

**Appendix A**  
**Storm Water and Non-Storm Water Discharge Monitoring Plan**  
**for Lehigh Southwest Cement Company**

**STORM WATER AND NON-STORM WATER DISCHARGE  
MONITORING PLAN**

Prepared for:

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June 2009

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## **1.0 INTRODUCTION**

This document provides a storm water monitoring plan and detailed instructions for use by Lehigh Southwest Cement Company (Lehigh). Lehigh personnel to complete the monitoring and sampling required under the Industrial Activities Storm Water Permit (State Water Resources Control Board Water Quality Order No. 97-03-DWQ; NPDES General Permit No. CAS000001) for discharge of storm water (Sections 2.0 through 6.0). The samples collected under this plan will be used to refine the subareas (and the sources) that are the largest contributors of storm water runoff and sediment to Permanente Creek. In addition, past analytical data from the Lehigh facility has refined the sampling protocol, allowing for additions and exclusions from future sampling events. In general, these changes occur when: (1) sampling data have indicated a monitoring location has met acceptable water quality objectives for total suspended solids (TSS), oil and grease, chemical oxygen demand (COD) and pH for two consecutive years, (2) no samples have been collected at a location due to lack of visible flow for two consecutive years, (3) a new proposed sample location meets the same objectives, (4) a new sediment source has been determined, or (5) access to an existing monitoring location in inclement weather is determined to be unsafe. These changes are noted within this report.

The non-storm water discharge visual monitoring program is described in Section 7.0. The monitoring plan is intended to be implemented by Lehigh personnel on a quarterly schedule as specified in the Industrial Activities Storm Water Permit for non-storm water discharges.

## **2.0 STORM WATER SAMPLING DESIGN**

The Storm Water Monitoring Plan included monitoring at 33 locations. The rationale for the 33 sample locations are provided on Table 1. In addition to the 33 samples, three field duplicates were collected from three of the monitoring locations for each rain event for a total of 36 samples.

No modifications to the existing Storm Water Monitoring Plan were implemented during the 2008/2009 sampling program. The total number of sampling locations proposed for the 2008/2009 sampling program were 33, with an additional three duplicate samples collected from three of the sampling locations. Changes to the Storm Water Monitoring Plan are based primarily on visual observations, sample location accessibility, and safety issues identified during the sampling or the result of facility improvements that have occurred within the past year.

Table 1 outlines the proposed sampling locations for the sampling program. The table also provides a correlation between the sampling locations and a particular source area, as well as the purpose for sampling at each location.

### 3.0 STORM WATER SAMPLING

The General Permit for industrial storm water discharges, in general, requires that non-storm water discharges to storm water systems be eliminated, a storm water pollution prevention plan (SWPPP) be developed and implemented, and storm water systems be monitored. The purpose of this sampling plan is to address these storm water monitoring requirements. The overall objectives of the storm water monitoring are to ensure compliance with the General Permit for industrial discharges, to evaluate the pollution control practices in place, to assist in implementing the SWPPP, to evaluate sediment contribution from potential sources, and to measure the effectiveness of the best management practices.

All industrial facility operators are required to:

1. Perform visual observations of storm water discharges and authorized storm water discharges.
2. Collect and analyze samples of storm water discharges. Analysis must include pH, total suspended solids (TSS), total organic carbon (TOC), specific conductance (SC), toxic chemicals, and other pollutants that are likely to be present in storm water discharges in significant quantities, and those parameters listed in Table D of the General Permit. TOC analysis may be substituted by oil and grease.

Table D of the General Permit lists additional analytical parameters required for specific industry types. Lehigh Southwest Cement Company is categorized as Sector E 3241, Hydraulic Cement, Industry. There are no additional parameters required for this industry type.

Due to consistently low dissolved and total copper concentrations detected up to, and including, the 1998/1999 wet season, copper was removed from the Storm Water Monitoring Plan starting in 1999/2000. The 2008/2009 sampling plan also excluded copper analysis of the storm water samples. Constituents to be analyzed will be TSS, oil and grease, pH, temperature, SC, and flow. Although chemical oxygen demand (COD) is not a required analytical parameter under the General Permit, Lehigh has analyzed the storm water samples for COD in the past and will continue to do so in the future.

The General Permit requires that each industrial facility collect storm water samples during the first hour of discharge from:

1. The first storm event of the wet season, and
2. At least one other storm event in the wet season.

Sample collection is only required of storm water discharges that occur during scheduled facility operating hours and that are preceded by at least three (3) working days without storm water discharge. The General Industrial Permit states that an industrial facility may conduct visual observations and sample collection more than one hour after discharge begins if the facility operator determines that the objectives of the storm water sampling

requirements will be better satisfied. Since the constituent of concern at Lehigh Southwest Cement Company is TSS, sampling after the first hour of the discharge would be more representative of long-term (greater than one hour) storm event effects.

A storm event needs to produce significant storm water drainage at the site in order for samples to be collected. Federal guidelines define a qualified storm event as one in which rainfall is greater than 0.1 inches and occurs at least 72 hours after the previous qualified storm. The storm duration and total rainfall should be within  $\pm 50\%$  of the average storm rainfall for the area.

### **3.1 Prior to Sample Collection**

Upon arrival at each sampling location, the sampler should record in a log book basic information such as station ID, sample ID, time, date, current weather conditions, the estimated flow at the sampling location, the duration of rain at time of sampling, and the duration of storm water discharge at that station, if known (see Form 1 for a sample log book). Each sample bottle should be labeled with the date, time, analysis to be performed, preservative used, if any, sampler initials, and sample ID (i.e., at one sample location, three sample bottles would be labeled with the same sample number, but with three different specified analyses).

Once the discharge at each location is determined to be significant, sample collection at each of the storm water monitoring locations will commence. Samples will be collected first from sampling locations at the upper end of the watershed to ensure that access is available to those locations.

### **3.2 Sample Collection**

Samples will be collected in clean bottles provided by the laboratory. Sample bottles will contain the appropriate preservative when delivered by the laboratory. Table 2 provides a description of the size and type of bottles to be used for sampling. Stream samples will be collected from mid-depth of the stream. Where necessary, a bailer with a sample collection scoop will be used to assist in sample collection. Filled sample containers will be placed on ice in laboratory-supplied ice chests. Each sample will be field-measured for temperature, pH, and conductivity.

Field duplicate samples at three pre-selected sampling locations (Pond 14, Pond 21, and Pond 22 effluents) will also be collected. This means that at three locations, two bottles will be collected for oil and grease analysis, two for COD analysis, and two for total suspended solids, pH, and conductivity.

#### **4.0 PREPARATION FOR ANALYSIS**

Each sample will be analyzed by a state-certified analytical laboratory for pH, SC, TSS, oil and grease, and COD. Measurement of temperature, pH, and conductivity will also be made by the sampler using portable field equipment.

#### **5.0 QUALITY ASSURANCE/QUALITY CONTROL**

The General Permit requires the QA/QC results be collected as part of the records that must be maintained at the Lehigh facility. QA/QC measures are used to ensure that data produced are accurate, precise, at the required level of quality, and that they can be used for their intended purpose (i.e., to support the General Permit and the SWPPP). Quality assurance measures are guidelines and procedures to assure data quality during gathering, analysis, and reporting. Quality control checks, including the use of blanks, duplicates, and other samples are then used to assess the overall analytical system and evaluate performance. Laboratory and field QC samples are used to characterize and quantify data quality. Precision of data characterizes reproducibility or uncertainty of repetitive measurements and is calculated using field and laboratory duplicate samples. Accuracy is the measure of correctness or how close the reported result is to a known value, and is measured using a sample spiked with a known amount of an analyte.

The QA/QC for this storm water sampling plan consists of pre-planning the sampling procedure, primarily through the use of this sampling plan, preparing and testing field equipment, and collecting three sets of duplicate field samples during each event. The data quality resulting from these activities will be sufficient to meet the sampling objectives for determining the subareas that contain the major sediment source areas.

#### **6.0 EQUIPMENT**

Both manual and automated equipment are available for measuring flow and for sample collection. Manual equipment is less expensive and can be carried from station to station. Automated equipment is expensive and must be installed at each location, but is useful for locations that become inaccessible during storm events. Table 3 is a checklist of equipment needed for each sampling event

#### **7.0 NON-STORM WATER DISCHARGE VISUAL MONITORING**

The non-storm water discharge visual monitoring program is intended to document existing authorized non-storm water discharges and its sources, and to inspect site drainage areas for the presence of unauthorized non-storm water discharges. Authorized non-storm water discharges are found near the base of the Rock Plant on the south side of Permanente Creek. The sources of non-storm water discharge are dust suppression water and wash down water as discussed in Section 3.2.2 of the SWPPP.

## **7.1 Visual Observations of Non-Storm Water Discharges**

Quarterly observations of authorized non-storm water discharges shall occur during the period of: January through March, April through June, July through September, October through December with all observations occurring within 6 to 18 weeks of each other. All observation shall occur during daylight hours and during scheduled facility operating hours. The locations of the visual observations for non-storm water discharge visual observations are summarized on Table 4. Visual observations of authorized non-storm water discharges will be performed on Rock Plant Road, Lower Quarry Road, and the entrance/exit to the Rock Plant. Visual observations/inspection for unauthorized non-storm water discharges will be performed within the drainage areas.

Each observation shall document the presence of discolorations, stains, floating materials, etc. and the source of the discharge. Observations and inspection records will include observation dates, locations, description of observation, and response taken (if required) to eliminate the unauthorized non-storm water discharge and reduce or prevent pollutants from contacting authorized non-storm water discharges. Visual observation will be recorded on Forms 5A and 5B (Non-Storm Water Visual Monitoring Forms).

# **TABLES**

**Table 3: Equipment Checklist**

Manual or automated rain gauge
Log book
Watch
Velocity meter or installed flow meter
Pole with sample collection scoop (bailer)
Sample bottles
Labels
Gloves
Coolers
Ice
Chain-of-custody forms
Hard hat
Safety glasses
Safety goggles
Steel-toe boots
Rain gear
Ear Plugs

# **FORMS**

**Form 1: Sample Collection Form**  
**Lehigh Southwest Cement Company**  
**Cupertino, California**

Location: \_\_\_\_\_

Date: \_\_\_\_\_

Initials: \_\_\_\_\_

Time: \_\_\_\_\_

Weather

Current: \_\_\_\_\_

Previous 24 Hours: \_\_\_\_\_

Observations (Clogged w/sediment, debris? Capacity exceeded? Water clarity)

**Form 2: Sample Form for Storm Event Characterization**  
**Lehigh Southwest Cement Company**  
**Cupertino, California**

Date: \_\_\_\_\_

Sampler: \_\_\_\_\_

Current Time: \_\_\_\_\_

Time Since Precipitation Began: \_\_\_\_\_

Time Since Last Storm Event: \_\_\_\_\_

Total Precipitation at Start of Sampling: \_\_\_\_\_

Total Storm Precipitation: \_\_\_\_\_

Total Duration of Storm Event: \_\_\_\_\_

**Form 3: Example Field Data Sheet for Surface Water Sampling  
Lehigh Southwest Cement Company  
Cupertino, California**

**STORM WATER DISCHARGE SAMPLING  
FIELD DATA**

Station Identification: \_\_\_\_\_ Project Name: \_\_\_\_\_

Location: \_\_\_\_\_ Project Number: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_ Photograph Roll: \_\_\_\_\_ Number: \_\_\_\_\_

Runoff or Creek Sample \_\_\_\_\_

Weather Conditions \_\_\_\_\_

Sampling Personnel (Initials) \_\_\_\_\_  
\_\_\_\_\_

**Field Measurements**

Gage Height: \_\_\_\_\_ Substrate Level on Gage: \_\_\_\_\_ pH: \_\_\_\_\_

Water Temperature (°C): \_\_\_\_\_

SC@ Field Temperature: \_\_\_\_\_ Estimated Streamflow (cfs): \_\_\_\_\_  
(microhos/cm): \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_

**Water Quality Samples**

Type of sample - (grab or composite)

\_\_\_\_\_ Sample I.D. \_\_\_\_\_

	Tag Number	Date/Time	Station	Sample No.	Replicate	Filtered	Preservative	Analysis
1.	_____	_____	_____	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____	_____	_____	_____

**Form 4: Example of Chain-of-Custody Form**

**Lehigh Southwest Cement Company  
Cupertino, California**

**CHAIN-OF-CUSTODY RECORD**

Project: \_\_\_\_\_ COC Form Number: \_\_\_\_\_

Sampler (Signature): \_\_\_\_\_

	Sample Tag	Sample No.	Date	Time	Matrix	Containers
1.	_____	_____	_____	_____	_____	_____
2.	_____	_____	_____	_____	_____	_____
3.	_____	_____	_____	_____	_____	_____
4.	_____	_____	_____	_____	_____	_____
5.	_____	_____	_____	_____	_____	_____
6.	_____	_____	_____	_____	_____	_____
7.	_____	_____	_____	_____	_____	_____
8.	_____	_____	_____	_____	_____	_____
9.	_____	_____	_____	_____	_____	_____
10.	_____	_____	_____	_____	_____	_____
11.	_____	_____	_____	_____	_____	_____
12.	_____	_____	_____	_____	_____	_____
13.	_____	_____	_____	_____	_____	_____
14.	_____	_____	_____	_____	_____	_____
15.	_____	_____	_____	_____	_____	_____
16.	_____	_____	_____	_____	_____	_____
17.	_____	_____	_____	_____	_____	_____
18.	_____	_____	_____	_____	_____	_____
19.	_____	_____	_____	_____	_____	_____
20.	_____	_____	_____	_____	_____	_____

**SAMPLE CUSTODY RECORDS**

Every sample transfer must be signed by both parties involved.

Relinquished By	Received By	Date	Time

**Form 5A: Authorized Non-Storm Water Discharge Visual Observation Report Form**  
**Lehigh Southwest Cement Company**  
**Cupertino, California**

Date: \_\_\_\_\_

No. of Weeks Since Last Observation: \_\_\_\_\_

Areas of Observation	Time	Evidence of Discharge	Source of Discharge	Visual Observations					Action(s) Taken	Staff Person Performing Inspection
				Discoloration	Stains	Odors	Floating Materials	Other		
Rock Plant Road Location: Upstream of Pond 9			Dust Suppression Water Spray							
Rock Plant Road Location: Between Pond 9 and the Dinky Shed Basin			Dust Suppression Water Spray							
Lower Quarry Road Location: Above Cross Drains at Pond 9			Dust Suppression Water Spray							
Lower Quarry Road Location: Below Cross Drains between Pond 9 and Dinky Shed Basin			Dust Suppression Water Spray							
Entrance/Exist Road to Rock Plant Location: Between Rock Plant and Cross Drains that Feed into Pond 17			Dust Suppression Water Spray							
Entrance/Exist Road to Rock Plant Location: Between Rock Plant and Cross Drains that feed into Pond 17 (south side of road)			Wash-Down Water from Rock Plant							
Entrance/Exist Road to Rock Plant Location: Below Cross Drains to Dinky Shed Basin			Dust Suppression Water Spray							

1) Evidence of Discharge? Answer yes or no.

2) Visual Observations - Answer yes or no

3) Describe Discharge if Observed: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Form 5B: Unauthorized Non-Storm Water Discharge Visual Observation Report Form**  
**Lehigh Southwest Cement Company**  
**Cupertino, California**

Date: \_\_\_\_\_

No. of Weeks Since Last Observation: \_\_\_\_\_

Areas of Observation	Time	Evidence of Discharge	Source of Discharge	Visual Observations					Action(s) Taken	Staff Person Performing Inspection
				Discoloration	Stains	Odors	Floating Materials	Other		
Drainage Area A Location of Observations:										
Drainage Area B Location of Observations:										
Drainage Area C Location of Observations:										
Drainage Area D Location of Observations:										
Drainage Area E Location of Observations:										
Drainage Area F Location of Observations:										

1) Evidence of Discharge? Answer yes or no.

2) Visual Observations - Answer yes or no

3) Describe Discharge if Observed: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Table 1: 2009/2010 Sampling Locations**

<b>2009/2010 Sample ID:</b>	<b>Sampling Location:</b>	<b>Potential Source Area(s):</b>	<b>Sample Purpose/Objective:</b>
Discontinued (SL-BG-CR)	Upstream creek sample.	Sediments in creek before entering Quarry area of influence	Background sample to assess water quality entering the facility.
<b>SL-1-CR</b>	Creek sample – downstream of background sample	Sediments in creek south of Overburden Stockpile	Previously used as background sample to assess water quality entering the facility. Now serves to assess sediments entering the stream between SL-BG-CR and SL-1-CR
<b>SL-2-RD</b>	Upper Quarry Road before Pond 5	Runoff from Upper Quarry Road	Evaluate the sediment load in storm water runoff from Upper Quarry Road that is diverted into Pond 5 - the Quarry Settlement Pond.
Discontinued (SL-3A-RD)	Inlet to Pond 5 from area north of pond	Runoff from area north of Pond 5	Evaluate the effectiveness of Pond 5 to reduce sediment load from area north of Pond 5.
Discontinued (SL-3-PD)	Effluent from Pond 5 - the Quarry Settlement Pond	Runoff from Upper Quarry Road	Evaluate the effectiveness of Pond 5 to reduce sediment load from Upper Quarry Road.
<b>SL-4-CR</b>	Downstream of Overburden Stockpiles before concrete footing	Former Overburden Stockpiles	Evaluate the sediment contribution from natural erosion and the Overburden stockpiles prior to entering the operation portion of the property (Creek Sample).
<b>SL-4A1-RD</b>	Inlet to Pond 4A (east end)	Runoff from Upper/Middle Quarry Road	Evaluate the sediment load in storm water runoff from Upper/Middle Quarry Road
Discontinued (SL-4A2-RD)	Inlet to Pond 4A (west end)	Runoff from Upper/Middle Quarry Road	Evaluate the sediment load in storm water runoff from Upper/Middle Quarry Road
<b>SL-4A3-PD</b>	Effluent from Pond 4A	Runoff from Upper/Middle Quarry Road	Evaluate the effectiveness of Pond 4A in removing sediment from the runoff from Upper/Middle Quarry Road
Discontinued (SL-4B1)	Inlet to Pond 4B	Runoff from Upper/Middle Quarry Road	Evaluate the sediment load in storm water runoff from Upper/Middle Quarry Road
Discontinued (SL-4B2-PD)	Effluent from Pond 4B (sample labeled SL-5A for 11/29/01 event)	Runoff from Upper/Middle Quarry Road	Evaluate the effectiveness of Pond 4B in removing sediment from the runoff from Upper/Middle Quarry Road
Discontinued (SL-4C1)	Inlet to Pond 4C	Runoff from Upper/Middle Quarry Road	Evaluate the sediment load in storm water runoff from Upper/Middle Quarry Road
Discontinued (SL-4C2-PD)	Effluent from Pond 4C	Runoff from Upper/Middle Quarry Road	Evaluate the effectiveness of Pond 4C in removing sediment from the runoff from Upper/Middle Quarry Road
<b>SL-5-CR</b>	Ore Feeder and the Primary Crusher	Upstream of runoff from the Primary Crusher	Determine the TSS in Permanente Creek before the runoff from the Ore Feeder and the Primary Crusher.
Discontinued (SL-5A-CR)	Creek Sample – downstream of Ponds 4A & 4B	Natural Erosion and Runoff from Ponds 4 & 4A	Determine the TSS in Permanente Creek before the runoff after Ponds 4 and 4A
<b>SL-6-RD</b>	Quarry Pit	Upper Quarry Road	Evaluate the quarry pit water, which consists of both runoff into the quarry and the infiltration of groundwater
Discontinued (SL-7)	Middle/Upper Quarry Road after Pond 5	Runoff from Upper/Middle Quarry Road after Pond 5 before the Primary Crusher	Evaluate the sediment load from Upper Quarry Road after Pond 5 but before the Primary Crusher at the inlet to the overflow pipe.
Discontinued (SL-9)	Primary Crusher	Runoff from the Primary Crusher	Evaluate the sediment load in the runoff (if any) from the Primary Crusher.
Discontinued (SL-10)	Ore Feeder and the Primary Crusher	Downstream from the Primary Crusher before Quarry Pit discharge	Evaluate the potential increase in TSS from the overland flow from the Ore Feeder and the Primary Crusher (Creek Sample).
<b>SL-11-CR</b>	Inlet to Pond 13	Primary Crusher	Evaluate the effectiveness of Pond 13 at removing sediment from the storm water
<b>SL-12-PD</b>	Outlet of Pond 13	Primary Crusher	Evaluate the effectiveness of Pond 13 at removing sediment from the storm water
<b>SL-13-PD</b>	Inlet to Pond 13 from Pond 13B	Primary Crusher	Evaluate the effectiveness of Pre-Settlement Pond 13B at removing sediment from storm water
<b>SL-13A-RD</b>	Inlet to Pond 13A at Rock Plant 1	Primary Crusher	Evaluate the effectiveness of Pre-Settlement Pond 13A at removing sediment from storm water

