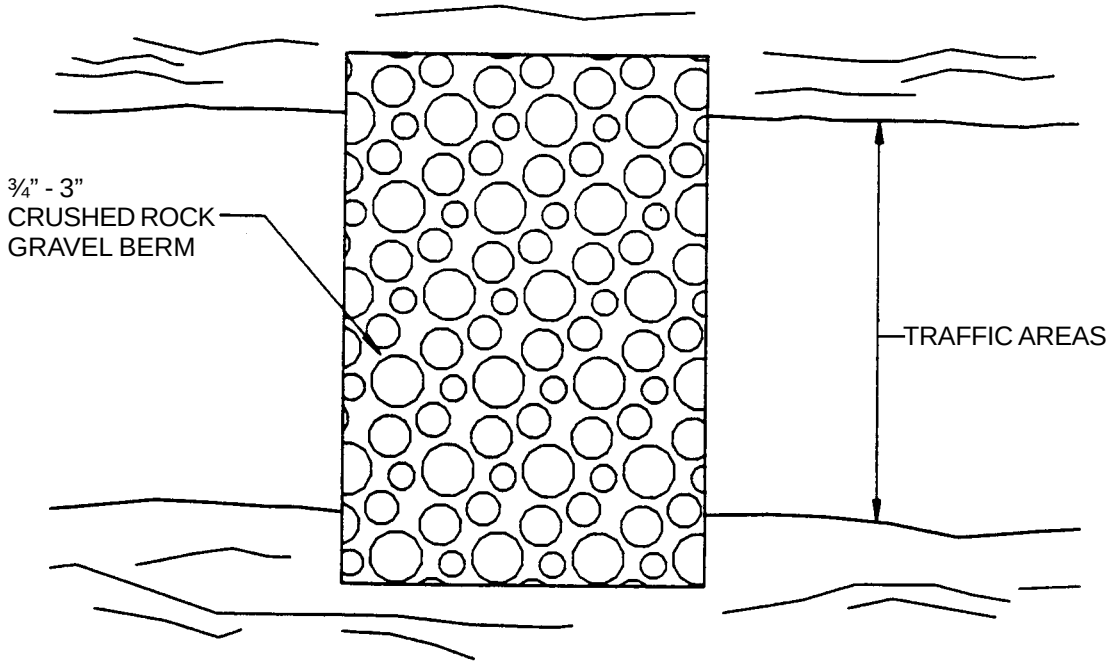
Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Storm Water Pollution Plan Handbook, First Edition, State of California. Department of Transportation Division of New Technology, Materials and Research, October 1992.

ESC53

ADDITIONAL INFORMATION: BRUSH OR ROCK FILTER



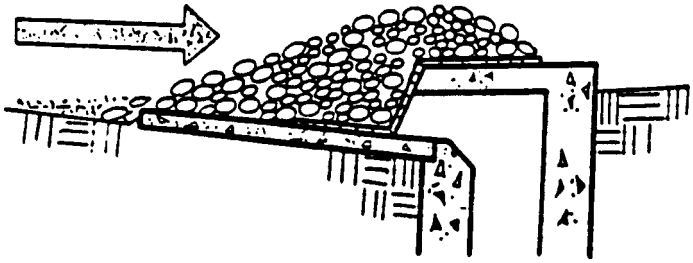


PLAN

GRAVEL FILTER BERM

ESC53

BMP: STORM DRAIN INLET PROTECTION



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DEFINITION

Devices of various designs which detain sediment-laden runoff and allow the sediment it to settle prior to discharge into a storm drain inlet or catch basin.

SUITABLE APPLICATIONS

- Every storm drain inlet receiving sediment-laden runoff should be protected, either by covering the inlet or promoting sedimentation upstream of the inlet.

INSTALLATION/APPLICATION

- Five types of inlet protection are presented below, however, it is recognized that other effective methods and proprietary devices exist and may be selected:
  - Filter Fabric Fence: Appropriate for drainage basins less than one acre with less than a 5 percent slope.
  - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
  - Gravel and Wire Mesh Filter: Used on curb or drop inlets where construction equipment may drive over the inlet.
  - Sand bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets.
  - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (see Sediment Trap ESC55).
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Use only for drainage areas smaller than one acre unless a sediment trap first intercepts the runoff.
- Provide area around the inlet for water to pond without flooding structures and property.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rain.
  - Replace clogged filter fabric or stone filters immediately.
  - Remove sediment when depth exceeds half the height of the filter, or half the depth of the sediment trap.
  - Remove as soon as upstream soils are stabilized and streets are swept.
- Cost (source: EPA, 1992)
  - Average annual cost for installation and maintenance (1 year useful life) is $150 per inlet.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ○ *Toxic Materials*
- ○ *Oil & Grease*
- ◒ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ◒ *Capital Costs*
- ○ *O&M Costs*
- ◒ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC54

BEST MANAGEMENT PRACTICES

LIMITATIONS

- Drainage area should not exceed 1 acre.
- Runoff will bypass protected inlets on slopes.
- Ponding will occur at a protected inlet, with possible short-term flooding.
- Straw bales are not effective for inlet protection.

ESC54

ADDITIONAL INFORMATION: STORM DRAIN INLET PROTECTION

Storm drain inlet protection consists of a sediment filter or an impounding area around or upstream of a storm drain, drop inlet, or curb inlet. This erosion and sedimentation control BMP prevents excessive sediment from entering storm drainage systems prior to permanent stabilization of the disturbed area.

All on-site storm drain inlets should be protected. Off-site, inlets should be protected in areas where construction activity tracks sediment onto paved areas or where inlets receive runoff from disturbed areas.

Installation/Application Criteria

Planning

Large amounts of sediment may enter the storm drain system when storm drains are installed before the upslope drainage area is stabilized, or where construction is adjacent to an existing storm drain. In cases of extreme sediment loading, the storm drain itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through a temporary Sediment Trap (see ESC56). Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Inlet protection methods not presented in this handbook should be approved by the *City*.

General Design and sizing criteria:

- Grates and spaces around all inlets should be scaled to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed) 1 to 2 feet with 2:1 side slopes around the inlet.

Installation procedures for filter fabric fence:

a. Place 2 inch by 2 inch wooden stakes around the perimeter of the inlet a maximum of 3 feet apart and drive them at least 8 inches into the ground. The stakes must be at least 3 feet long.
b. Excavate a trench approximately 8 inches wide and 12 inches deep around the outside perimeter of the stakes.
c. Staple the filter fabric (for materials and specifications, see Silt Fence ESC50) to wooden stakes so that 32 inches of the fabric extends out and can be formed into the trench. Use heavy-duty wire staples at least one inch in length.
d. Backfill the trench with 3/4 inch or less washed gravel all the way around.

Installation procedure for block and gravel filter:

a. Place hardware cloth or comparable wire mesh with one-half inch openings over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.
b. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 inches, 8 inches, and 12 inches wide. The row of blocks should be at least 12 inches but no greater than 24 inches high.
c. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with one half inch openings.
d. Pile washed stone against the wire mesh to the top of the blocks. Use 3/4 to 3 inch gravel.

Installation procedure for gravel and wire mesh filters:

a. Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Use hardware cloth or comparable wire mesh with one-half inch openings. If more than one strip of mesh is necessary, overlap the strips. Place filter fabric over wire mesh.

ESC54

b. Place 3/4 to 3 inch gravel over the filter fabric/wire mesh. The depth of the gravel should be at least 12 inches over the entire inlet opening (see attached figure).

Installation procedure for sand bag barrier:

a. Use sand bag made of geotextile fabric (not burlap), and fill with 3/4 in. rock or 1/4 in. pea gravel.
b. Construct on gently sloping street.
c. Leave room upstream of barrier for water to pond and sediment to settle.
d. Place several layers of sand bags -- overlapping the bags and packing them tightly together.
e. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10-year storm) should not overtop the curb.

Maintenance Requirements

- For filter fabric fences: Inspections should be made on a regular basis, especially after large storm events. If the fabric becomes clogged, it should be replaced. Sediment should be removed when it reaches approximately one-half the height of the fence. If a sump is used, sediment should be removed when it fills approximately one-half the depth of the hole.
- For gravel filters: If the gravel becomes clogged with sediment, it must be carefully removed from the inlet, and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, use the sediment-laden stone instead as fill and put fresh stone around the inlet.
- The inlet protection should be removed 30 days after the upslope area has been fully stabilized. Any sediment around the inlet must be carefully removed and disposed.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September, 1992.

"Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursetynsky, P.E., McGraw Hill Book Company.

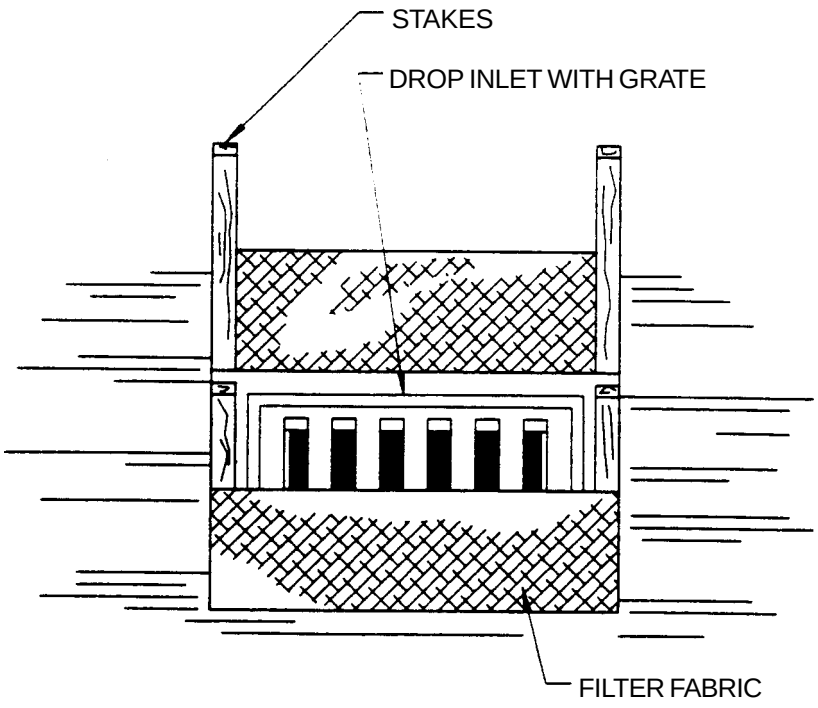
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, June 1981.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April, 1992.