PD = Sample collected from pond  
 CR = Sample collected from creek  
 RD = Sample collected from road runoff

**Table 1: 2009/2010 Sampling Locations**

2009/2010 Sample ID:	Sampling Location:	Potential Source Area(s):	Sample Purpose/Objective:
Discontinued (SL 13B-PD)	Effluent from Pond 13A into Pond 13B	Primary Crusher	Evaluate the effectiveness of Pre-Settlement Pond 13A at removing sediment from storm water
SL-14-CR	Screen Tower Number 4 (under bridge)	Upstream of Screen Tower Number 4	Determine the TSS in the creek before Screen Tower Number 4 and the adjacent creek embankment (Creek Sample).
SL-15-CR	Creek embankment below Screen Tower 4	Downstream of Screen Tower Number 4	Determine the sediment contribution and potential increase from Screen Tower Number 4 and the creek embank runoff (Creek Sample).
SL-16A-RD	Inlet to Pond 9 (from culvert under Lower Quarry Road)	Runoff from Lower Quarry Road originating after the Primary Crusher	Evaluate the potential sediment load runoff from Lower Quarry Road originating after the Primary Crusher which is diverted into Pond 9.
SL-16B-RD	Inlet to Pond 9 (from eastern culvert from Middle Quarry Road)	Runoff from Middle Quarry Road originating after the Primary Crusher	Evaluate the potential sediment load runoff from Middle Quarry Road originating after the Primary Crusher which is diverted into Pond 9.
SL-17-PD	Effluent from Pond 9	Runoff from Lower Quarry Road originating after the Primary Crusher	Evaluate the effectiveness of Pond 9 in removing sediment from the runoff from Lower Quarry Road.
SL-18-RD	Lower Quarry Road	Runoff from Lower Quarry Road after the drop inlet to Pond 9	Evaluate the sediment load from Lower Quarry Road that is not captured by Pond 9 and the potential contribution of the sand pile flowing into Dinky Shed Basin.
Discontinued (SL 19-PD)	Effluent from Dinky Shed Basin	Effluent from the new Dinky Shed Basin	Evaluate the effectiveness of the new treatment system at removing sediment from the runoff entering the Dinky Shed Basin from the Lower Quarry Road after Pond 9.
SL-20-RD	Inlet to Pond 17 at Rockplant 2	Screen Tower Number 4	Evaluate the effectiveness of Pond 17 at removing sediment from storm water
SL-21-PD	Outlet of Pond 17 at Rockplant 2 (from the last point near effluent pipe if no discharge)	Screen Tower Number 4	Evaluate the effectiveness of Pond 17 at removing sediment from storm water
SL-22A-CR	Downstream of Dinky Shed Basin. Upstream of hillside runoff (jar labeled P-14 for 11/19 storm, labeled P-16 for 4/17/00 storm)	Effluent from the Dinky Shed Basin	Evaluate the cleanout effectiveness of the new Dinky Shed Basin
SL-22B-CR	Downstream of Dinky Shed Basin and downstream of hillside runoff behind the shed. (jar labeled P-13 for 11/19 storm, labeled P-17 for 4/17/00 storm.)	Hillside runoff observed on 11/19/99	Evaluate the impact of hillside runoff if present
SL-23-CR	Creek Sample along Railroad tracks	KACC	Evaluate the impact of the cement plant and the former KACC property on the creek between Pond 9 and the rail road tracks
Discontinued (SL 24-PD)	Outlet of Pond 21 along railroad tracks	KACC	Assess the quality of the creek downstream of Ponds 19, 20, and 21, as well as the impact of storm water from the former KACC property.
Discontinued (SL D24-PD)	Duplicate sample of Pond 21 effluent		QA/QC
SL-25-CR	Inlet to Pond 22	NA	Evaluate the efficiency of Pond 22 at reducing TSS concentrations.
SL-D25-CR	Duplicate sample of Pond 22 Inlet	NA	QA/QC
SL-26-PD	Effluent of Pond 22 (sample bottle labeled SL-12 for 11/19/99 sampling event, labeled P-18 for 4/17/00 storm).	Treatment of all sources that originate either upstream or from the Hanson property	Determine the effectiveness of the in-stream ponds at reducing sediment load before leaving the Hanson property (Creek Sample).
SL-D26-PD	Duplicate sample of Pond 22 effluent		QA/QC
SL-27-PD	Effluent from Pond 14		Evaluate the effectiveness of Pond 14 at removing sediment from storm water.
SL-D27-PD	Duplicate sample of Pond 14 effluent		QA/QC

PD = Sample collected from pond  
 CR = Sample collected from creek  
 RD = Sample collected from road runoff

**Appendix B**  
**Sediment Pond Cleanout Procedures**

**Long-Term Stormwater Facility Maintenance Plan,  
Cupertino, Santa Clara County, California**

**Prepared for:**

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**June 2009**

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This report should be cited as: Huffman-Broadway Group, Inc. 2009. *Long-Term Stormwater Facility Maintenance Plan, Cupertino, Santa Clara County,*. June 2009. San Rafael, California. 4 pp. Prepared for Leigh Southwest Cement Company.

# 1 Introduction and Executive Summary

2 On behalf of Lehigh Southwest Cement Company (Lehigh)<sup>1</sup>, Huffman-Broadway Group, Inc.  
3 (HBG) has prepared this Long-Term Stormwater Facilities Maintenance Plan to conduct periodic  
4 maintenance and sediment removal from sedimentation basins and culverts in support of current  
5 and future mining operations at the Permanente Quarry (Quarry).

## 6 1.1 Goal and Objectives of the Long Term Stormwater Facilities Maintenance 7 Plan

8 The objective of this Long-Term Stormwater Facilities Maintenance Plan (Plan) is to conduct  
9 periodic maintenance and sediment removal from sedimentation basins in upland areas within  
10 the Quarry in a manner that avoids impacts to federally-listed threatened California red-legged  
11 frog (CRLF; *Rana aurora draytonii*). The Plan will maintain design capacity of constructed  
12 sedimentation basins, also referred to as “sedimentation ponds”, to minimize sediment load into  
13 Permanente Creek as mandated by San Francisco Bay Regional Water Quality Control Board  
14 (SFBRWQCB) requirements (including SFBRWQCB Cleanup and Abatement Order #99-018)  
15 for current and future mining operations.

## 16 1.2 Responsible Parties

17 Successful implementation of this Long-Term Stormwater Facilities Maintenance Plan is the  
18 responsibility of the following:

### **Party with Financial Responsibility for Implementation of Plan:**

Leigh Southwest Cement Company  
24001 Stevens Creek Blvd.  
Cupertino, California 95014-5659  
Contact: Mr. Henrik Wesseling, Plant Manager

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<sup>1</sup> Lehigh is the site operator. The property owner is Hanson Permanente Cement, Inc.

## 2 Sedimentation Basin Maintenance Schedule, Maintenance Procedure and Conservation Measures

This section describes the implementation of the Plan for conducting sedimentation basin maintenance activities. The Plan involves maintenance to remove accumulated sedimentation and repair structures within the sedimentation basins on an “as-needed” basis. Implementation of this Plan will incorporate conservation measures designed to avoid potential impacts to CRLF that may occupy a sedimentation basin.

### 2.1 Sedimentation Basin Maintenance Schedule

Sedimentation Basin and Culvert Maintenance will be implemented on an as-needed basis and will be inspected, at a minimum, annually as described below.

<b>Table 1. Sedimentation Basin and Culvert Maintenance Schedule</b>			
<b>Sedimentation Basin/Ponds</b>	<b>Frequency of Sedimentation Removal</b>	<b>Frequency of Inspection and Repair of Mechanical Structures in Sedimentation Basins and Culverts</b>	<b>Comments</b>
Pond 9	As-Needed	Annual	
Pond 13A	As-Needed	Annual	
Pond 13B	As-Needed	Annual	
Pond 16	As-Needed	Annual	
Pond 17	As-Needed	Annual	
Pond 19	As-Needed	Annual	
Pond 20	As-Needed	Annual	
Pond 4A	NA	NA	Maintenance activities will resume pending approval from Corps, USFWS, SFBRWQCB and CADFG
Pond 11	NA	NA	
Pond 13	NA	NA	
Pond 14	NA	NA	
Pond 21	NA	NA	
Pond 22	NA	NA	

## **2.2 Ponds 9, 13a, 13b, 16, 17, 19 and 20 Sedimentation Basin Maintenance Procedure**

- 1 Sediment would be excavated using heavy equipment (e.g. backhoe loader, excavator, etc), placed in a truck and disposed of in an upland location.
- 2 If water is present within a Pond, prior to scheduled sedimentation removal activities, existing outflow control structures would be closed or capped off to prevent the discharge of water into Permanente Creek.
- 3 If water is present within a Pond, prior to scheduled sedimentation removal activities or maintenance on control structures within a Pond, a preconstruction CRLF survey would be conducted by a qualified biologist as described in Section 2.3.1 below.

## **2.3 Conservation Measures**

In order to avoid potential effects to special-status species and their habitats, the following conservation measures will be implemented:

### **2.3.1 CRLF Conservation Measures**

1. Prior to the start of sedimentation removal or maintenance activities, all construction personnel will receive CRLF training by a field supervisor who has received training from a qualified biologist. If new personnel are added during the course of construction they will also receive training on CRLF by the field supervisor prior to being allowed to work on-site. An educational brochure containing color photographs of CRLF and description of their habitat will be distributed to all construction personnel. A list of employees who attend the training sessions will be maintained and made available for review upon request.
2. If water is present within a Pond, prior to scheduled sedimentation removal activities or maintenance on water control structures, a preconstruction CRLF survey would be conducted by a qualified biologist. Preconstruction surveys would consist of two daytime and two night time focused pre-construction surveys for CRLF within 30 days of a scheduled activity. If CRLF are determined to be present within a Pond, the scheduled work activity would be delayed until a qualified biologist verifies the CRLF have moved from the Pond.
3. The United States Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG) shall be notified within twenty-four (24) hours of the finding of any injured or dead CRLF.
4. If a CRLF is found within the work zone during sedimentation removal or maintenance activities, all work shall immediately stop. Work may resume once a

qualified biologist verifies the CRLF have moved from the Pond.

5. A representative(s) will be appointed by Lehigh to be the contact source for any employee or contractor who might inadvertently kill or injure a CRLF or who finds a dead, injured, or entrapped individual. The representative will be responsible for immediately reporting any incident to the Service. The appointed representative(s) will be identified during the CRLF training program.

### **3.0 Reporting Requirements**

The USFWS and CADFG shall be notified within twenty-four (24) hours of the finding of any injured or dead CRLF.

**Appendix C**  
**California Storm Water Best Management Practices (Source Control)**

## 4. SOURCE CONTROL BMPs

### INTRODUCTION

This chapter describes specific source control Best Management

Practices (BMPs) for common industrial activities that may pollute storm water. Chapter 2 led you through the steps of identifying activities at your facility that can pollute storm water while Chapter 3 provided guidance on selection of BMPs. This chapter provides you with the BMPs that best fill your facility's need. Best management practices for each of the activities shown below are provided in the following fact sheets.

Each fact sheet contains a cover sheet with:

- A description of the BMP
- Approach
- Requirements
  - Cost, including capital costs, and Operation and Maintenance (O&M)
  - Maintenance (including administrative and staffing)
- Limitations

The side bar presents information on where this BMP applies, targeted constituents, and an indication of the level of effort and cost to implement.

Further information is also provided in additional sheets. This information includes a more detailed description of the BMP, requirements to implement, examples of effective programs, and references.

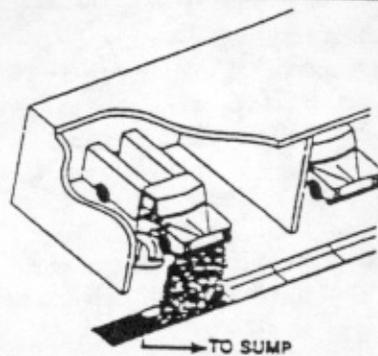
BMPs are provided for each of the following industrial activities consistent with Worksheet 4 in Chapter 2.

#### Industrial Activities Requiring BMPs

- SC1 Non-Storm Water Discharges to Drains
- SC2 Vehicle and Equipment Fueling
- SC3 Vehicle and Equipment Washing and Steam Cleaning
- SC4 Vehicle and Equipment Maintenance and Repair
- SC5 Outdoor Loading/Unloading of Materials
- SC6 Outdoor Container Storage of Liquids
- SC7 Outdoor Process Equipment Operations and Maintenance
- SC8 Outdoor Storage of Raw Materials, Products, and By-Products
- SC9 Waste Handling and Disposal
- SC10 Contaminated or Erodible Surface Areas
- SC11 Building and Grounds Maintenance
- SC12 Building Repair, Remodeling, and Construction
- SC13 Over-Water Activities
- SC14 Employee Training

Fact sheet SC14, Employee Training, is a compilation of the training aspects of the individual source control fact sheets. Its purpose is to facilitate the integration and development of a comprehensive training program for all industrial activities at a facility.

# ACTIVITY: VEHICLE AND EQUIPMENT WASHING & STEAM CLEANING



## Applications

Manufacturing

Material Handling

Vehicle Maintenance

Construction

Commercial Activities

Roadways

Waste Containment

Housekeeping Practices

## DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment washing and steam cleaning.

## APPROACH

- Consider off-site commercial washing and steam cleaning businesses.
- Use designated wash areas, preferably covered to prevent contact with storm water and bermed to contain wash water.
- Discharge wash water to sanitary sewer, after contacting local sewer authority to find out if pretreatment is required.
- Educate employees on pollution prevention measures.
- Consider filtering and recycling wash water.
- Do not permit steam cleaning wash water to enter the storm drain.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

## REQUIREMENTS

- Capital costs vary depending on measures implemented.
  - Low cost (\$500-1,000) for berm construction.
  - Medium cost (\$5,000-20,000) for plumbing modifications (including re-routing discharge to sanitary sewer and installing simple sump).
  - High cost (\$30,000-150,000) for on-site treatment and recycling.
- O&M costs increase with increasing capital investment.
- Maintenance
  - Berm repair and patching.
  - Inspection and maintenance of sumps, oil/water separators, and on-site treatment/recycling units.

## LIMITATIONS

- Some municipalities may require pretreatment and monitoring of wash water discharges to the sanitary sewer.
- Steam cleaning can generate significant pollutant concentrations requiring permitting, monitoring, pretreatment, and inspections. The measures outlined in this fact sheet are insufficient to address all the environmental impacts and compliance issues related to steam cleaning.

## Targeted Constituents

- Sediment
- Nutrients
- Heavy Metals
- Toxic Materials
- Floatable Materials
- Oxygen Demanding Substances
- Oil & Grease
- Bacteria & Viruses
- Likely to Have Significant Impact
- Probable Low or Unknown Impact

## Implementation Requirements

- Capital Costs
- O&M Costs
- Maintenance
- Training

● High ○ Low

SC3



## Additional Information — Vehicle and Equipment Washing and Steam Cleaning

Washing vehicles and equipment outdoors or in areas where wash water flows onto the ground can pollute storm water. If your facility washes or steam cleans a large number of vehicles or pieces of equipment, consider contracting out this work to a commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Contracting out this work can also be economical by eliminating the need for a separate washing/cleaning operation at your facility.

If washing/cleaning must occur on-site, consider washing vehicles inside the building to control the targeted constituents by directing them to the sanitary sewer where they can be pretreated or sent directly to the sanitary treatment facility.

Washing operations outside should be conducted in a designated wash area having the following characteristics:

- Paved with Portland cement concrete,
- Covered or bermed to prevent contact with storm water,
- Sloped for wash water collection,
- Discharges wash water to the sanitary or process waste sewer, or to a dead-end sump. Discharge pipe should have a positive control valve that allows switching between the storm drain and sanitary or process sewer,
- Clearly designated, and
- Equipped with an oil/water separator (see Chapter 5, TC7, Oil/Water Separators and Water Quality Inlets).

### Examples of Effective Programs

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are applicable to industrial vehicle service facilities.

The U.S. Postal Service in West Sacramento has a new vehicle wash system that collects, filters, and recycles the wash water.

### REFERENCES

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 8320R-92-006, USEPA, 1992.

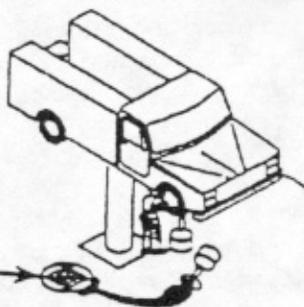
Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC3



# ACTIVITY: VEHICLE AND EQUIPMENT MAINTENANCE AND REPAIR

DIKE TO PREVENT SPILLS/LEAKS FROM ENTERING STORM DRAIN



## Applications

Manufacturing

Material Handling

Vehicle Maintenance

Construction

Commercial Activities

Roadways

Waste Containment

Housekeeping Practices

## DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment maintenance and repair by running a dry shop.

## APPROACH

- Keep equipment clean, don't allow excessive build-up of oil and grease.
- Keep drip pans or containers under the areas that might drip.
- Do not change motor oil or perform equipment maintenance in non-appropriate areas. Use a vehicle maintenance area designed to prevent storm water pollution.
- Inspect equipment for leaks on a regular basis.
- Segregate wastes.
- Make sure oil filters are completely drained and crushed before recycling or disposal.
- Make sure incoming vehicles are checked for leaking oil and fluids.
- Clean yard storm drain inlet(s) regularly and especially after large storms.
- Do not pour materials down drains or hose down work areas; use dry sweeping.
- Store idle equipment under cover.
- Drain all fluids from wrecked vehicles.
- Recycle greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.
- Switch to non-toxic chemicals for maintenance when possible.
- Clean small spills with rags, general clean-up with damp mops and larger spills with absorbent material.
- Paint signs on storm drain inlets to indicate that they are not to receive liquid or solid wastes.
- Train employees.
- Minimize use of solvents.
- For a quick reference on disposal alternatives for specific wastes see Table 4.1, SC1.

## REQUIREMENTS

- Costs (Capital, O&M) - Should be low, but will vary depending on the size of the facility.
- Maintenance - Should be low if procedures for the approach are followed.

## LIMITATIONS

- Space and time limitations may preclude all work being conducted indoors.
- It may not be possible to contain and clean up spills from vehicles/equipment brought on-site after working hours.
- Drain pans (usually 1 ft. x 1 ft.) are generally too small to contain antifreeze, which may gush from some vehicles, so drip pans (3 ft. x 3 ft.) may have to be purchased or fabricated.
- Dry floor cleaning methods may not be sufficient for some spills. Use three-step method instead.
- Identification of engine leaks may require some use of solvents.

## Targeted Constituents

Sediment

Nutrients

Heavy Metals

Toxic Materials

Floatable Materials

Oxygen Demanding Substances

Oil & Grease

Bacteria & Viruses

Likely to Have Significant Impact

Probable Low or Unknown Impact

## Implementation Requirements

Capital Costs

O&M Costs

Maintenance

Training

High  Low

SC4



## Additional Information — Vehicle and Equipment Maintenance and Repair

Vehicle or equipment maintenance is a potentially significant source of storm water pollution. Activities that can contaminate storm water include engine repair and service (parts cleaning, spilled fuel, oil, etc.), replacement of fluids, and outdoor equipment storage and parking (dripping engines). For further information on vehicle or equipment servicing, see SC2, Vehicle and Equipment Fueling, and SC3, Vehicle and Equipment Washing and Steam Cleaning.

### Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, 1,1,1-trichloroethane or methylene chloride. Many of these cleaners are harmful and must be disposed of as a hazardous waste. Cleaning without using liquid cleaners (e.g. wire brush) whenever possible reduces waste. Prevent spills and drips of solvents and cleansers to the shop floor. Do all liquid cleaning at a centralized station so the solvents and residues stay in one area. Locate drip pans, drain boards, and drying racks to direct drips back into a solvent sink or fluid holding tank for re-use.

### Safer Alternatives

If possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example:

- Use non-caustic detergents instead of caustic cleaning agents for parts cleaning (ask your supplier about alternative cleaning agents).
- Use detergent-based or water-based cleaning systems in place of organic solvent degreasers. Wash water may require treatment before it can be discharged to the sewer. Contact your local sewer authority for more information.
- 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 and 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.
- Choose cleaning agents that can be recycled.
- Contact your supplier or refer to trade journals for more waste minimization ideas.

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.

### Recycling

Separating wastes allows for easier recycling and may reduce treatment 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 non-chlorinated solvents (like kerosene and mineral spirits).

Many products made of recycled (i.e., refined or purified) materials are available. Engine oil, transmission fluid, antifreeze, and hydraulic fluid are available in recycled form. Buying recycled products supports the market for recycled materials.

### Spill Leak Clean Up

Clean leaks, drips, and other spills with as little water as possible. Use rags for small spills, a damp mop for general cleanup, and dry absorbent material for larger spills. Use the following three-step method for cleaning floors:

1. Clean spills with rags or other absorbent materials.
2. Sweep floor using dry absorbent material.
3. Mop floor. Mop water may be discharged to the sanitary sewer via a toilet or sink.

SC4



## Additional Information — Vehicle and Equipment Maintenance and Repair

### Good Housekeeping

Also consider the following measures:

- Avoid hosing down your work areas. If work areas are washed, direct wash water to sanitary sewer.
- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.
- Keep a drip pan under the vehicle while you unclip hoses, unscrew filters, or remove other parts. Use a drip pan under any vehicle that might leak while you work on it to keep splatters or drips off the shop floor.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around.

Do not pour liquid waste to floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections. Used or leftover cleaning solutions, solvents, and automotive fluids and oil are toxic and should not be put in the sanitary sewer. Post signs at sinks to remind employees, and paint stencils at outdoor drains to tell customer and others not to pour wastes down drains.

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Most municipalities prohibit or discourage disposal of these items in solid waste facilities. Place the oil filter in a funnel over the waste oil recycling or disposal collection tank to drain excess oil before disposal. Oil filters can be crushed and recycled. Ask your oil supplier or recycler about recycling oil filters.

Put pans under leaks to collect fluids for proper recycling or disposal. Keeping leaks off the ground reduces the potential for storm water contamination and reduces cleanup time and costs. If the vehicle or equipment is to be stored outdoors, oil and other fluids should be drained first.

Designate a special area to drain and replace motor oil, coolant, and other fluids, where there are no connections to the storm drain or the sanitary sewer and drips and spills can be easily cleaned up.

Be especially careful with wrecked vehicles, whether you keep them indoors or out, as well as vehicles kept on-site for scrap or salvage. Wrecked or damaged vehicles often drip oil and other fluids for several days.

- As the vehicles arrive, place drip pans under them immediately, even if you believe that the fluids have leaked out before the car reaches your shop.
- Build a shed or temporary roof over areas where you park cars awaiting repair or salvage, especially if you handle wrecked vehicles. Build a roof over vehicles you keep for parts.
- Drain all fluids, including air conditioner coolant, from wrecked vehicles and "part" cars. Also drain engines, transmission, and other used parts.
- 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.

### Examples of Effective Programs

The City of Palo Alto has an effective program for commercial vehicle service facilities. Many of the program's elements, including specific BMP guidance and lists of equipment suppliers, are also applicable to industrial vehicle service facilities.

Pick N Pull Auto Dismantlers in Rancho Cordova drains all fluids from automobiles before they enter the yard.

Ecology Auto Wrecking in Rialto is surrounded by a steel plate/concrete fence and has a completely paved lot that is graded to a central low point. Collected storm water is channeled through an underground drainage system of clarifiers

SC4



## Additional Information — Vehicle and Equipment Maintenance and Repair

and then stored in a 60,000 gallon UST before being processed through a filter system. In addition, the work area is covered, ventilated and has an additional sump. Vehicle fluids are drained in this area and segregated for recycling.

All Auto Parts, Fontana, has a complete water recycling system in a 10,000 square foot concrete slab surrounded by a curb that contains all the runoff and sends it to the recycling system. All receiving, dismantling, and shipping occurs on the slab.

### REFERENCES

Best Management Practices for Automotive-Related Industries, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Best Management Practices for Controlling Oil and Grease in Urban Storm Water Runoff, G. S. Silverman, et. al, 1986 Environmental Professional, Vol. 8, pp 351-362.

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Fact Sheet - Waste Reduction for Automotive Repair Shops; DTSC, 1989.

Hazardous Waste Reduction Assessment Handbook - Automotive Repair Shops; DTSC, 1988.

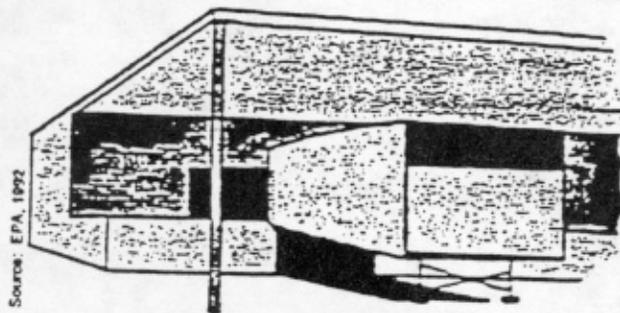
Hazardous Waste Reduction Checklist - Automotive Repair Shops; DTSC, 1988.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

SC4



## ACTIVITY: OUTDOOR LOADING/UNLOADING OF MATERIALS



### Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

### DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from outdoor loading/unloading of materials.

### APPROACH

- Park tank trucks or delivery vehicles so that spills or leaks can be contained.
- Cover the loading/unloading docks to reduce exposure of materials to rain.
- Seal or door skirt between trailer and building can also prevent exposure to rain.
- Design loading/unloading area to prevent storm water runoff:
  - grading or berming, and
  - position roof downspouts to direct storm water away from loading/unloading areas.
- Contain leaks during transfer.
- Use drip pans under hoses.
- Make sure fork lift operators are properly trained.
- Employee training for spill containment and cleanup.

### REQUIREMENTS

- Costs (Capital, O&M) - Should be low except when covering a large loading/unloading area.
- Maintenance
  - Conduct regular inspections and make repairs as necessary. The frequency of repairs will depend on the age of the facility.
  - Check loading and unloading equipment regularly for leaks:
    - valves,
    - pumps,
    - flanges, and
    - connections.

### LIMITATIONS

- Space and time limitations may preclude all transfers from being performed indoors or under cover.
- It may not be possible to conduct transfers only during dry weather.

### Targeted Constituents

- Sediment
- Nutrients
- Heavy Metals
- Toxic Materials
- Floatable Materials
- Oxygen Demand-  
ing Substances
- Oil & Grease
- Bacteria & Viruses

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

### Implementation Requirements

- Capital Costs
- O&M Costs
- Maintenance
- Training

- High  Low

## SC5



## Additional Information — Outdoor Loading/Unloading of Materials

The loading/unloading of materials usually takes place outside. Loading or unloading of materials occurs in two ways: materials in containers or direct liquid transfer. Materials spilled, leaked or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned. Rainfall may wash pollutants from machinery used to unload or move materials. The loading or unloading may involve rail or truck transfer.

The most important factors in preventing these constituents from entering storm water is:

- Limit exposure of material to rainfall.
- Prevent storm water runoff.
- Check equipment regularly for leaks.
- Contain spills during transfer operations.

Loading or unloading of liquids should occur in the manufacturing building so that any spills that are not completely retained can be discharged to the sanitary sewer, treatment plant, or treated in a manner consistent with local sewer authorities and permit requirements. Best management practices include:

- Use overhangs or door skirts that enclose the trailer.
- Park tank trucks during delivery so that spills or leaks can be contained.
- Design loading/unloading area to prevent storm water runoff which would include grading or berming the area, and positioning roof downspouts so they direct storm water away from the loading/unloading areas.
- Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections.
- Look for dust or fumes during loading or unloading operations.
- Use a written operations plan that describes procedures for loading and/or unloading.
- Have an emergency spill cleanup plan readily available.
- Employees trained in spill containment and cleanup should be present during the loading/unloading.
- Establish depots of cleanup materials next to or near each loading/unloading area, and train employees in their use.
- For loading and unloading tank trucks to above and below ground storage tanks, the following procedures should be used.
  - The area where the transfer takes place should be paved. If the liquid is reactive with the asphalt, Portland cement should be used to pave the area.
  - Transfer area should be designed to prevent runoff of storm water from adjacent areas. Sloping the pad and using a curb, like a speed bump, around the uphill side of the transfer area should reduce runoff.
  - Transfer area should be designed to prevent runoff of spilled liquids from the area. Sloping the area to a drain should prevent runoff. The drain should be connected to a dead-end sump or to the sanitary sewer. A positive control valve should be installed on the drain.
- For transfer from rail cars to storage tanks that must occur outside, use the following procedures:
  - Drip pans should be placed at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles. Use drip pans when making and breaking connections.
  - Drip pan systems should be installed between the rails to collect spillage from tank cars.

### REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992

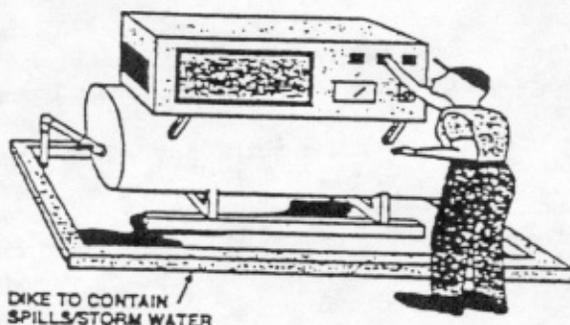
Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC5



## ACTIVITY: OUTDOOR PROCESS EQUIPMENT OPERATIONS AND MAINTENANCE



Applications

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

### DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from outdoor process equipment operations and maintenance by reducing the amount of waste created, enclosing or covering all or some of the equipment, installing secondary containment, and training employees.

### APPROACH

- Alter the activity to prevent exposure of pollutants to storm water.
- Move activity indoors.
- Cover the area with a permanent roof.
- Minimize contact of storm water with outside manufacturing operations through burning and drainage routing (run on prevention).
- Connect process equipment area to public sewer or facility wastewater treatment system.
- Clean regularly the storm drainage system.
- Use catch basin filtration inserts (Chapter 5, TC6, Media Filtration) as a means to capture particulate pollutants.
- Some municipalities require that secondary containment areas (regardless of size) be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.

### REQUIREMENTS

- Costs (Capital, O&M)
  - Variable depending on the complexity of the operation and the amount of control necessary for storm water pollution control.
- Maintenance
  - Routine preventive maintenance, including checking process equipment for leaks.

### LIMITATIONS

- Providing cover may be expensive.
- Space limitations may preclude enclosing some equipment.
- Storage sheds often must meet building and fire code requirements.

### Targeted Constituents

- Sediment
- Nutrients
- Heavy Metals
- Toxic Materials
- Floatable Materials
- Oxygen Demanding Substances
- Oil & Grease
- Bacteria & Viruses

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

### Implementation Requirements

- Capital Costs
- O&M Costs
- Maintenance
- Training

High  Low

**SC7**



## Additional Information — Outdoor Process Equipment Operations and Maintenance

Outside process equipment operations can contaminate storm water runoff. Activities, such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, landfills, waste piles, wastewater and solid waste treatment and disposal, and land application are process operations that use hazardous materials and that can lead to contamination of storm water runoff. Pollutants from the wastewater and solid waste treatment and disposal areas result from waste pumping, additions of treatment chemicals, mixing, aeration, clarification, and solids dewatering.

Possible storm water contaminants include heavy metals, toxic materials, and oil and grease. Waste spilled, leaked, or lost from outdoor process equipment operations may build up in soils or on other surfaces and be carried away by storm water runoff. There is also a potential for liquid waste from lagoons or surface impoundments, associated with outdoor equipment operations, to overflow to surface waters or soak the soil, which can be picked up by storm water runoff.

The preferred (and possibly the most economical) action to reduce storm water pollution is to alter the nature of activity such that pollutants are not exposed to storm water. This may mean performing the activity during dry periods only or substituting benign materials for more toxic ones. Actions other than altering the activity include enclosing the activity in a building and connecting the floor drains to the sanitary sewer. The area used by the activity may be so great as to make enclosure prohibitively expensive. Building cost can be reduced by not covering the sides, and thus eliminating the need for ventilating and lighting systems. When certain parts of the activity are the worst source of pollutants, those parts can be segregated and enclosed or covered.

Curbs can be placed around the immediate boundaries of the process equipment. The storm drains from these interior areas can be connected to the facility's process wastewater system.

Reducing the amount of waste that is created and consequently the amount that must be stored or treated is another way to reduce the potential for storm water contamination from outside manufacturing activities. Waste reduction BMPs are available for a wide range of industries and are designed to provide ideas and ways to reduce waste (see References).

### Hydraulic/Treatment Modifications

If storm water becomes polluted, it should be captured and treated. If you do not have your own process wastewater treatment system, consider discharging to the public sewer system. Use of the public sewer might be allowed under the following conditions:

- If the activity area is very small (less than a few hundred square feet), the local sewer authority may be willing to allow the area to remain uncovered with the drain connected to the public sewer.
- It may be possible under unusual circumstances to connect a much larger area to the public sewer, as long as the rate of storm water discharges do not exceed the capacity of the wastewater treatment plant. The storm water could be stored during the storm and then transferred to the public sewer when the normal flow is low, such as at night.

The majority of the pollutants in storm water are discharged over time by the small, high frequency storms. Less polluted runoff from the infrequent large storms can be bypassed to the storm drain. To implement this BMP, a hydraulic evaluation of the downstream sewer system should occur in consultation with the local sewer authority.

Industries that generate large volumes of process wastewater typically have their own treatment system that discharges directly to the nearest receiving water. These industries have the discretion to use their wastewater treatment system to treat storm water within the constraints of their permit requirements for process treatment. It may also be possible for the industry to discharge the storm water directly to its effluent outfall without treatment as long as the total loading of the discharged process water and storm water does not exceed the loading had a storm water treatment device been used. This could be achieved by reducing the loading from the process wastewater treatment system. Check with your Regional Water Quality Control Board, as this option would be subject to permit constraints and potentially regular monitoring.

SC7



## Additional Information — Outdoor Process Equipment Operations and Maintenance

### REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control. Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Publications That Can Work For You!; California Department of Toxic Substances Control, Sacramento, CA, 1991 (A list and order form for waste minimization publications from the State).

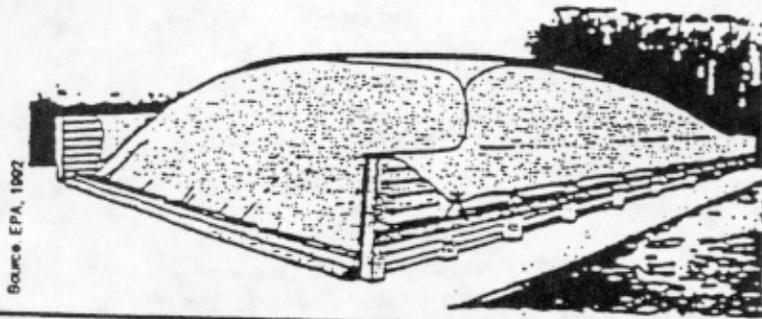
Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, USEPA, 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC7



**ACTIVITY: OUTDOOR STORAGE OF RAW MATERIALS, PRODUCTS, AND BY-PRODUCTS**



**Applications**

- Manufacturing
- Material Handling
- Vehicle Maintenance
- Construction
- Commercial Activities
- Roadways
- Waste Containment
- Housekeeping Practices

**DESCRIPTION**

Prevent or reduce the discharge of pollutants to storm water from outdoor material and product storage areas by enclosing or covering materials, installing secondary containment, and preventing storm water runoff.

**APPROACH**

- Protect materials from rainfall, runoff, runoff and wind dispersal:
  - Store material indoors.
  - Cover the storage area with a roof.
  - Cover the material with a temporary covering made of polyethylene, polypropylene, or hypalon.
  - Minimize storm water runoff by enclosing the area or building a berm around the area.
  - Use "doghouse" for storage of liquid containers.
- Parking lots or other surfaces near bulk materials storage areas should be swept periodically to remove debris blown or washed from storage area.
- Install pellet traps at storm water discharge points where plastic pellets are loaded and unloaded.
- Keep liquids in a designated area on a paved impervious surface within a secondary containment.
- Keep outdoor storage containers in good condition.
- Use berms and curbing.
- Use catch basin filtration inserts (Chapter 5, TC6, Media Filtration)

**REQUIREMENTS**

- Costs (Capital, O&M)
  - Costs should be low except where large areas may have to be covered.
- Maintenance
  - Berm and curbing repair and patching.

**LIMITATIONS**

- Space limitations may preclude storing some materials indoors.
- Some municipalities require that secondary containment areas (regardless of size) be connected to the sanitary sewer, prohibiting any hard connections to the storm drain.
- Storage sheds often must meet building and fire code requirements.

**Targeted Constituents**

- Sediment
  - Nutrients
  - Heavy Metals
  - Toxic Materials
  - Floatable Materials
  - Oxygen Demanding Substances
  - Oil & Grease
  - Bacteria & Viruses
- Likely to Have Significant Impact
  - Probable Low or Unknown Impact

**Implementation Requirements**

- Capital Costs
- O&M Costs
- Maintenance
- Training

- High     Low

**SC8**



## Additional Information — Outdoor Storage of Raw Materials, Products, and By-Products

Raw materials, by-products, finished products, containers, and material storage areas exposed to rain and/or runoff can pollute storm water. Storm water can become contaminated by a wide range of contaminants when materials wash off or dissolve into water or are added to runoff by spills and leaks.

Paved areas should be sloped in a manner that minimize the pooling of water on the site, particularly with materials that may leach pollutants into storm water and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5 percent is recommended.

Curbing should be placed along the perimeter of the area to prevent the runoff of uncontaminated storm water from adjacent areas as well as runoff of storm water from the stockpile areas. The storm drainage system should be designed to minimize the use of catch basins in the interior of the area as they tend to rapidly fill with manufacturing material. In these cases, consider the use of the catch basin insert filter described in Chapter 5, TC6 (Media Filtration). The area should be sloped to drain storm water to the perimeter where it can be collected or to internal drainage alleyways where material is not stockpiled. If the raw material, by-product, or product is a liquid, more information for outside storage of liquids can be found under SC6, Outdoor Container Storage of Liquids.

### Examples

The "doghouse" design has been used to store small liquid containers. The roof and flooring design prevent contact with direct rain or runoff. The doghouse has two solid structural walls and two canvas covered walls. The flooring is wire mesh about secondary containment. The unit has been used successively at Lockheed Missile and Space Company in Sunnyvale.

### REFERENCES

Best Management Practices for Industrial Storm Water Pollution Control, Santa Clara Valley Nonpoint Source Pollution Control Program, 1992.

Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans, and Best Management Practices, EPA 832-R-92-006, EPA, 1992.

Water Quality Best Management Practices Manual, City of Seattle, 1989.

SC8



## ACTIVITY: EMPLOYEE TRAINING



### Applications

Manufacturing

Material Handling

Vehicle Maintenance

Construction

Commercial Activities

Roadways

Waste Containment

Housekeeping Practices

### DESCRIPTION

Employee training, like equipment maintenance, 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 training from the individual source controls into a comprehensive training program as part of a facility's Storm Water Pollution Prevention Plan (SWPPP).

The specific employee 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 training in storm water pollution prevention. Accordingly, the organization of this fact sheet differs somewhat from the other fact sheets in this chapter.

### OBJECTIVES

Employee 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 ownership of the problems and the solutions; and
- Integrate employee 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 Illness and Injury Prevention Program (IIPP) (SB 198) (California Code of Regulations Title 8, Section 3203), 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) (California Health and Safety Code, Section 6.95).
- Businesses, particularly smaller ones that are not regulated by Federal, State, or local regulations, may use the information in this Handbook to develop a training program to reduce their potential to pollute storm water.

### LISTING OF INDUSTRIAL ACTIVITIES

Employee training is a vital component of many of the individual source control BMPs included in this chapter. Following is a compilation of the training aspects of the source control fact sheets.

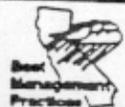
## SC14



## ACTIVITY — EMPLOYEE TRAINING (Continue)

- SC1 Non-Storm Water Discharges to Drains**
- Use the quick reference on disposal alternatives (Table 4.1) to train employees in proper and consistent methods for disposal.
  - Consider posting the quick reference table near storm drains to reinforce training.
- SC2 Vehicle and Equipment Fueling**
- Train employees in proper fueling and cleanup procedures.
  - The SPCC Plan may be an effective program to reduce the number of accidental spills from fueling.
- SC3 Vehicle and Equipment Washing and Steam Cleaning**
- Train employees in standard operating procedures and spill cleanup techniques described in the fact sheet.
- SC4 Vehicle and Equipment Maintenance and Repair**
- Train employees in standard operating procedures and spill cleanup techniques described in the fact sheet.
  - Paint stencils to remind employees not to pour waste down storm drains.
- SC5 Outdoor Loading/Unloading of Materials**
- Use a written operations plan that describes procedures for loading and/or unloading.
  - Have an emergency spill cleanup plan readily available.
  - Employees trained in spill containment and cleanup should be present during loading/unloading.
  - Make sure fork lift operators are also properly trained.
- SC6 Outdoor Container Storage of Liquids**
- Registered and specifically trained professional engineers can identify and correct potential problems such as loose fittings, poor welding, and improper or poorly fitted gaskets for newly installed tank systems.
  - Employees trained in emergency spill cleanup procedures should be present when dangerous waste, liquid chemicals, or other wastes are handled.
- SC7 Outdoor Process Equipment Operations and Maintenance**
- The preferred and possibly most economical action to reduce storm water pollution is to alter the activity. This may mean training employees to perform the activity during dry periods only or substituting benign materials for more toxic ones.
- SCX Outdoor Storage of Raw Materials, Products, and By-Products**
- Train employees in standard operating procedures and spill cleanup techniques described in the fact sheet.
- SC9 Waste Handling and Disposal**
- Train employees in standard operating procedures and spill cleanup techniques described in the fact sheet.
  - Paint stencils to remind employees not to pour waste down storm drains.
- SC10 Contaminated or Erodible Surface Areas**
- Training is not a significant element of this best management practice.

SC14



## ACTIVITY — EMPLOYEE TRAINING (Continue)

### SC11 Building and Grounds Maintenance

- Personnel who use pesticides should be trained in their use. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Written procedures for the use of pesticides and fertilizers relevant to your facility would help maintenance staff understand the "do's" and "don'ts". If you have large vegetated areas, consider the use of integrated pest management (IPM) techniques to reduce the use of pesticides.

### SC12 Building Repair, Remodeling, and Construction

- Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employees can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do.

### SC13 Over-Water Activities

- Post signs to indicate proper use and disposal of residual paints, rags, used oil, and other engine fluids.
- Educate tenants and employees on spill prevention and cleanup.
- Include appropriate language in tenant contracts indicating their responsibilities.

SC14



**Appendix D**  
**California Storm Water Best Management Practices (Erosion and Sediment Control)**

## 5. 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. Chapter 2 led you through the steps of identifying activities at your site that can cause erosion, while Chapter 3 provided guidance with BMP selection. This chapter will provide you with the BMPs 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.

Sizing and design criteria for erosion and sedimentation control may be standardized for each local area. This handbook cannot develop specific sizing criteria for all topographies and climates in California. Many local agencies have developed such criteria and should be consulted before sizing specific BMPs. A common design storm for sizing temporary erosion and sedimentation controls is a two-

### BMPs for Erosion and Sedimentation Control

#### Site Planning Considerations

- ESC1 Scheduling
- ESC2 Preservation of Existing Vegetation

#### 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

#### 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
- ESC51 Straw Bale Barrier
- ESC52 Sand Bag Barrier
- ESC53 Brush or Rock Filter
- ESC54 Storm Drain Inlet Protection
- ESC55 Sediment Trap
- ESC56 Sediment Basin

year, 24-hour storm. Sizing criteria given in this handbook assume that such a storm would result in 0.042 ac-ft/ac. of runoff (0.5 inches of runoff). This should be appropriate for sizing controls in most areas. 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. In all cases, however, local erosion and sedimentation criteria and standards supersede the suggested criteria on these fact sheets.

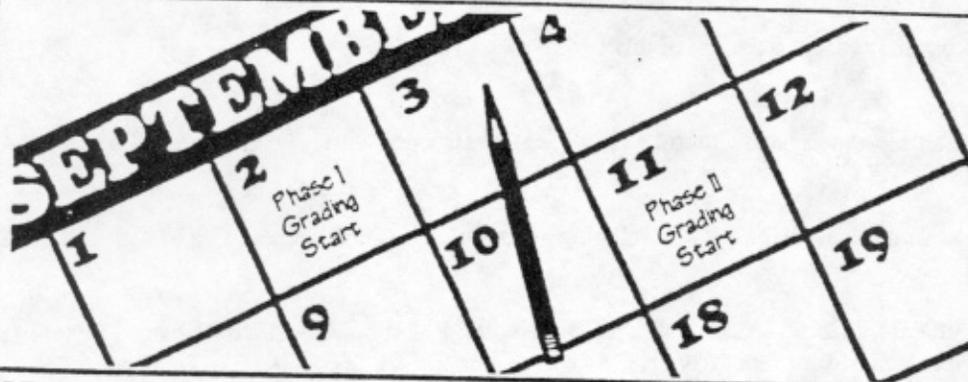
BMPs fact sheets are provided for each of the following BMP categories, and are consistent with Worksheet 5 in Chapter 2.

TABLE 5.1 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	
<b>Site Planning Considerations</b>								
ESC1	✓	✓	✓	✓	✓	✓	✓	✓
ESC2			✓	✓	✓	✓		
<b>Vegetative Stabilization</b>								
ESC10				✓	✓			
ESC11				✓	✓			
<b>Physical Stabilization</b>								
ESC20				✓	✓			
ESC21	✓		✓	✓		✓		
ESC22	✓		✓	✓	✓			
ESC23	✓		✓	✓	✓			
ESC24	✓		✓	✓	✓	✓		
<b>Diversion of Runoff</b>								
ESC30		✓						✓
ESC31						✓		✓
ESC32						✓		✓
<b>Velocity Reduction</b>								
ESC40								
ESC41							✓	✓
ESC42				✓				✓

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
		<b>Sediment Trapping/Filtering</b>						
ESC50	Silt Fence						✓	✓
ESC51	Straw Bale Barrier						✓	✓
ESC52	Sand Bag Barrier					✓	✓	✓
ESC53	Brush or Rock Filter					✓	✓	✓
ESC54	Storm Drain Inlet Protection						✓	✓
ESC55	Sediment Trap							✓
ESC56	Sediment Basin							✓

## 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 ESC 10 to 24) or to install temporary sediment trapping devices (see ESC 50 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-effectiveness 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



## BMP: SCHEDULING ( Continue)

### 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.

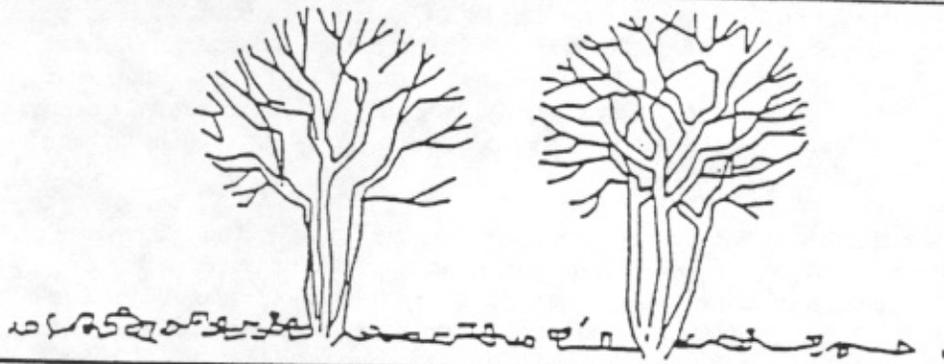
Storm Water Management for Construction Activities. Developing Pollution Prevention Plans and Best Management Practices, U.S. Environmental Protection Agency, Office of Water (EPA 832-R-92-005) - September, 1992.

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: vernal pools, wetlands, marshes, certain oak trees, 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**



## 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 heat 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. For example, in Sacramento County a tree ordinance has been adopted that protects the native California Oak tree. 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 dripline 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 Soil Conservation Service should be contacted about existing vegetation for sites throughout California. 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 Existing 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).
- For the California Oak tree, no trenching or irrigation should be allowed within the driplines of the tree, since both these activities are detrimental to the preservation of the tree.
- Where grading under trees is necessary, excavation and fill should be limited to 1 foot within the driplines.

### 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.

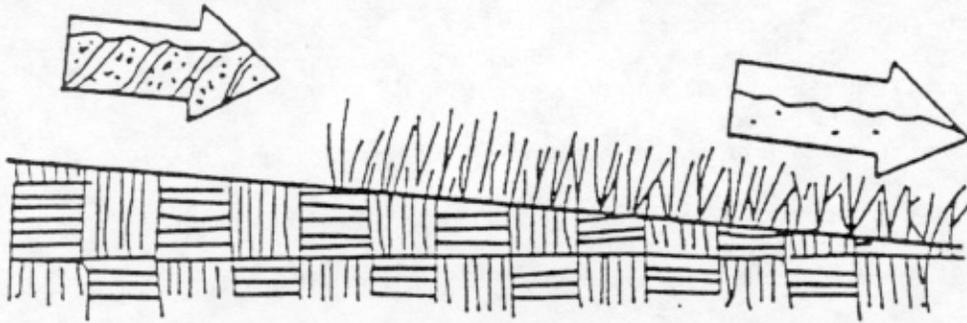
Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

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

ESC2



## BMP: SEEDING AND PLANTING



### GENERAL DESCRIPTION

Seeding of grasses and plantings of trees, shrubs, vines and ground covers provide long-term 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, temperature extremes, 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.

### 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

## ESC10



Best Management Practices

APPENDIX H

CALIFORNIA STORM WATER  
BEST MANAGEMENT PRACTICES  
(EROSION AND SEDIMENT CONTROL)

## 5. 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. Chapter 2 led you through the steps of identifying activities at your site that can cause erosion, while Chapter 3 provided guidance with BMP selection. This chapter will provide you with the BMPs 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.

Sizing and design criteria for erosion and sedimentation control may be standardized for each local area. This handbook cannot develop specific sizing criteria for all topographies and climates in California. Many local agencies have developed such criteria and should be consulted before sizing specific BMPs. A common design storm for sizing temporary erosion and sedimentation controls is a two-

### BMPs for Erosion and Sedimentation Control

#### Site Planning Considerations

- ESC1 Scheduling
- ESC2 Preservation of Existing Vegetation

#### 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

#### 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
- ESC51 Straw Bale Barrier
- ESC52 Sand Bag Barrier
- ESC53 Brush or Rock Filter
- ESC54 Storm Drain Inlet Protection
- ESC55 Sediment Trap
- ESC56 Sediment Basin

year, 24-hour storm. Sizing criteria given in this handbook assume that such a storm would result in 0.042 ac-ft/ac. of runoff (0.5 inches of runoff). This should be appropriate for sizing controls in most areas. 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. In all cases, however, local erosion and sedimentation criteria and standards supersede the suggested criteria on these fact sheets.

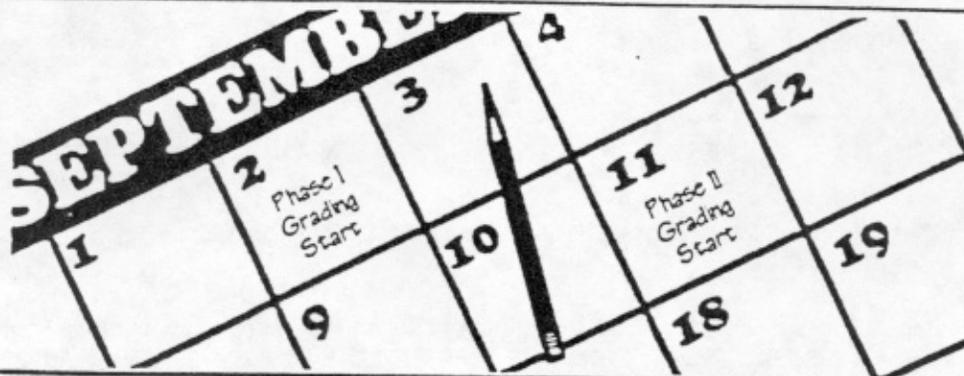
BMPs fact sheets are provided for each of the following BMP categories, and are consistent with Worksheet 5 in Chapter 2.

TABLE 5.1 EROSION AND SEDIMENT CONTROL, AND BMP OBJECTIVES

BMP CATEGORY	BMP OBJECTIVES							
	PRACTICE GOOD HOUSEKEEPING	CONTAIN WASTE	MINIMIZE DISTURBED AREA	STABILIZE DISTURBED AREA	PROTECT SLOPES AND CHANNELS	CONTROL SITE PERIMETER	CONTROL INTERNAL EROSION	
<b>Site Planning Considerations</b>								
ESC1	✓	✓	✓	✓	✓	✓	✓	✓
ESC2			✓	✓	✓	✓		
<b>Vegetative Stabilization</b>								
ESC10				✓	✓			
ESC11				✓	✓			
<b>Physical Stabilization</b>								
ESC20				✓	✓			
ESC21	✓		✓	✓	✓			
ESC22	✓		✓	✓	✓			
ESC23	✓		✓	✓	✓			
ESC24	✓		✓	✓	✓			
<b>Diversion of Runoff</b>								
ESC30		✓			✓			✓
ESC31					✓			✓
ESC32					✓			✓
<b>Velocity Reduction</b>								
ESC40							✓	
ESC41							✓	
ESC42				✓				

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
	<b>Sediment Trapping/Filtering</b>							
ESC50	Silt Fence						✓	✓
ESC51	Straw Bale Barrier						✓	✓
ESC52	Sand Bag Barrier					✓	✓	✓
ESC53	Brush or Rock Filter					✓	✓	✓
ESC54	Storm Drain Inlet Protection						✓	✓
ESC55	Sediment Trap							✓
ESC56	Sediment Basin							✓

## 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 ESC 10 to 24) or to install temporary sediment trapping devices (see ESC 50 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-effectiveness 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

## BMP: SCHEDULING ( Continue)

### 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.

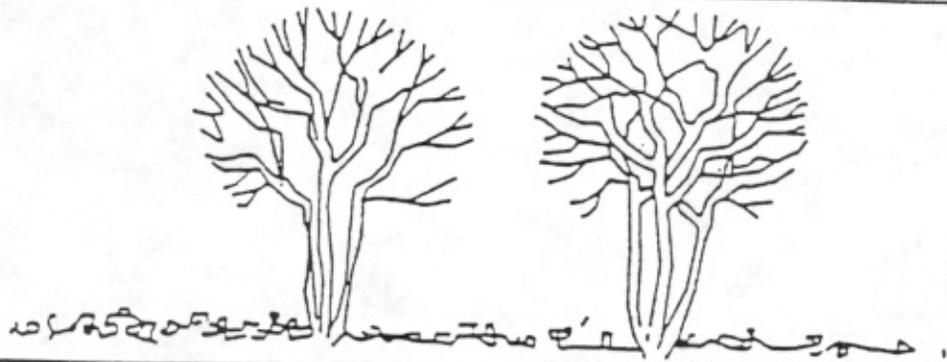
Storm Water Management for Construction Activities. Developing Pollution Prevention Plans and Best Management Practices, U.S. Environmental Protection Agency, Office of Water (EPA 832-R-92-005) - September, 1992.

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

*Housakeeping 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: vernal pools, wetlands, marshes, certain oak trees, 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



East  
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 heat 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. For example, in Sacramento County a tree ordinance has been adopted that protects the native California Oak tree. 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 dripline 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 Soil Conservation Service should be contacted about existing vegetation for sites throughout California. 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 Existing 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).
- For the California Oak tree, no trenching or irrigation should be allowed within the driplines of the tree, since both these activities are detrimental to the preservation of the tree.
- Where grading under trees is necessary, excavation and fill should be limited to 1 foot within the driplines.

### 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.

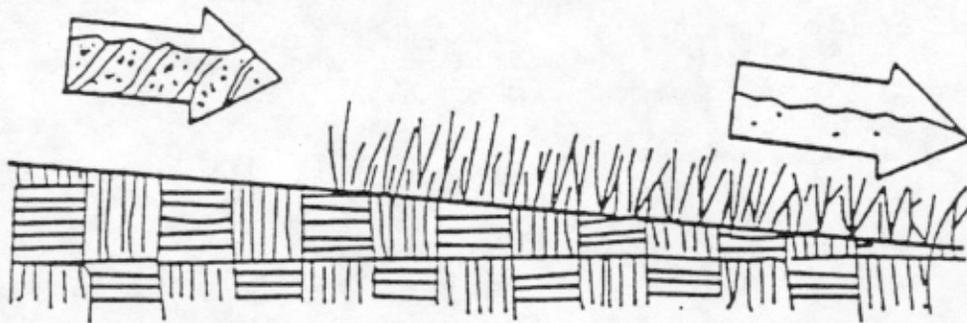
Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

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

ESC2



## BMP: 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 long-term 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, temperature extremes, 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



## BMP: SEEDING AND PLANTING (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 Municipal Handbook). Additionally, vegetated swales, steep and/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 within California, a set of general guidelines is included for installation/application of grasses, trees and shrubs, vines and ground covers. However, your local municipality, Soil Conservation Service, 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 soil-bed 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. Several grasses are adaptable to the various California climates. The figure at the end of these fact sheets shows appropriate grasses for regions within California. Blue grass is well adapted throughout California except for in the valley regions. The blue grass is found on dry, sandy soils that have good drainage. Bermuda grass, on the other hand is well adapted in the valley region where soils are dry, coarse and heavier. 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. Broadcast the seedings in the late fall or early spring. In the late fall, seedings should be planted by mid- September to have established grass by the October rainy season.
4. 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:

Time of Year - Late fall through winter (November to February) is the preferred time for transplanting in most of California.

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 such as the California Poppy and California buckwheat, both of which compete poorly with introduced grasses (e.g., planting wild oats is illegal in California). 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. Soil 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. The plants discussed in this handbook are those which are known to be adapted to California, and commonly available from commercial nurseries. 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 State Department of Water Resources or the Soils 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-a-year trimming to promote growth.

ESC10



## Additional Information — Seeding and Planting

### 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.

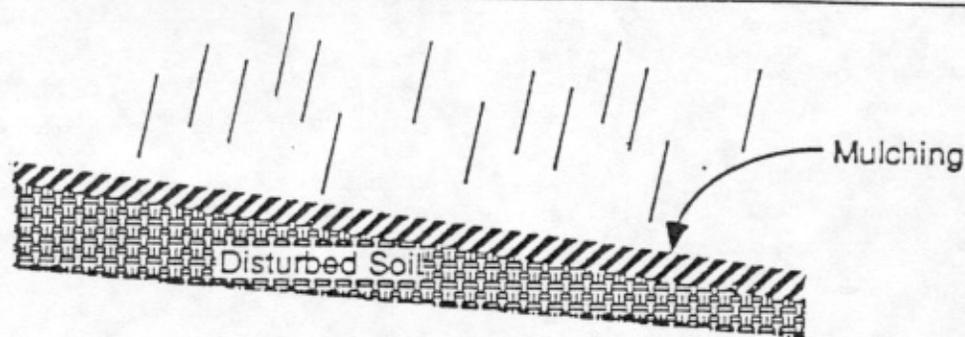
### REFERENCES

- Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, September 1992.
- "Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.
- Guides for Erosion and Sediment Controls in California, USDA Soils Conservation Service - January 1991.
- Kiowa Engineering, Interim Erosion and Sedimentation Control for Construction Activities, Urban Drainage and Flood Control District, Denver, Colorado.
- Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, Jun 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.
- Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

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).
- Mulches such as gravel and decomposed soils may be used as post-construction BMPs, particularly in arid regions.