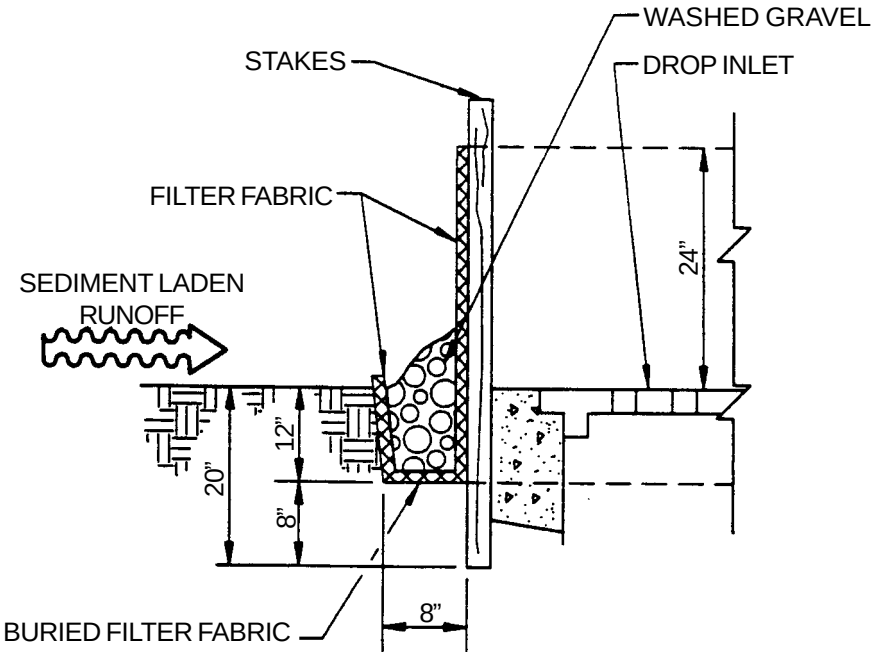
Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

Storm Water Pollution Prevention Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials, and Research, October 1992.