### INSTALLATION/APPLICATION CRITERIA

Mulch prevents erosion by protecting the soil surface and fostering growth of new seedlings 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.
  - Jute Netting: \$12,500 per acre.

### LIMITATIONS

- Wood fiber mulches should be used only in areas with over 20 inches annual precipitation.
- Organic mulches are not permanent erosion control measures.
- Mulches tend to lower the soil surface temperature, and may delay germination of some seeds.
- Permanent mulches for arid regions should include gravel and decomposed soils.

### 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



## Additional Information — Mulching

Mulching protects the soil from rainfall impact; increases infiltration; conserves moisture around trees, shrubs and seedlings; prevents compaction and cracking of soil; and aids plant growth for seedlings 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 soil 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 seedlings;
- 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 fall 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 Soils Conservation Service 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 an emulsified asphalt or binder either independently or followed by crimping. If tacked, straw mulch may be applied at a rate of 1 3/4 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).

### REFERENCES

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.

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

"Environmental Criteria Manual", City of Austin, Texas.

Guides for Erosion & Sediment Control in California, USDA Soils Conservation Service - January 1991.

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.

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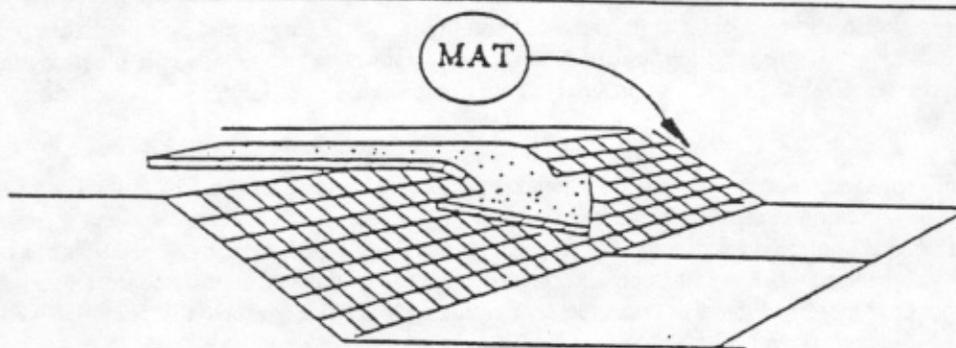
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Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC11



## BMP: GEOTEXTILES AND MATS



### Objectives

Housekeeping Practices

Contain Waste

Minimize Disturbed Areas

Stabilize Disturbed Areas

Protect Slopes/Channels

Control Site Perimeter

Control Internal Erosion

### GENERAL DESCRIPTION

Matings 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

Matings 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 are 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.

### 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

## ESC20



Best Management Practices

## Additional Information — Geotextiles and Mats

Matings are used to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matings 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

Matings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Matings 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 matings 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% ( $\pm 3\%$ ) agricultural straw and 30% ( $\pm 3\%$ ) 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 matings 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 inches 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.

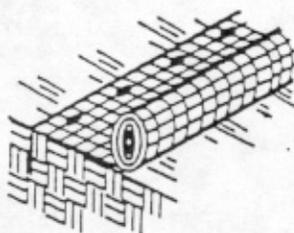
Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.

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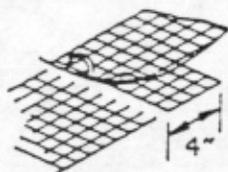
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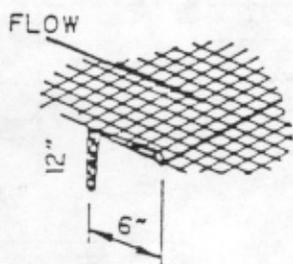
## Additional Information — Geotextiles and Mats



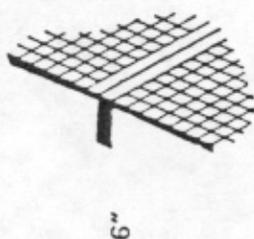
**ANCHOR SLOT:** BURY THE UP-CHANNEL END OF THE NET IN A 12" DEEP TRENCH. TAMP THE SOIL FIRMLY. STAPLE AT 12" INTERVALS ACROSS THE NET.



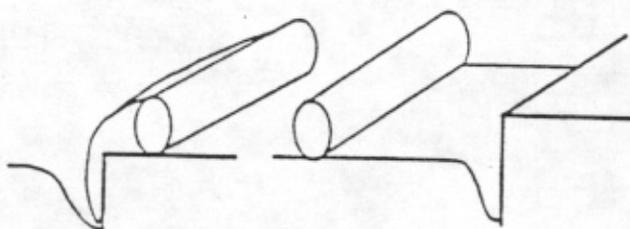
**OVERLAP:** OVERLAP EDGES OF THE STRIPS AT LEAST 4". STAPLE EVERY 12" DOWN THE CENTER OF THE STRIP.



**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 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 TRAMP 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.

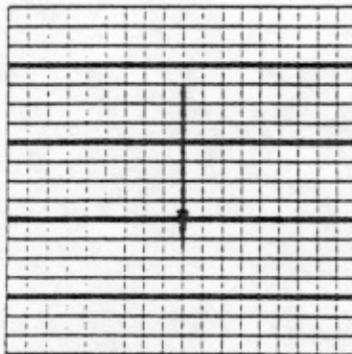
### INSTALLATION OF NETTING AND MATTING

ESC20

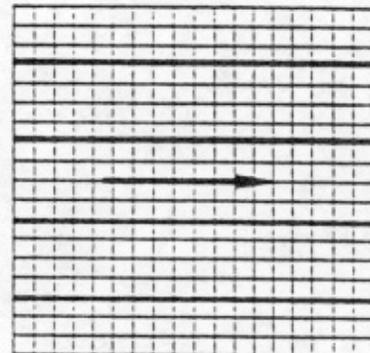
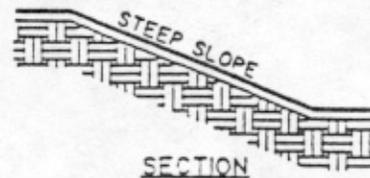


# Additional Information — Geotextiles and Mats

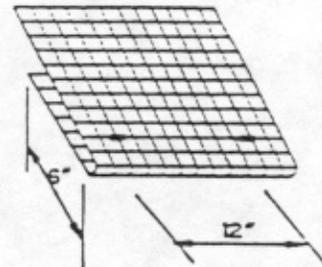
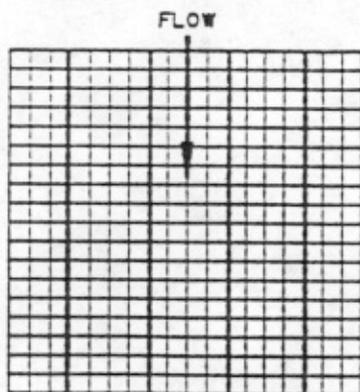
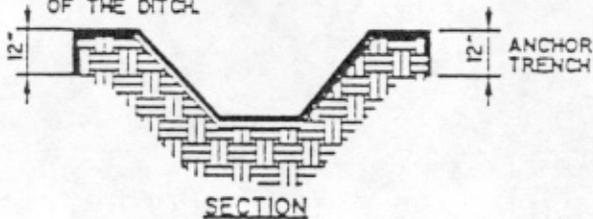
ON SHALLOW SLOPES, STRIPS OF NETTING MAY BE APPLIED ACROSS THE SLOPE.



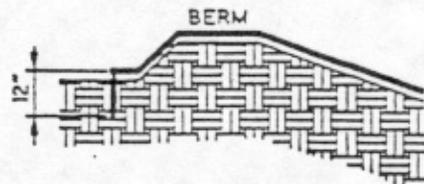
ON STEEP SLOPES, APPLY STRIPS OF NETTING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY.



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.



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



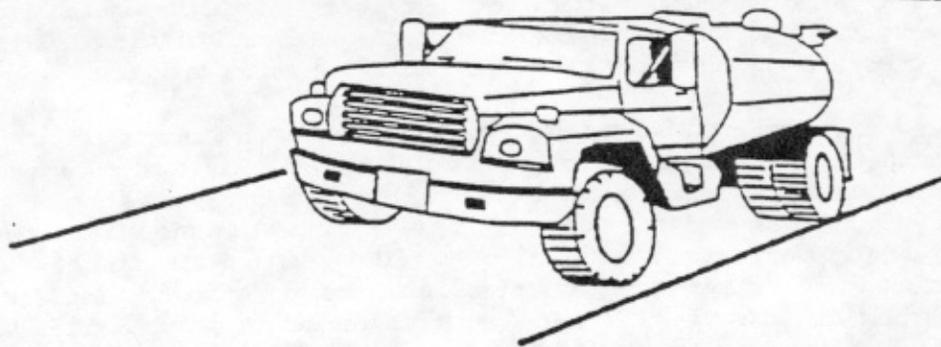
WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE MATTING OVER THE BERM AND ANCHOR IT BEHIND THE BERM WITH A 12" ANCHOR TRENCH.

## 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 ESC 1).
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering (See ESC 10 and 11).
- Identify and stabilize key access points prior to commencement of construction (See ESC 24).
- Minimizing the impact of dust by anticipating the direction of prevailing winds.
- Direct most construction traffic to stabilized roadways within the project site (See ESC 23).

### 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

California's mediterranean climate, with short wet seasons and long hot dry seasons, allow the soils to thoroughly dry out. During these dry seasons, construction activities are at their peak, and disturbance and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment.

Dust control, as a BMP, is a practice that is already in place for many construction activities. Los Angeles, the North Coast and Sacramento, among others have enacted dust control ordinances for construction activities that cause dust to be transported beyond the construction project property line. Recently, the State Air Resources Control Board has, under the authority of the Clean Air Act, started to address air quality in relation to inhalable particulate matter less than 10 microns (PM-10). 90% of these small particles are considered to be dust. Existing dust control regulations by local agencies, municipal departments, public works department, and/or public health departments are in place in some regions within California. For jurisdictions that have no formal dust control regulations and/or standards, Sections 10, 17 and 18 of CalTrans' Standard Specifications provide detailed provisions for dust control practices.

Many local agencies require dust control in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. The following are measures that local agencies may have already implemented as requirements for dust control from contractors:

- Construction & Grading Permits: Require provisions for dust control plans;
- Opacity Emission Limits: Enforce compliance with California air pollution control laws;
- Increase overall enforcement activities: Priority given to cases involving citizen complaints;
- Maintain Field Application Records: Require records of dust control measures from contractor;
- Stormwater Pollution Prevention Plan: (SWPPP): Integrate dust control measures into SWPPP.

### 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 stockpiles. The types of chemicals available and recommendations for their use are tabulated in Table ESC 21.2, 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 (ESC 10)
- Mulching (ESC 11)
- Construction Road Stabilization (ESC 23)
- Stabilized Construction Entrances (ESC 24)

### 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	X	X	X	X	X				X	
Disturbed Areas Subject to Traffic			X	X	X				X	
Material Stock Pile Stabilization			X	X		X			X	
Demolition			X				X	X		
Clearing/Excavation			X	X					X	
Truck Traffic on Unpaved Roads			X	X	X			X		
Mud/Dirt Carry-Out					X		X			

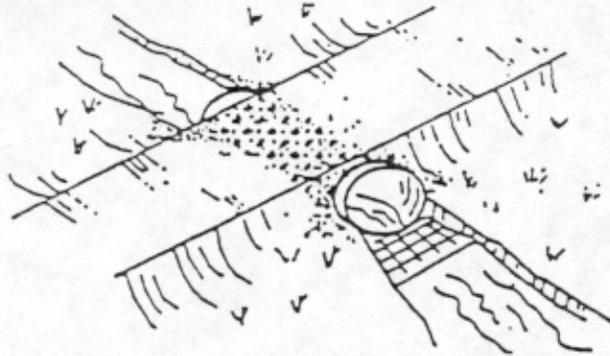
TABLE ESC 21.2 COMMONLY USED CHEMICALS FOR DUST CONTROL.

	SALTS	ORGANIC, NON PETROLEUM-BASED	PETROLEUM BASED PRODUCTS <sup>1</sup>
CHEMICAL TYPES	<ul style="list-style-type: none"> <li>• Calcium Chloride<sup>2</sup></li> <li>• Magnesium Chloride</li> <li>• Natural Brines</li> </ul>	<ul style="list-style-type: none"> <li>• Calcium Lignosulfonate</li> <li>• Sodium Lignosulfonate</li> <li>• Ammonium Lignosulfonate</li> </ul>	<ul style="list-style-type: none"> <li>• Bunker Oil</li> <li>• Asphalt Primer</li> <li>• Emulsified Asphalt</li> </ul>
LIMITATIONS	<p>Can lose effectiveness in dry periods with low humidity. Leaches from road in heavy rain</p> <p>Not recommended for gravel road surfaces with low fines. Recommended 10-20% fines.</p>	<p>Not affected by dry weather and low humidity. Leached from road in heavy rain if not sufficiently cured.</p> <p>Best performance on gravel roads with high surface fines (10-30%) and dense compact surface with loose gravel.</p>	<p>Generally effective regardless of climatic conditions may pothole in wet weather.</p> <p>Best performance on gravel roads with 5-10% fines.</p>
COMMENTS	<p>Calcium Chloride is popular. May become slippery when wet on gravel surfaces with high fines.</p>	<p>Ineffective on gravel surfaces low in fines. May become slippery when wet on gravel surfaces with high fines content.</p>	<p>Creates a hardened crust.</p>

<sup>1</sup> Motor oils and oil treatments are not recommended due to adverse effects on plant life and groundwater.

<sup>2</sup> 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 California 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.
- Cost
  - CalTrans Construction Cost Index for temporary bridge crossing is \$45-\$95 per square feet.

### 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.

### 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



## 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 California. 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 of California.

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 long summer construction season in California, 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



## Additional Information — Temporary Stream Crossing

- 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 local municipal storm water agency for additional information.

### REFERENCES

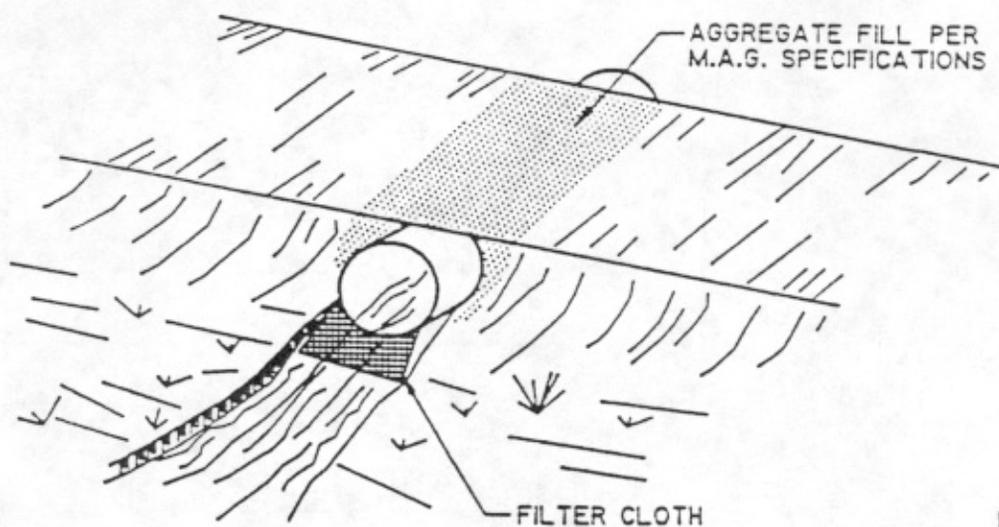
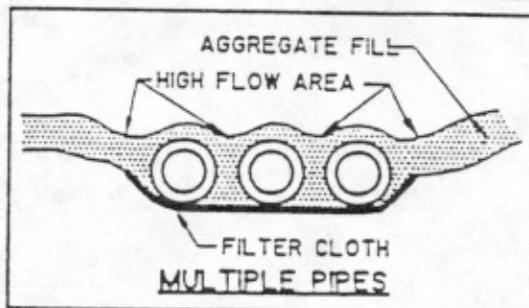
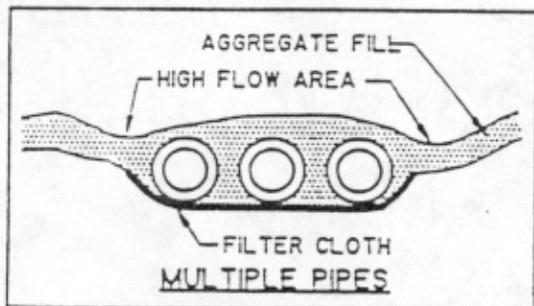
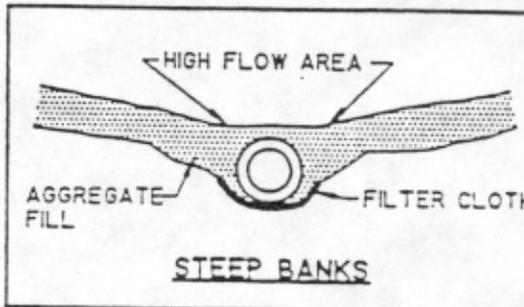
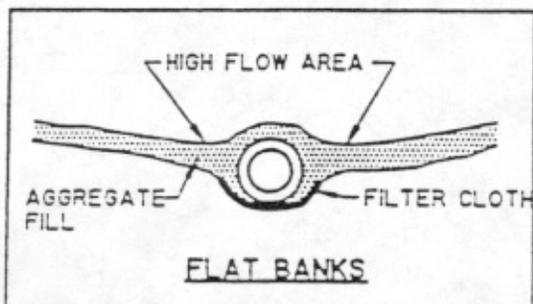
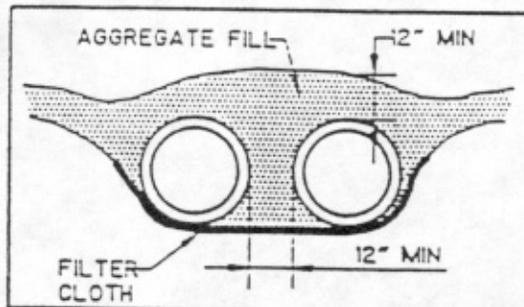
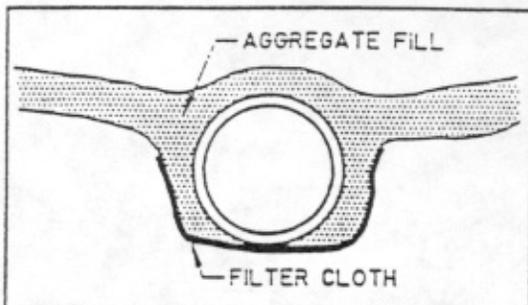
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ESC22