ESC54



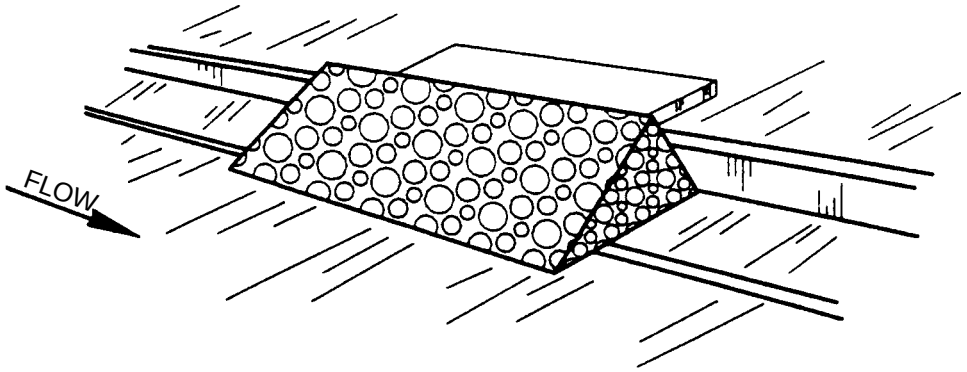
STRAW BALE BARRIERS

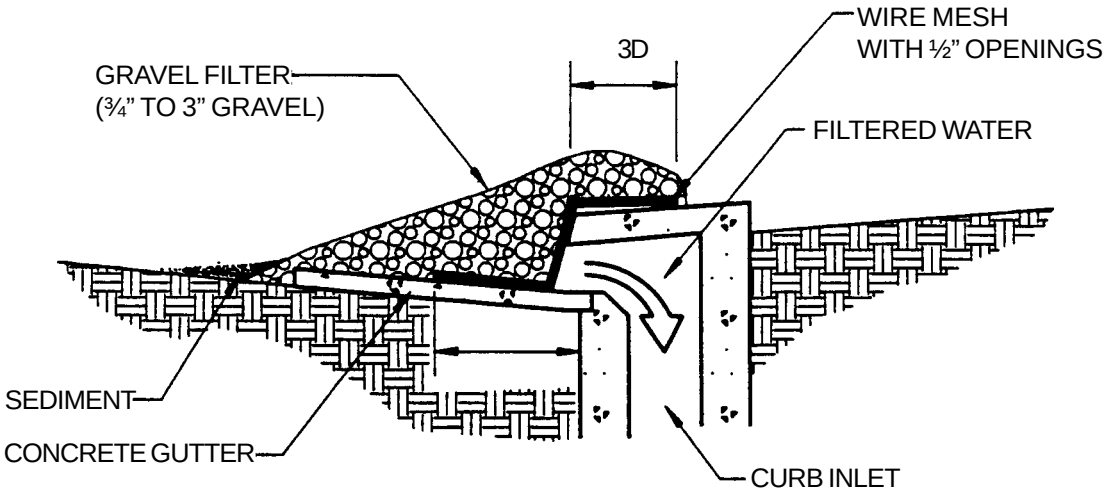


PROFILE

ESC54

FILTER FABRIC FENCE DROP INLET FILTER

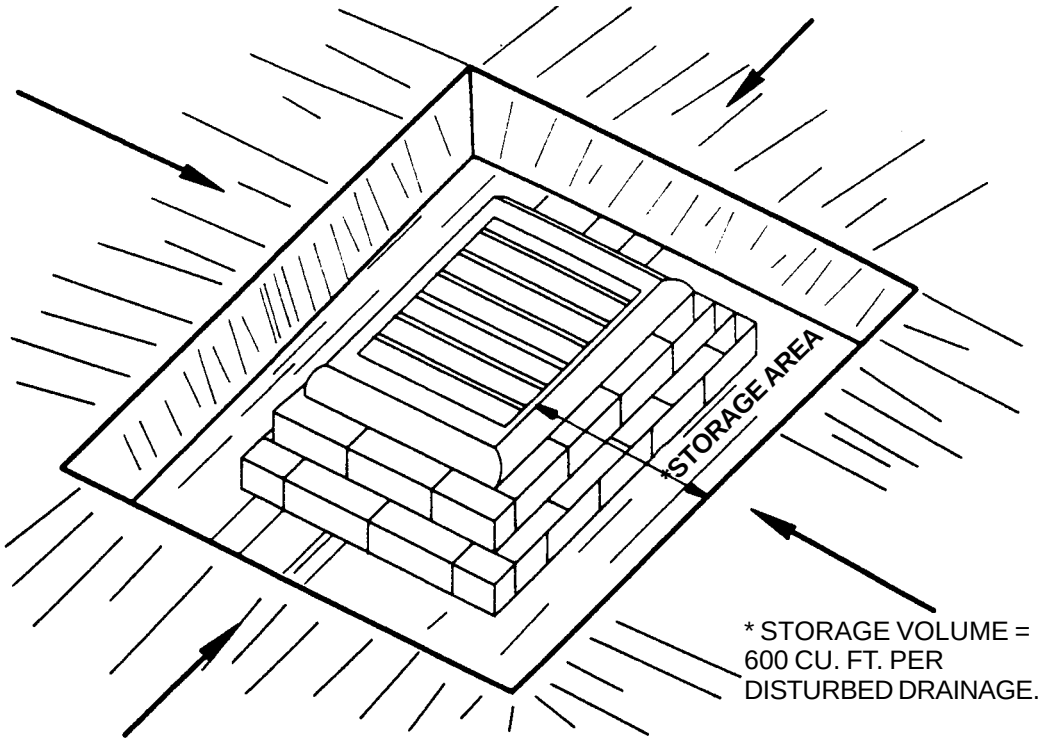


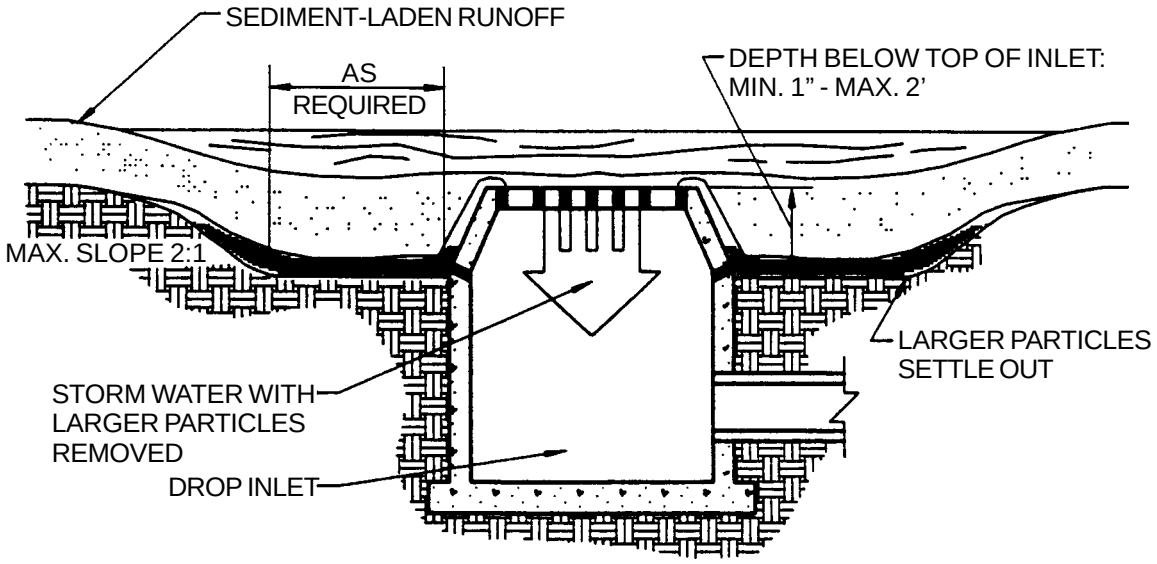


GRAVEL AND WIRE MESH FILTER FOR CURB INLET

ESC54

ADDITIONAL INFORMATION: STORM DRAIN INLET PROTECTION

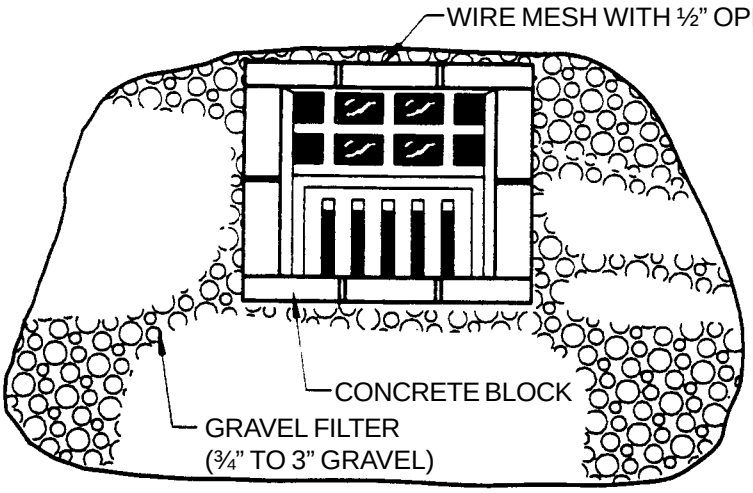


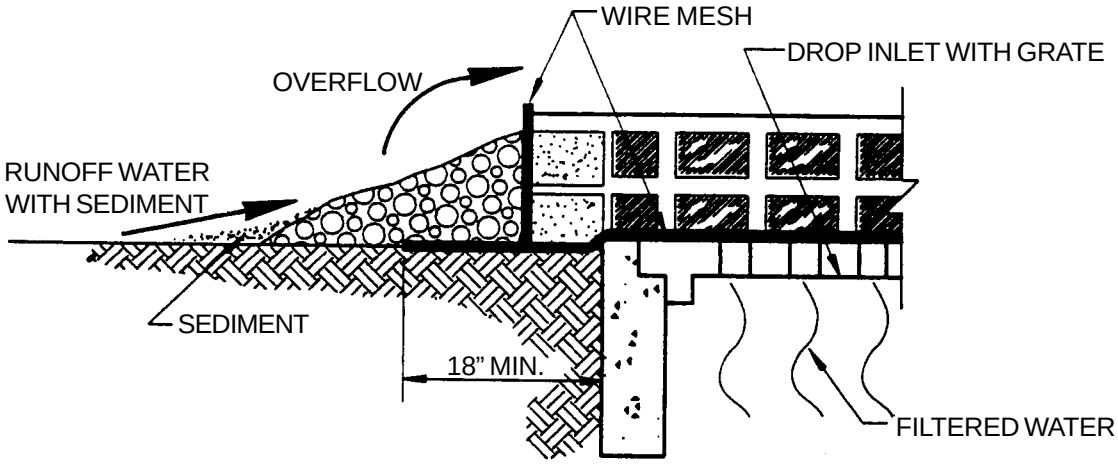


THIS METHOD OF INLET PROTECTION IS APPLICABLE WHERE HEAVY FLOWS ARE EXPECTED AND WHERE AND OVERFLOW CAPABILITY AND EASE OF MAINTENANCE ARE DESIRABLE.