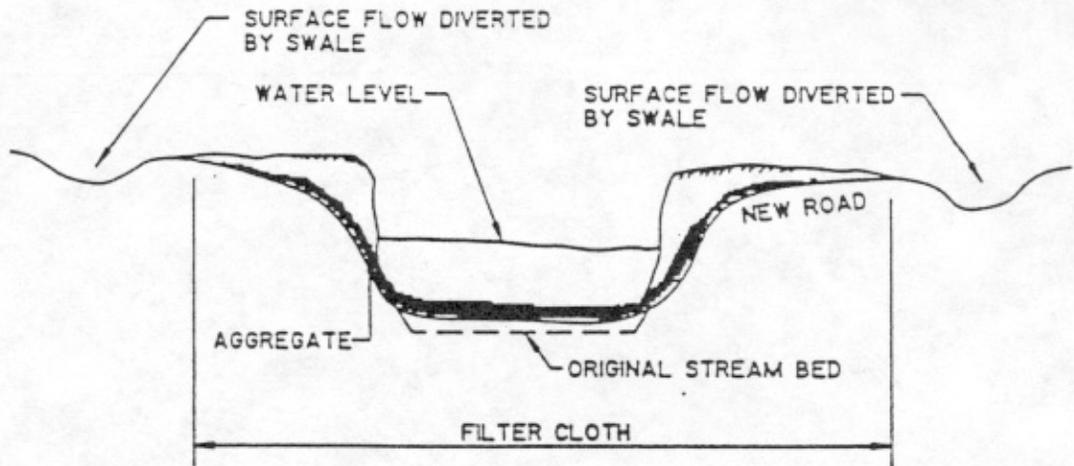
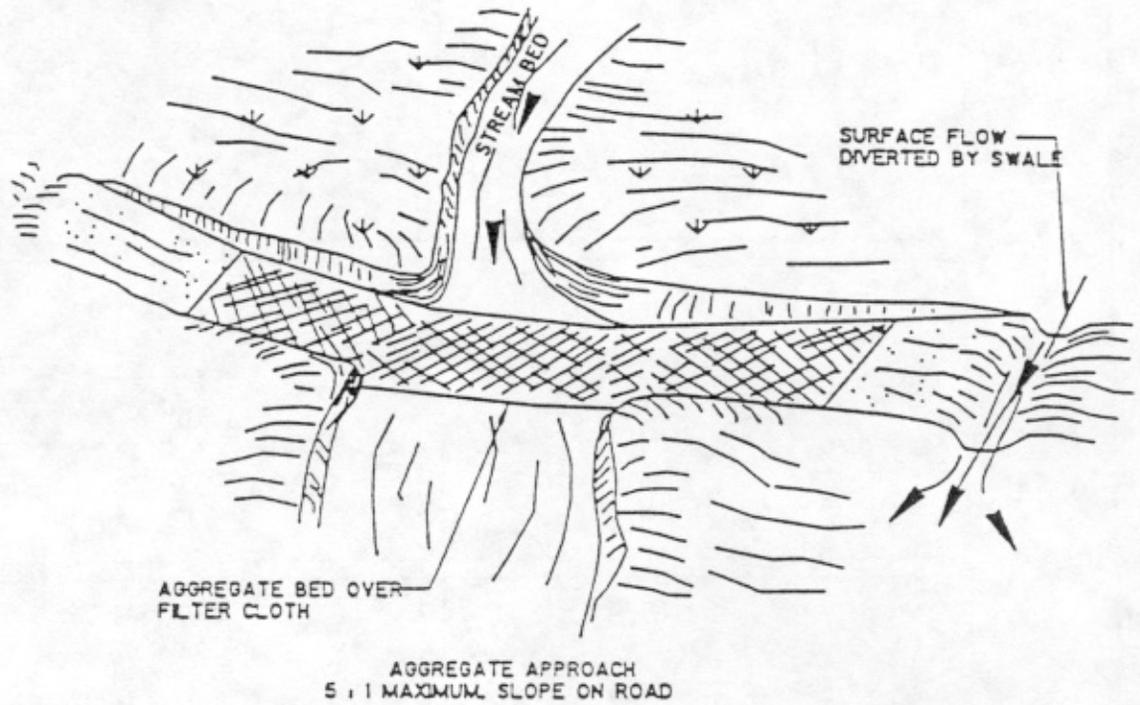
## Additional Information — Temporary Stream Crossing



**TEMPORARY ACCESS CULVERT**



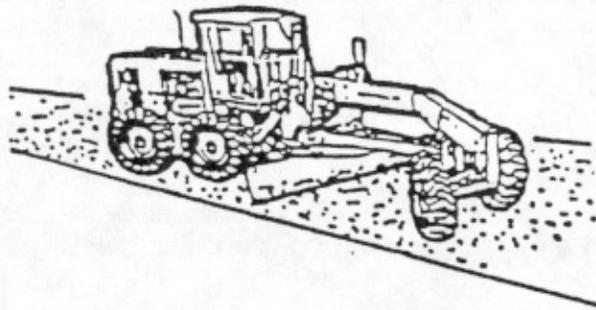
# Additional Information — Temporary Stream Crossing



## TEMPORARY ACCESS FORD



## 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 ESC 21).

### 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 ESC 21).
- 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



## 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 ESC 21). 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" ESC 54).

### 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.

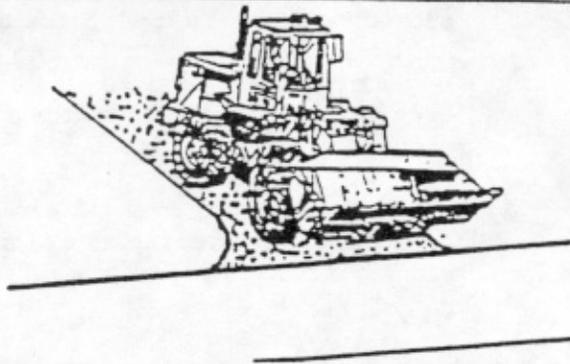
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ESC23



## BMP: STABILIZED CONSTRUCTION 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 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 Rack: \$1500 each.
  - With Wash Rack: \$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



## Additional Information — Stabilized Construction Entrance

A stabilized construction entrance is a 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. 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 built 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.

The aggregate for a stabilized construction entrance aprons should be 1 to 3 inches in size, washed, well-graded gravel or crushed rock. Minimum apron dimensions of 30 ft. x 50 ft. and 6 inches deep is adequate for two-way ingress/egress traffic.

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 (ESC 55 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.

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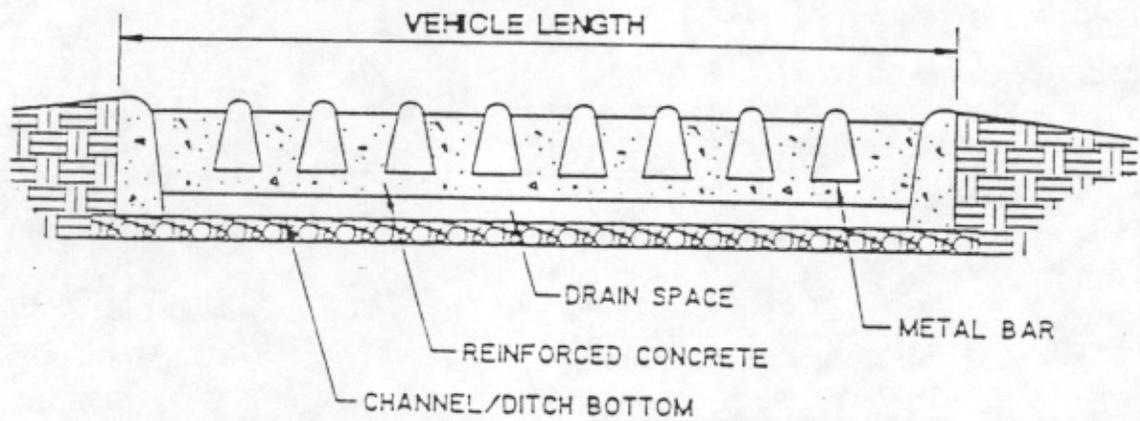
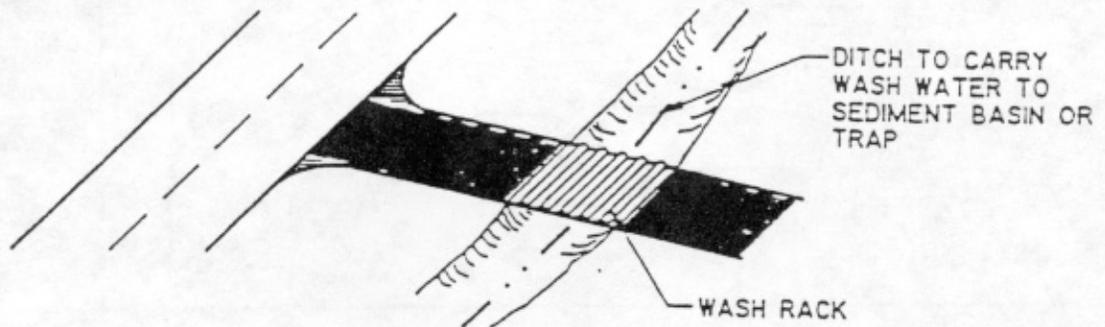
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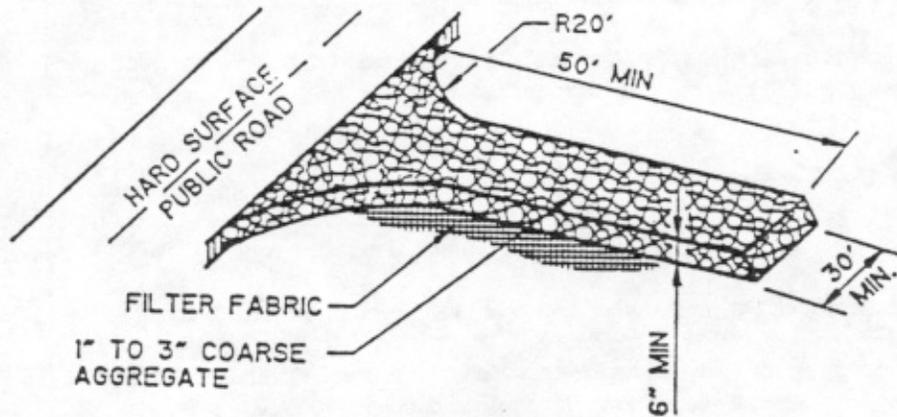
ESC24



# Additional Information — Stabilized Construction Entrance



WASH RACK (SCHEMATIC)

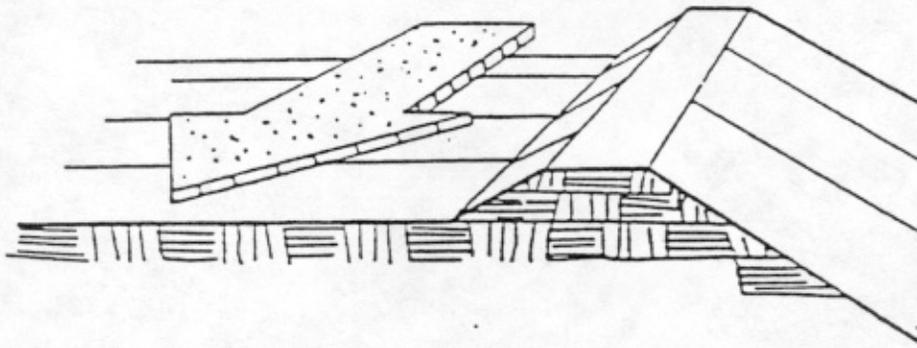


STABILIZED CONSTRUCTION ENTRANCE

ESC24



## BMP: EARTH DIKE



### 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.

### 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

## ESC30



## 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 (ESC 55) or sediment basin (ESC 56) 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:

<u>CHANNEL</u>	<u>RIPRAP</u>
<u>GRADE</u>	<u>STABILIZATION</u>
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

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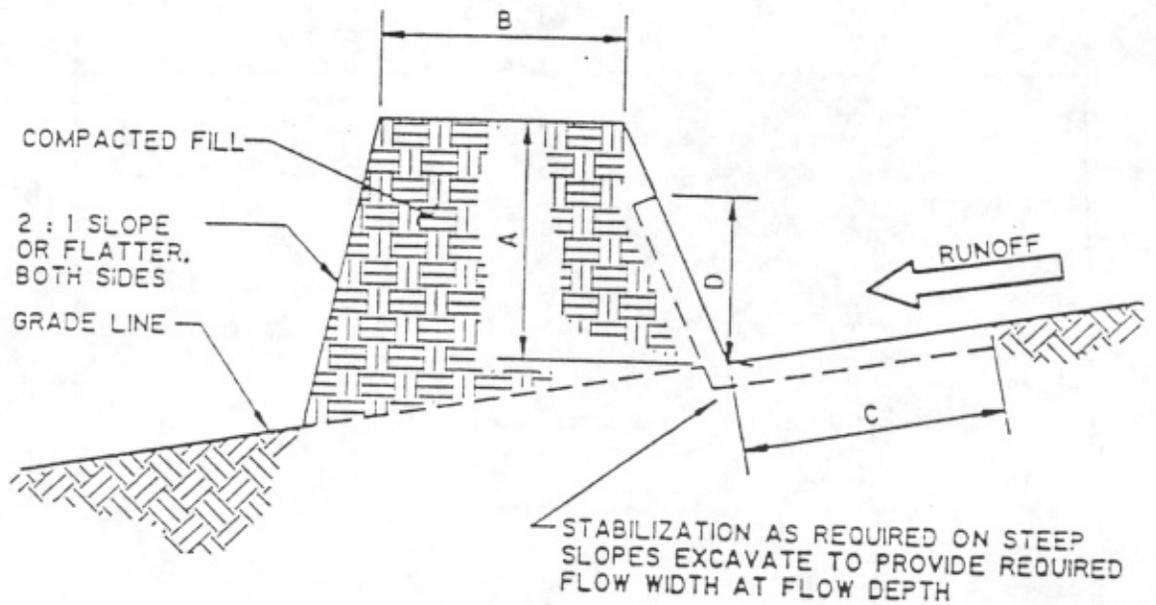
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ESC30



## Additional Information — Earth Dike



REQUIREMENTS BASED ON UPSTREAM DRAINAGE AREA

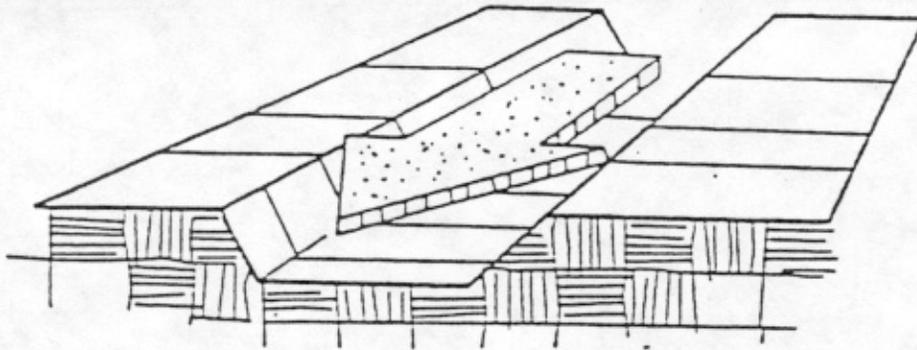
	DIKE 1 (5 ACRES OR LESS)	DIKE 2 (5-10 ACRES)
A-DIKE HEIGHT	18"	36"
B-DIKE WIDTH	24"	36"
C-FLOW WIDTH	4'	6'
D-FLOW DEPTH	8"	15"

### TEMPORARY DIVERSION DIKE

ESC30



## BMP: TEMPORARY DRAINS AND SWALES



### 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. Typical 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 floodplain management requirements.

### 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*

## ESC31



## 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 local drainage design manual). Unless local 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 laid 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.

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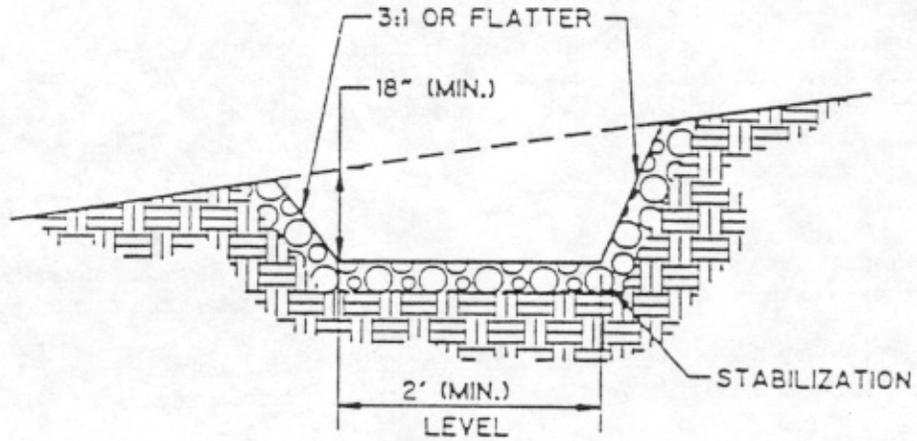
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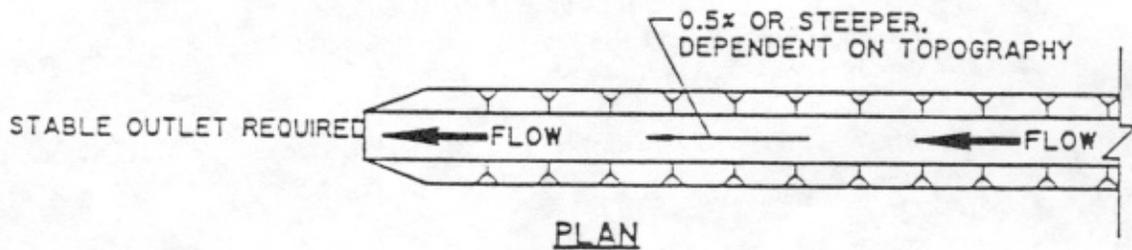
ESC31



# Additional Information — Temporary Drains and Swales



CROSS SECTION

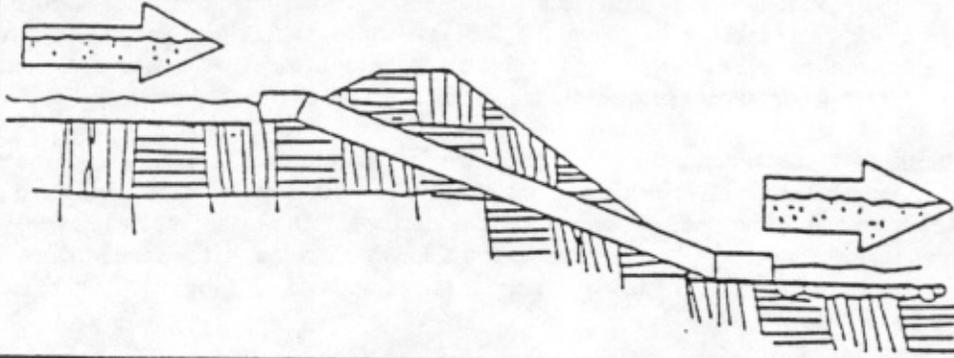


TEMPORARY DRAINAGE SWALE

ESC31



## BMP: SLOPE DRAIN



### 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.
- Cost
  - CalTrans Cost Schedule gives regional cost ranges.

### 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.

### 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

## ESC32



## 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 is often established by the local municipality. 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 local 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 local municipality. 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.