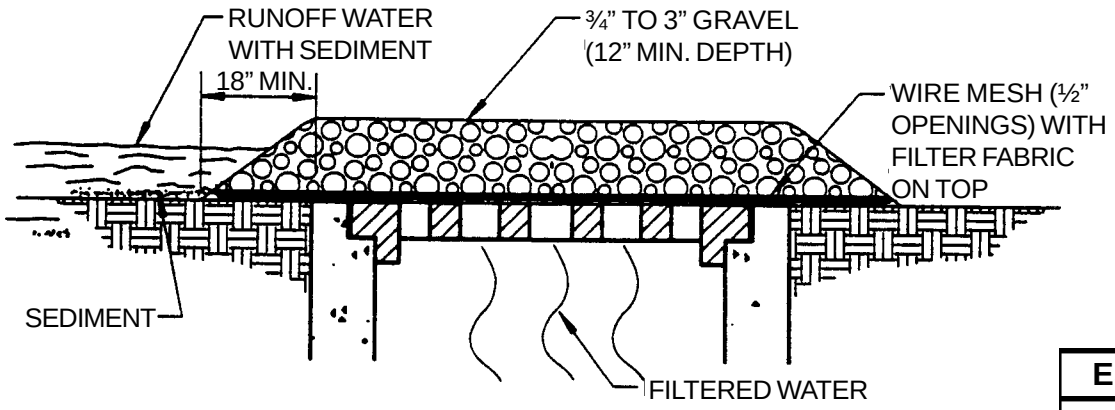
ESC54

EXCAVATED DROP INLET SEDIMENT TRAP





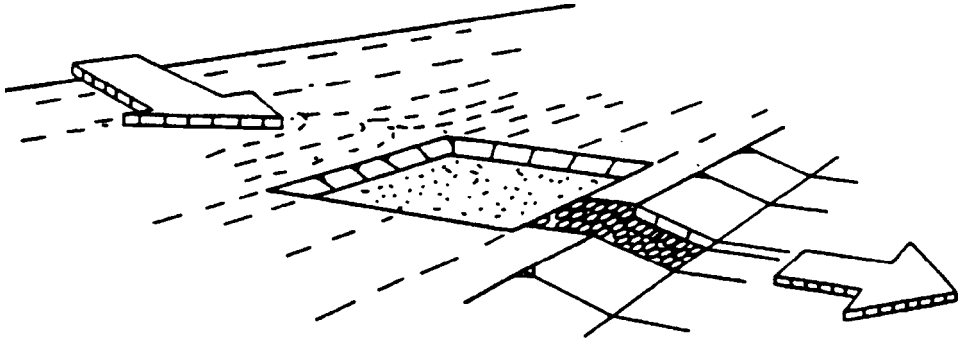
BLOCK AND GRAVEL FILTER AT DROP INLET



GRAVEL AND WIRE MESH FILTER FOR DROP INLET

ESC54

BMP: SEDIMENT TRAP



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion*

GENERAL DEFINITION

A sediment trap is a small, excavated or bermed area where runoff from small drainage areas is detained and sediment can settle.

SUITABLE APPLICATIONS

- Any disturbed area less than 5 acres. (Sediment Basin, ESC56, must be used for drainage areas greater than 5 acres).
- Along the perimeter of the site at locations where sediment-laden runoff is discharged off-site.
- Around and/or upslope from storm drain inlet protection measures.
- At any point within the site where sediment-laden runoff can enter stabilized or natural areas or waterways.

INSTALLATION/APPLICATION CRITERIA

- Build outside the area to be graded before clearing, grubbing, and grading begin.
- Locate where the trap can be easily cleared of sediment.
- Trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency.
- The larger the trap, the less frequently sediment must be removed.
- The outlet of the trap must be stabilized with rock, vegetation, or another suitable material.
- A stable emergency spillway must be installed to safely convey major floods (*see City drainage requirements*).

REQUIREMENTS

- Maintenance
  - Remove sediment when the sediment storage zone is no more than 1 ft. from being full.
  - Inspect weekly and after each rain.
- Cost (source: EPA, 1992)
  - Average annual cost per installation and maintenance (18 month useful life) is \$0.70 per $ft.^3$ (\$1,300 per drainage acre).

LIMITATIONS

- Only use for drainage areas up to 5 acres (see *Sediment Basin ESC56* for larger areas).
- Only removes coarse sediment (medium silt size and larger) unless sized like a sedimentation basin.

Targeted Pollutants

- ● *Sediment*
- ○ *Nutrients*
- ◒ *Toxic Materials*
- ○ *Oil & Grease*
- ○ *Floatable Materials*
- ○ *Other Construction Waste*

- ● *Likely to Have Significant Impact*
- ○ *Probable Low or Unknown Impact*

Implementation Requirements

- ○ *Capital Costs*
- ◒ *O&M Costs*
- ○ *Maintenance*
- ○ *Training*
- ○ *Suitability for Slopes >5%*

● *High* ○ *Low*

ESC55

BEST MANAGEMENT PRACTICES

ADDITIONAL INFORMATION: SEDIMENT TRAP

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation and/or by constructing an earthen embankment. Its purpose is to collect and store sediment from sites cleared and/or graded during construction. It is intended for use on small drainage areas, with no unusual drainage features, and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately 6 months, and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Application Criteria

Planning:

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to *Sediment Basin (ESC56)*, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed of, such as for in fill areas on-site, or removal to an approved off-site dump. Sediment traps used as a perimeter control should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. Also, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks.

1. Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
2. Restrict basin side slopes to 3:1 or flatter.

Design:

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see Sediment Basin ESC56). As a rule of thumb, the larger the basin volume the greater the sediment removal efficiency. Sizing criteria *have been established in the "Rules Relating to Soil Erosion Standards and Guidelines*." The sizing criteria below assume that this runoff volume is *one inch-acre of runoff per acre*. The following criteria should trap moderate to high amounts of sediment in most areas.

- Trap settling volume at least 133 cu. yd. per acre.
- Trap sediment storage volume at least 33 cu. yd. per acre (note: the larger this volume, the less frequently the trap must be cleaned out).
- Trap length greater than twice the basin width.
- Flood volume large enough to contain a major flood without upstream damage and overtopping the embankment.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a barrier or lowhead 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 must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
2. The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.

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3. The trap is removed and the area stabilized when the upslope drainage area has been properly stabilized.
4. All cut-and-fill slopes should be 3:1 or flatter.
5. When a riser is used, all pipe joints must be watertight.
6. When a riser is used, at least the top two-thirds of the riser shall be perforated with 1 to 4 inch diameter holes spaced 8 inches vertically and 10 to 12 inches horizontally. (See Sediment Basin, ESC56).
7. When an earth or stone outlet is used, the outlet crest elevation should be at least 1 foot below the top of the embankment.
8. When a crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be crushed if crushed stone is not available.

REFERENCES

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Rough Draft - July 1992.

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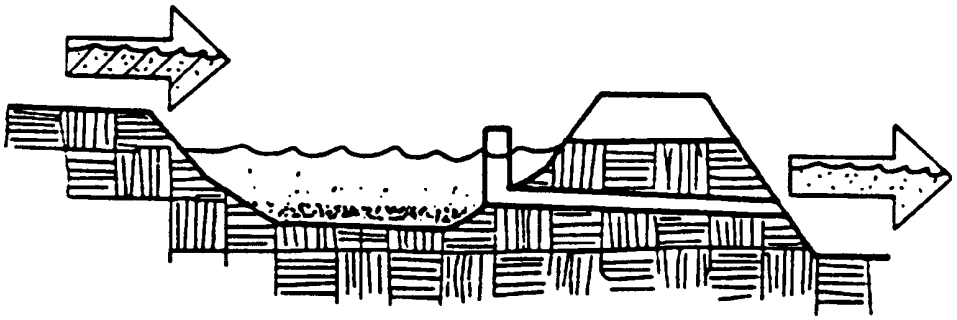
BMP: SEDIMENT BASIN



Objectives

- *Housekeeping Practices*
- *Contain Waste*
- *Minimize Disturbed Areas*
- *Stabilize Disturbed Areas*
- *Protect Slopes/Channels*
- *Control Site Perimeter*
- *Control Internal Erosion* (●)

GENERAL DEFINITION

A pond created by excavation or constructing and embankment, and designed to retain or detain runoff sufficiently to allow excessive sediment to settle.