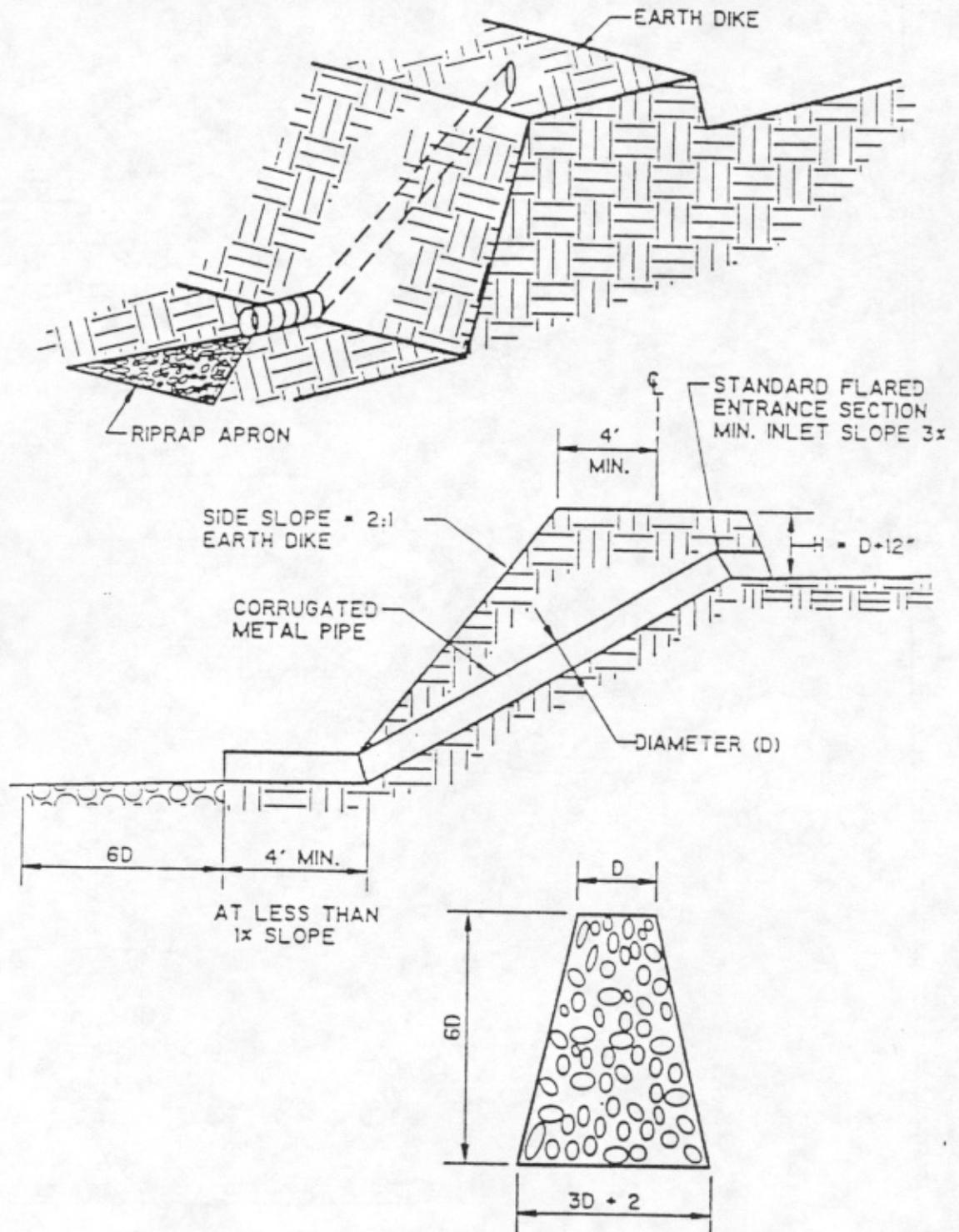
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## Additional Information — Slope Drain

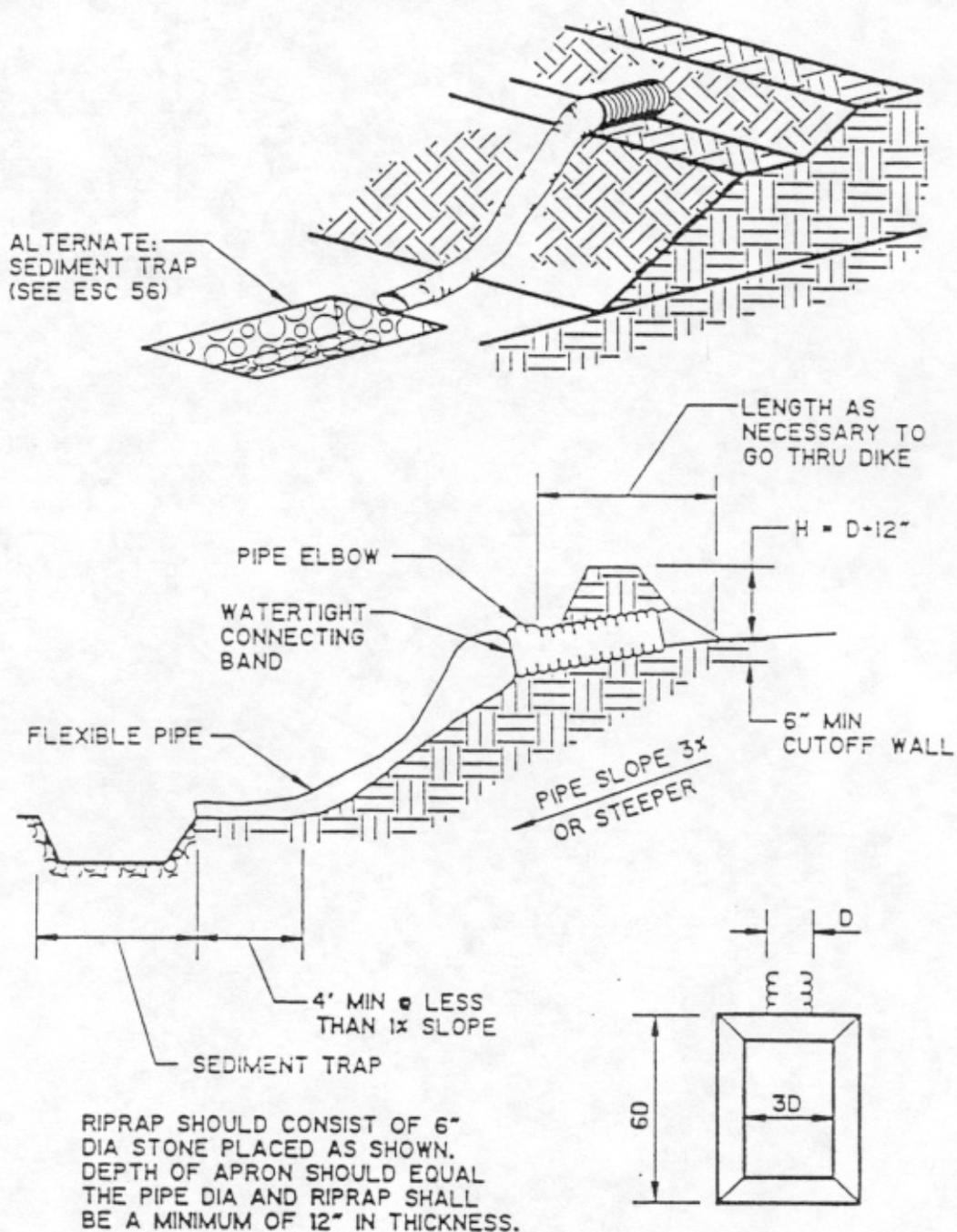


RIPRAP SHOULD CONSIST OF 6" DIAMETER STONE PLACED AS SHOWN AND SHOULD BE A MINIMUM OF 12" IN THICKNESS.

### PIPE SLOPE DRAIN (RIGID)



# Additional Information — Slope Drain

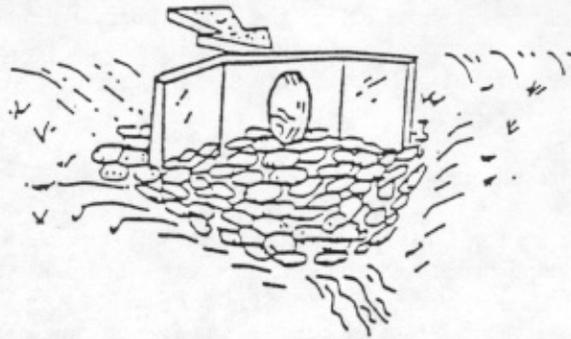


ALTERNATIVE SEDIMENT TRAP; RIPRAP PLAN

## 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.
- Grouted riprap should be avoided in areas of freeze and thaw because the grout will break up.

### 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. CalTrans Standard Specifications or the local municipality can provide 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.
- Cost
  - CalTrans Cost Schedule gives regional cost ranges.

### 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



## 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 local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection that 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. Your local municipality or CalTrans should be consulted for appropriate sizing criteria in your area.

### 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.

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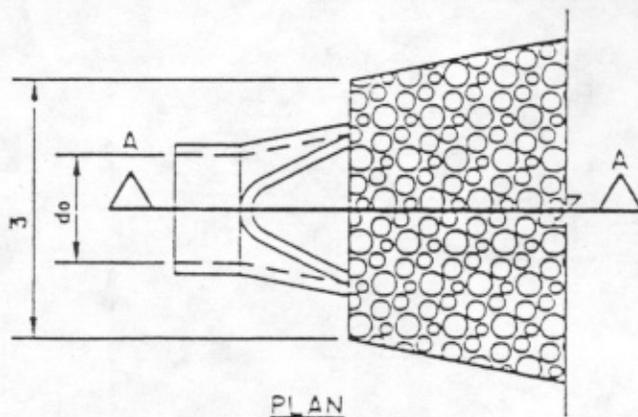
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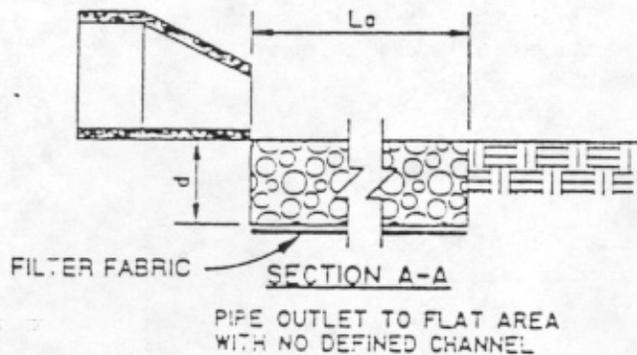


## Additional Information — Outlet Protection



$L_a$  = LENGTH OF APRON  
 $d_o$  = INSIDE PIPE DIAMETER  
 $w$  = APRON WIDTH  
 $d$  = APRON THICKNESS

PLAN



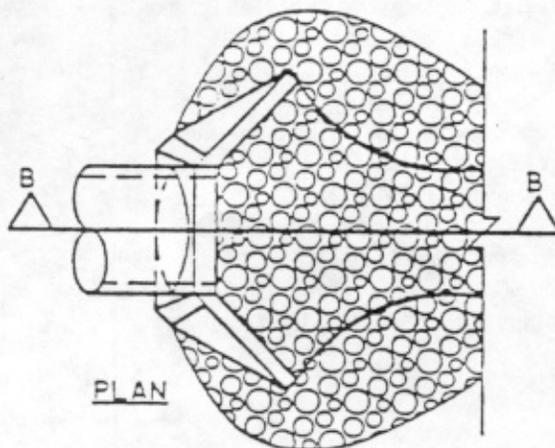
FILTER FABRIC

SECTION A-A

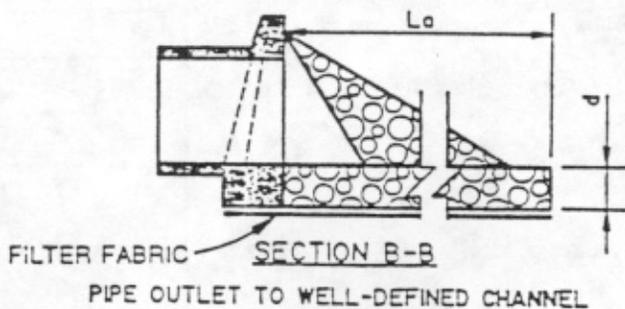
PIPE OUTLET TO FLAT AREA  
WITH NO DEFINED CHANNEL

### 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.  $L_a$  AND ROCK SIZE MUST BE SET TO SLOW THE FLOW TO NON-EROSIVE VELOCITIES (e.g., LESS THAN 10 fps). SEE CALTRANS AND LOCAL AGENCY DESIGN CRITERIA FOR APPROPRIATE SIZING CRITERIA.
3.  $d = 1.5$  TIMES THE MAXIMUM ROCK SIZE DIAMETER BUT NOT LESS THAN 6 INCHES.



PLAN



FILTER FABRIC

SECTION B-B

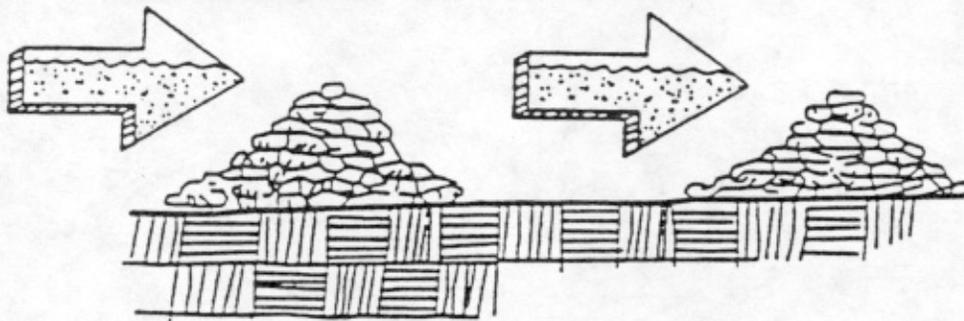
PIPE OUTLET TO WELL-DEFINED CHANNEL

### PIPE OUTLET CONDITIONS

ESC40



## BMP: CHECK DAMS



### 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.
- Cost
  - See CalTrans Cost Schedule for regional cost data.

### LIMITATIONS

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

### 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

## ESC41



## 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"-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.

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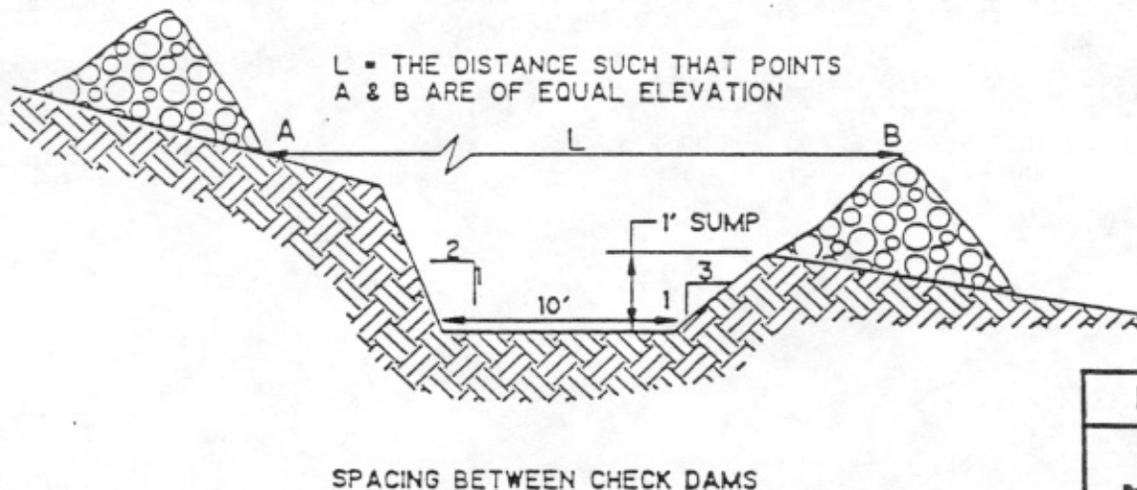
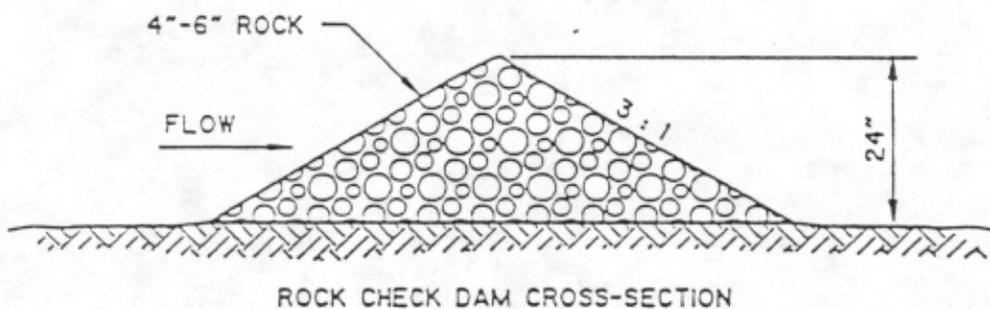
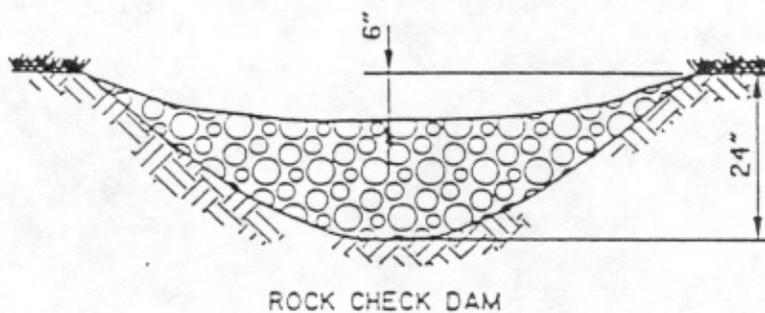
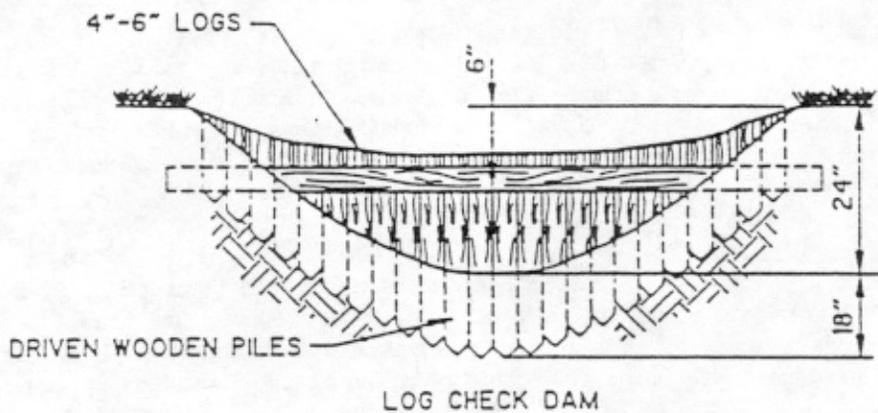
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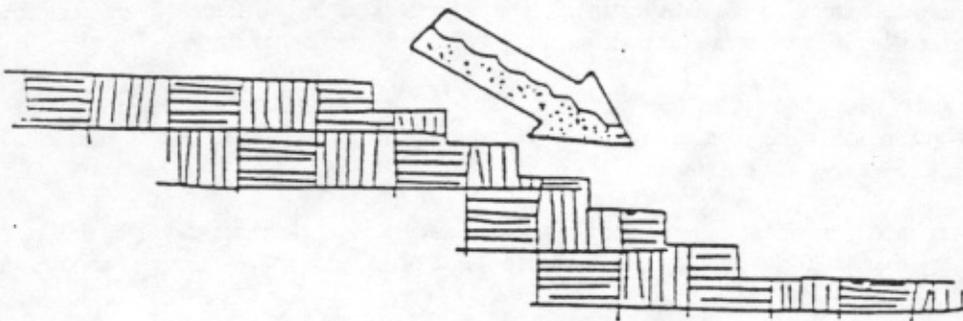
## Additional Information — Check Dams