SUITABLE APPLICATIONS

At the outlet of all disturbed watershed 10 acres or larger. At the outlet of smaller disturbed watersheds, as necessary. Where post construction detention basins will be located. Should be used in association with dikes, temporary channels, and pipes used to divert disturbed areas into the basin and undisturbed areas around the basin.

INSTALLATION/APPLICATION

- Construct before clearing and grading work begins.
- Do <u>not</u> locate in a stream.
- All basin sites should be located where failure of the embankment would not cause loss of life/property damage.
- Large basins are subject to state/local dam safety requirements.
- Securely anchor and install an anti-seep collar on the outlet pipe/riser, and provide an emergency spillway for passing major floods (see local flood control agency).
- The basin volume should be sized to appropriate design *criteria specified by the City*. A detention time of 24 to 40 hours should allow 70 to 80 percent of sediment to settle.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 foot deep.
  - A settling zone at least 2 feet deep.
- The length to settling depth ratio (L/SD) should be less than 200.
- The length to width ratio should be greater than 6:1, or baffles are required to prevent short circuiting.

REQUIREMENTS

- Maintenance
  - Inspect weekly and after each min.
  - Remove sediment where the sediment storage zone is half full.
- Cost: Average annual cost for installation and maintenance (2 year useful life, source: EPA. 1992)
  - Basin less than 50,000 ft.^{3}: $0.40 per ft.^{3} ($700 per drainage acre)
  - Basin size greater than 50,000 ft.^{3}: $0.20 per ft.^{3} ($350 per drainage acre)

Targeted Pollutants

- (●) *Sediment*
- ( ) *Nutrients*
- (◒) *Toxic Materials*
- ( ) *Oil & Grease*
- ( ) *Floatable Materials*
- ( ) *Other Construction Waste*

- (●) *Likely to Have Significant Impact*
- ( ) *Probable Low or Unknown Impact*

Implementation Requirements

- ( ) *Capital Costs*
- (◒) *O&M Costs*
- ( ) *Maintenance*
- ( ) *Training*
- ( ) *Suitability for Slopes >5%*

(●) *High* ( ) *Low*

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BEST MANAGEMENT PRACTICES

LIMITATIONS

- The basin should have shallow side slopes (minimum 4:1) or be fenced to prevent drowning.
- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Basins in excess of 25 feet height and/or an impounding capacity of 50 ac. ft. must obtain approval from *State Department of Land and Natural Resources*.
- Standing water may cause mosquitos or other pests to breed.
- Basins in excess of certain depth and storage volume criteria must meet State *Department of Land and Natural Resources* and *City* safety requirements.

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ADDITIONAL INFORMATION: SEDIMENT BASIN

A sediment basin is a controlled storm water release structure formed by excavation or by constructing an embankment of compacted soil across a drainageway, or other suitable location. Its purpose is to collect and store sediment from sites cleared and/or graded during construction or for extended periods of time before reestablishment of permanent vegetation and/or construction of permanent drainage structures. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure (with a design life of 12 to 18 months) and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sedimentation basins are suitable for nearly all types of construction projects. Whenever possible, construct the sedimentation basins before clearing and grading work begins.

Basins should be located at the stormwater outlet from the site, but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet
Some development projects will be required by the *City and County of Honolulu* to provide a storm water detention basin for post-construction flood control, desiltation, or stormwater pollution control. A temporary sediment basin maybe constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70-80 percent of the sediment which flows into them if designed according to this handbook. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Installation/Application Criteria
Planning:
To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations arc generally low areas below disturbed areas. Drainage into the basin can be improved by the use of diversion dikes and ditches. The basin must not be located in a stream but should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Design:
- The sedimentation basin volume consists of two zones:
  - The sediment storage zone (at least 1 foot in depth).
  - A settling zone at least 2 feet in depth.
- The sedimentation basin may be formed by partial excavation and/or by construction of a compacted embankment. It may have one or more inflow points.
- A securely anchored riserpipe with an anti-seep collar is the principal outlet, along with an emergency overflow spillway. A solid riser pipe with two inch diameter dewatering holes located at the top of the sediment storage volume on opposite sides of the riser pipe usually provides, sufficient detention time for basins draining about 10 acres. Rock, rip-rap, or other suitable outlet protection is provided to reduce erosion at the riser pipe outlet.
- Settling Zone Volume

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ADDITIONAL INFORMATION: SEDIMENT BASIN

The settling zone volume is determined by the following equation:

$$(V) = 1.2(SD)Q / V_{SED}$$

Q = design inflow based on the peak discharge from a specified design storm from the tributary drainage area as computed using the methods required by the *City*.

V_{SED} = the settling velocity of the design soil particle. The design particle chosen is medium silt (0.02 mm). This has a settling velocity (V_{SED}) of 0.00096 ft/sec. As a general rule it will not be necessary to design for a particle of size less than 0.02 mm, especially since the surface area requirement increases dramatically for smaller particle sizes. For example, a design particle of 0.01 mm requires about three times the surface area of 0.02 mm. Note also that choosing V_{SED} of 0.00096 ft/sec equates to a surface area (SA) of 1250 sq. ft. per cfs of inflow.

SD = settling depth, which should be at least 2 ft., and no shallower than the average distance from the inlet to the outlet of the pond (L) divided by 200 (i.e., SD > L/200).

Total sediment basin volume and dimension are determined as outlined below:

a. The details shown in the attached figure may be useful in designing the sediment basin.
b. Determine basin geometry for the sediment storage volume calculated above using a minimum of 1 ft depth and 3:1 side slopes from the bottom of the basin. Note, the basin bottom is level.
c. Extend the basin side slopes (at 3:1 max.) as necessary to obtain the sealing zone volume as determined above.
d. Adjust the geometry of the basin to effectively combine the settling zone volume and sediment storage volumes while preserving the depth and side slope criteria.
e. Provide an emergency spillway with a crest elevation one foot above the top of the riser pipe.
f. The ratio between the basin length and width of the pond should either be greater than 6:1, or baffles should be installed to prevent short-circuiting.

Limitations

Sediment traps and ponds must be installed only within the property limits. Failure of the structure must not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the pond is required, the type of fence and its location shall be shown in the SWPPP and in the construction specifications.

- Generally, temporary sedimentation ponds are limited to drainage of 5 acres or more.
- Sediment ponds may be capable of trapping smaller sediment particles if additional detention time is provided. However, they are most effective when used in conjunction with other BMPs, such as seeding or mulching.
- Ponds may become an “attractive nuisance” and care must be taken to adhere to all safety practices.
- Sediment ponds designed according to this handbook are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) will pass through untreated emphasizing the need to stabilize the soil quickly.

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ADDITIONAL INFORMATION: SEDIMENT BASIN

REFERENCES

A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zones, Metropolitan Washington Council of Governments, March, 1992.

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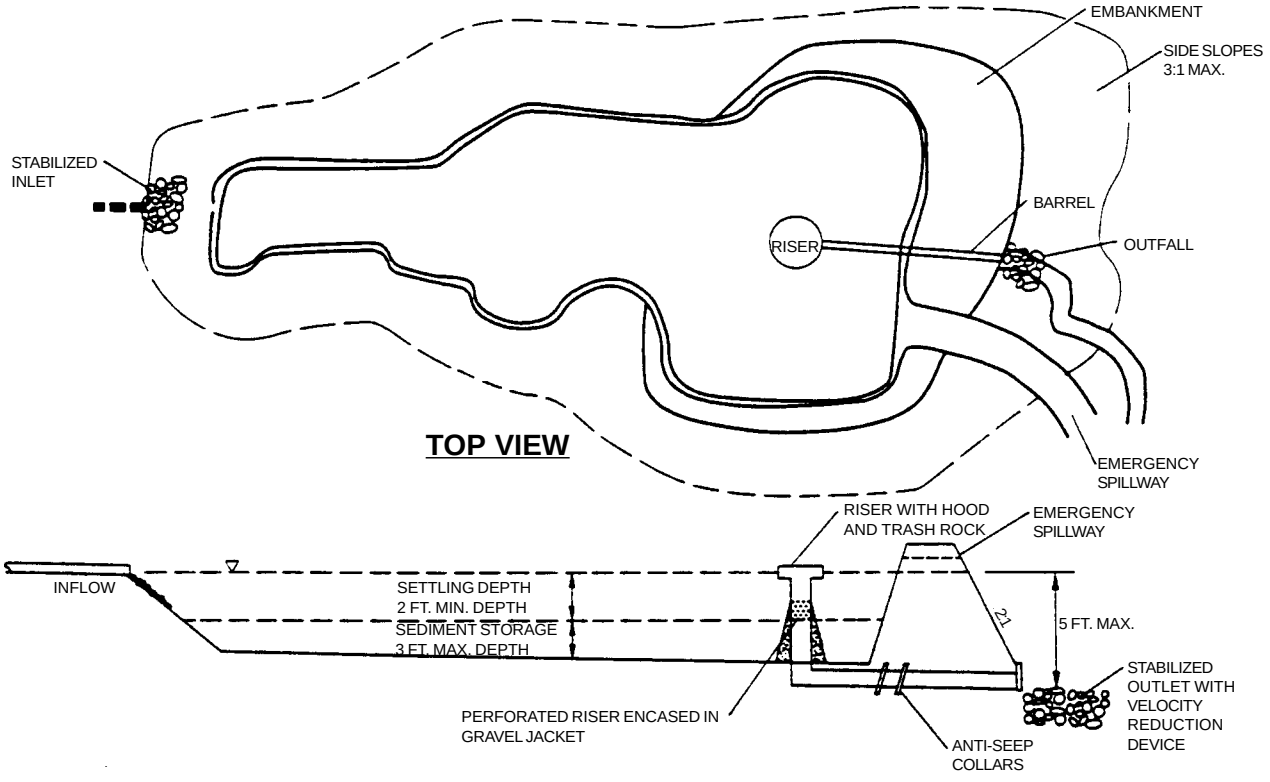

TEMPORARY SEDIMENT BASIN

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