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



## 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 (these 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.

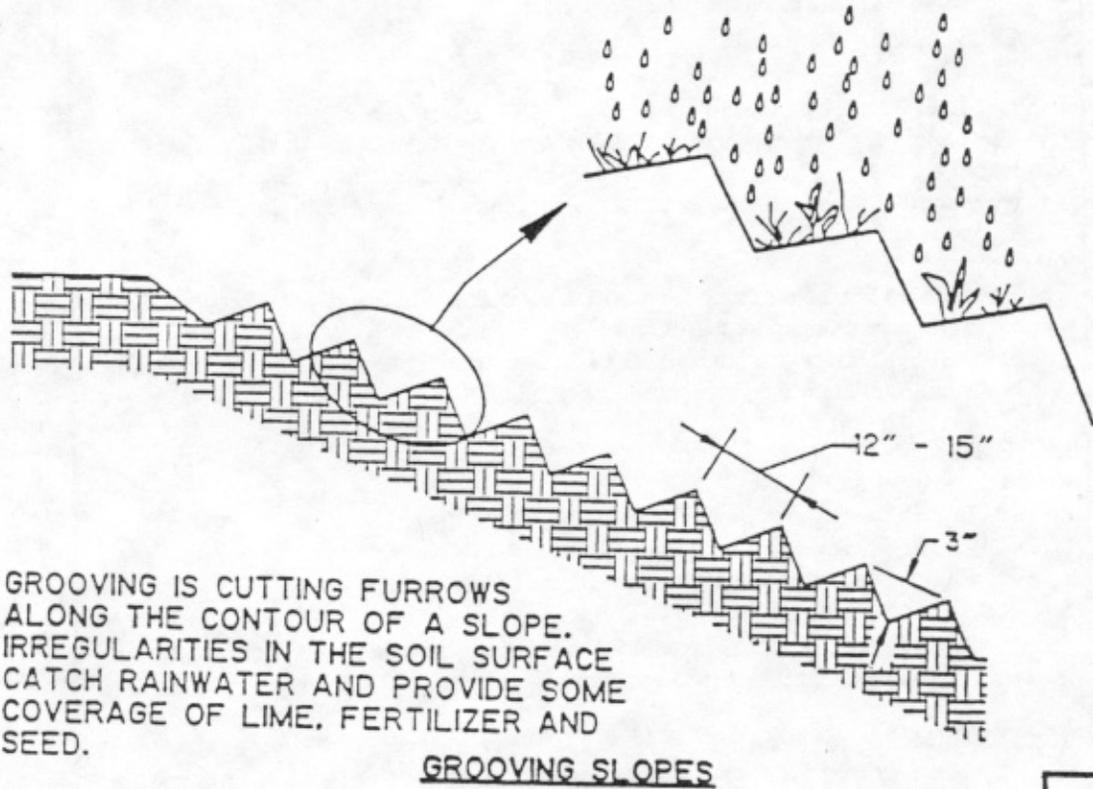
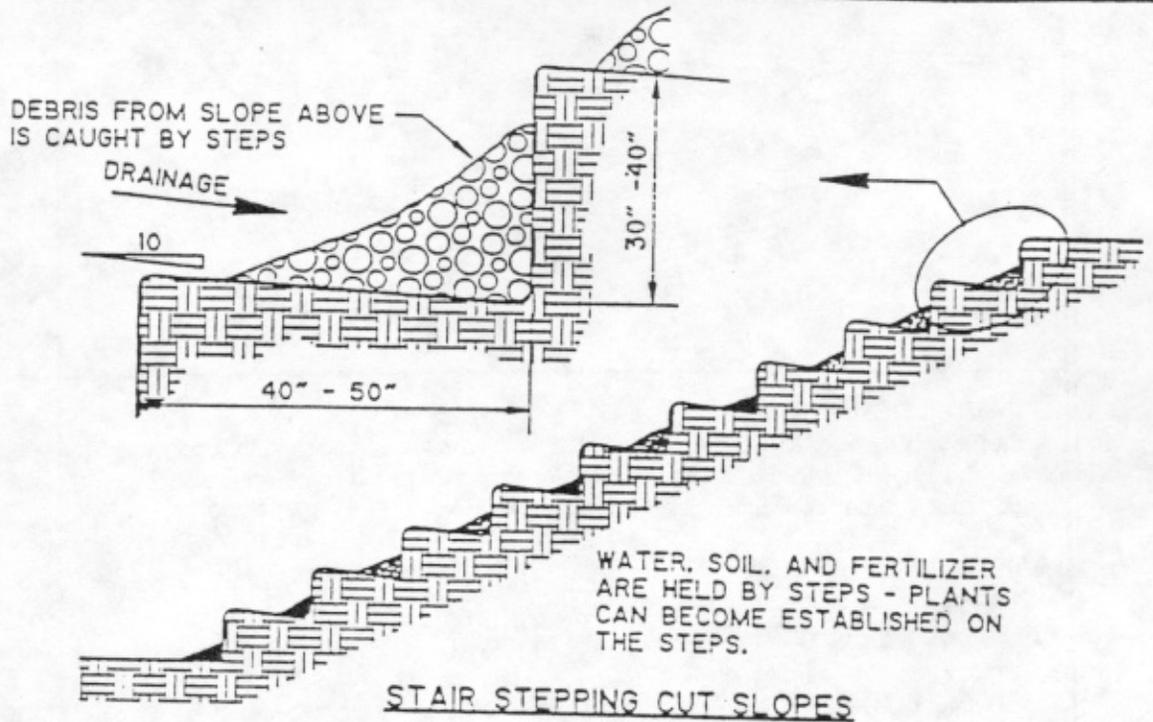
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ESC42



## Additional Information — Slope Roughening/Terracing

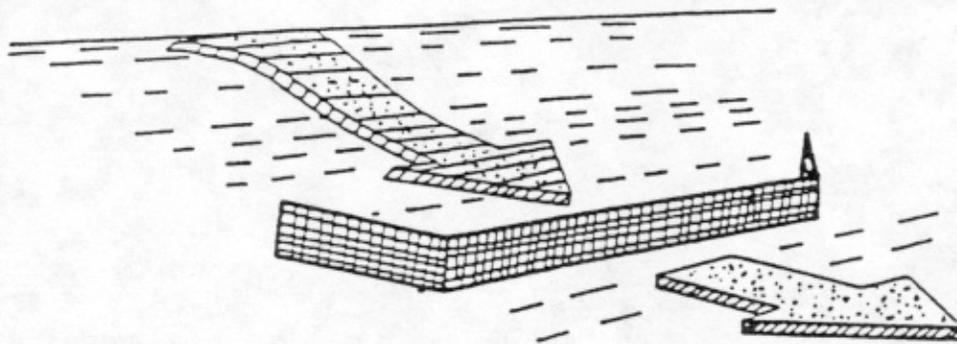


### STAIR-STEPPING CUT SLOPES AND GROOVING SLOPES

ESC42



## BMP: SILT FENCE



### 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 top 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.

### 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

## ESC50



## 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 0° F. to 120° 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.

Environmental Action Manual, City of Austin, Texas, 1989.

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

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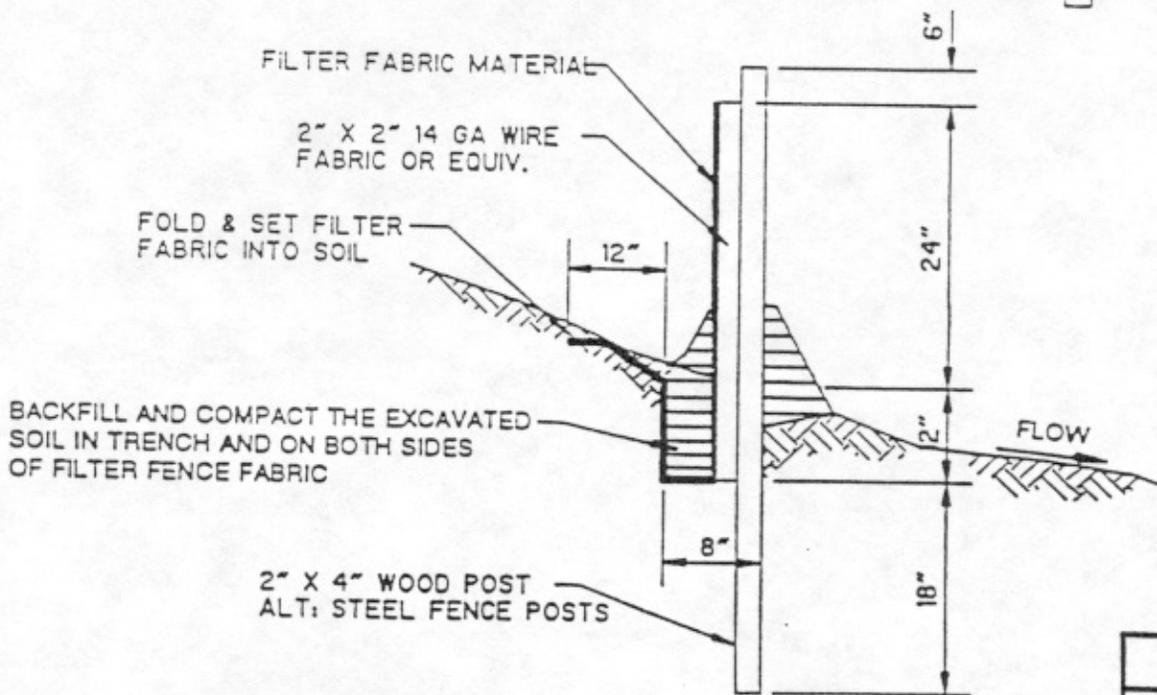
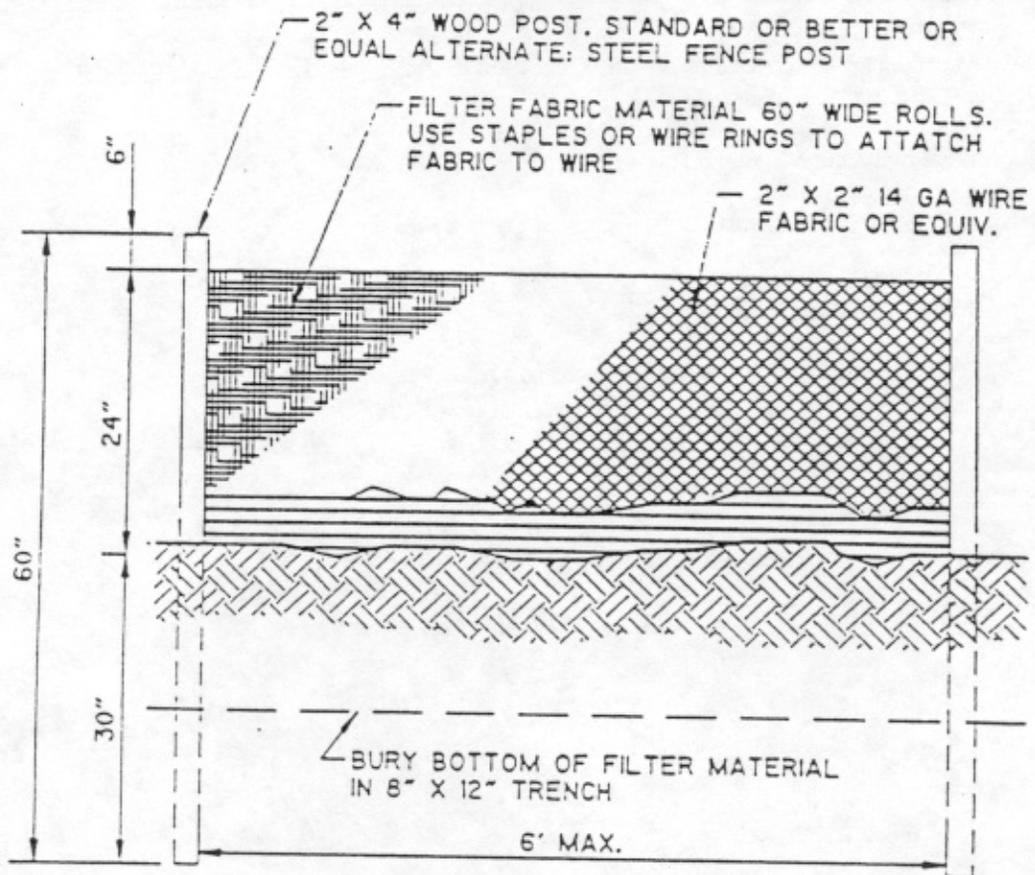
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ESC50



## Additional Information — Silt Fence

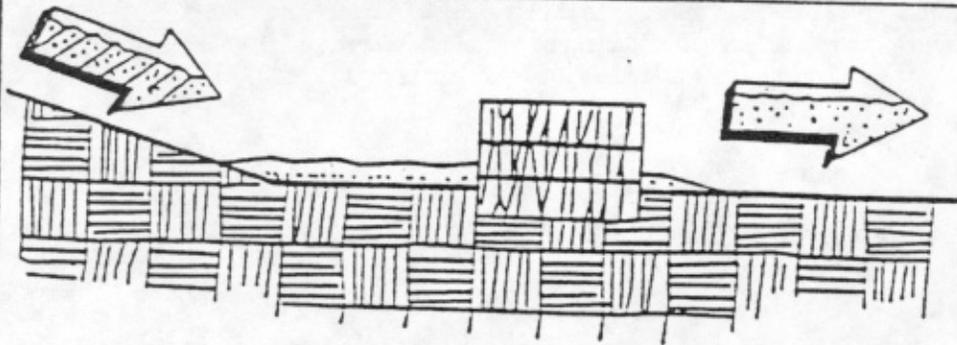


**SILT FENCE**

ESC50



## BMP: STRAW BALE BARRIERS



### GENERAL DEFINITION

A straw bale barrier consists of straw bales placed end to end along a level contour in a shallow trench and staked to hold them in place. The barrier detains runoff, creating a pond behind the barrier where sedimentation occurs.

### SUITABLE APPLICATIONS

- Along the perimeter of the site.
- Along streams and channels.
- Across swales with small catchments.
- Around temporary spoil areas.
- Below other small, cleared areas.

### INSTALLATION/APPLICATION CRITERIA

- Use primarily in areas where sheet or rill flow occurs.
- No more than 1/4 acre per 100 feet of barrier should drain to the barrier.
- Install along a level contour.
- Place in a 4-inch deep trench.
- Backfill and compact the excavated soil on the upstream face of the barrier.
- Secure each bale with two stakes.
- Leave enough area (about 1200 sq. ft. per acre) behind the barrier for runoff to pond (no more than 1.5 ft. depth) and sediment to settle.

### REQUIREMENTS

- Maintenance
  - Inspect weekly and after each rain.
  - Replace bales which have decomposed or whose bindings have broken.
  - Remove sediment behind the barrier when it reaches a depth of 6 inches.
- Costs (source: EPA, 1992)
  - Average annual cost for installation and maintenance (assumes 3 month useful life): \$17 per lineal foot (\$6,800 per drainage acre).

### LIMITATIONS

- Straw bale barriers are not to be used for extended periods of time because they tend to rot and fall apart.
- Suitable only for sheet flow on slopes of 2% or flatter.
- Not appropriate for large drainage areas, limit to one acre or less.
- Straw bales lose their effectiveness rapidly due to rotting, thus constant maintenance is required.
- Not recommended for concentrated flow, inlet protection, channel flow, and live streams.
- Bale bindings of jute or cotton not recommended.

### 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

**ESC51**



## BMP: STRAW BALE BARRIERS (Continue)

- Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainageways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow.

ESC51



## Additional Information — Straw Bale Barrier

A straw bale barrier consists of a series of secured anchored bales placed to intercept sediment-laden runoff from small drainage areas of disturbed soil. The barrier ponds runoff and allow sediment to settle. Straw bale dikes should not be used for extended periods of time because they tend to rot and fall apart.

The straw bale barrier is used where there are no concentrations of water in a channel or drainageway, and where erosion would occur from sheet flow. These barriers are typically constructed below disturbed areas subject to sheet flow of runoff.

### Installation/Application

Straw bale barriers should be used for drainage areas no more than 1/4 acre per 100 feet of barrier length, with no more than 100 ft upstream of any point along the barrier. The barrier should be placed along a level contour no greater than 2:1. When installed and maintained according to the guidelines on this fact sheet, straw bale dikes remove approximately 67% of the sediment transported in construction site runoff. This optimum efficiency can only be achieved through careful maintenance, with special attention to replacing rotted or broken bales. The barrier should be constructed on a level contour to prevent concentration of flow against a small portion of the barrier.

An effective straw bale barrier should be installed in the following manner:

1. Bales should be placed on the contour and in a row with ends tightly abutting the adjacent bales.
2. Leave area for runoff to pond upstream of the barrier by locating barrier away from the toe of slopes. This also provides access for maintenance.
3. Each bale should be embedded in the soil a minimum of (4) inches and placed so the bindings are horizontal. Bindings placed on soil will soon disintegrate and cause the barrier to fail.
4. Bales should be securely anchored in place by either two stakes or re-bars driven through the bale. The first stake in each bale should be driven toward the previously laid bale at an angle to force the bales together. Stakes should be driven flush with the bale.
5. Backfill and compact the excavated soil along the upstream face of the barrier.
6. Remove the barrier when it has served its usefulness so as not to block or impede storm flow or drainage.

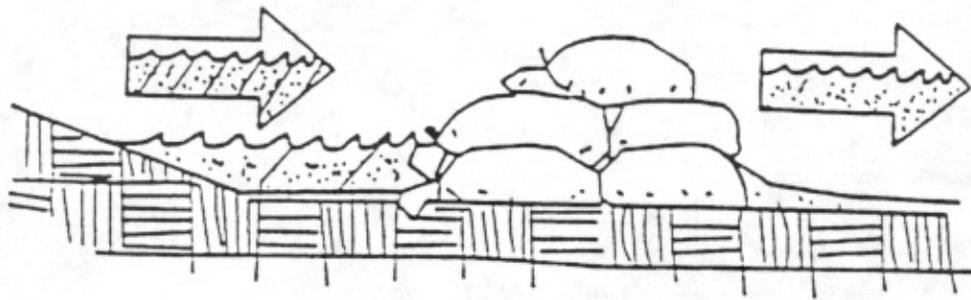
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- "Draft - Sedimentation and Erosion Control, An Inventory of Current Practices", U.S.E.P.A., April, 1990.
- "Environmental Criteria Manual", City of Austin, Texas.
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- Stormwater Management Water for the Puget Sound Basin, Washington State Department of Ecology, The Technical Manual - February 1992, Publication # 91-75.
- Water Quality for Construction Businesses, City of Bellevue, Washington.
- Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC51



## 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 below 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**



## 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.

### 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 may 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

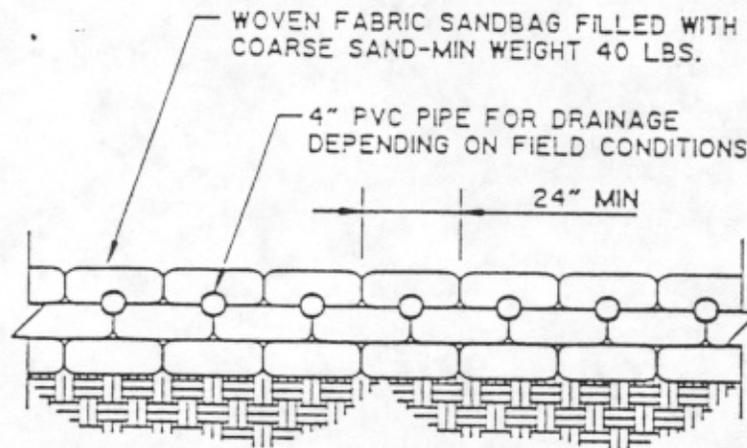
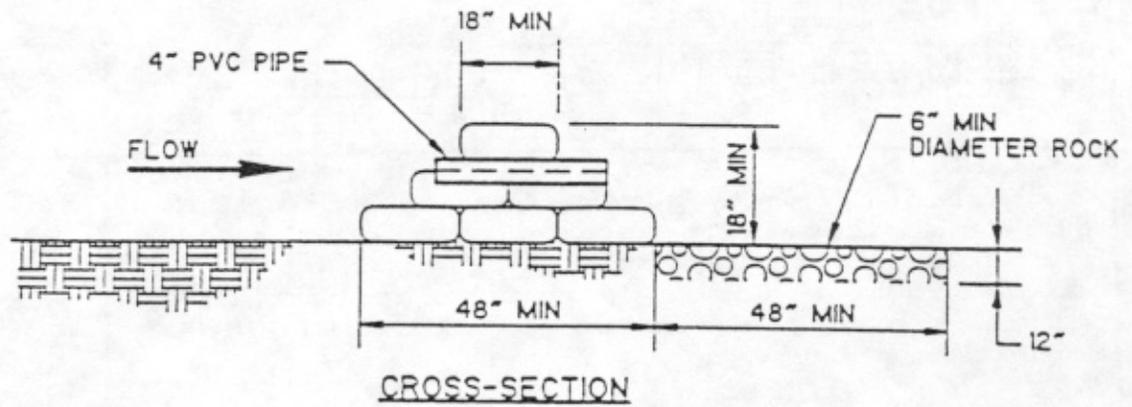
Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

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

ESC52



# Additional Information — Sand Bag Barrier

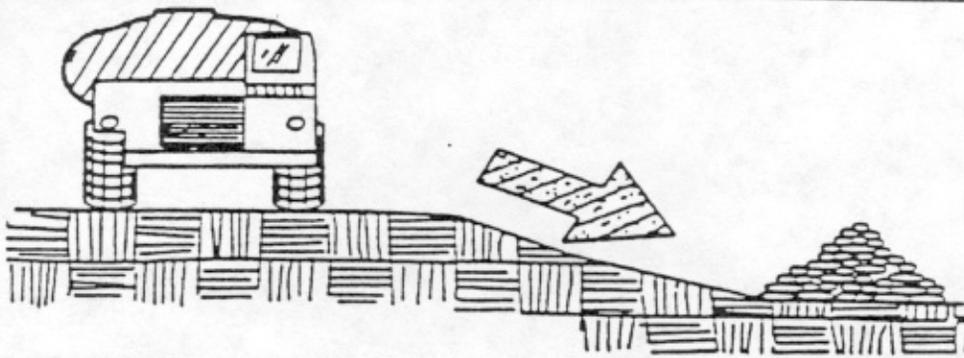


SAND BAG BERM

ESC52



## BMP: BRUSH OR ROCK FILTER



### 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.

### 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

## 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 (ESC 26), 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



## BMP: BRUSH OR ROCK FILTER (Continue)

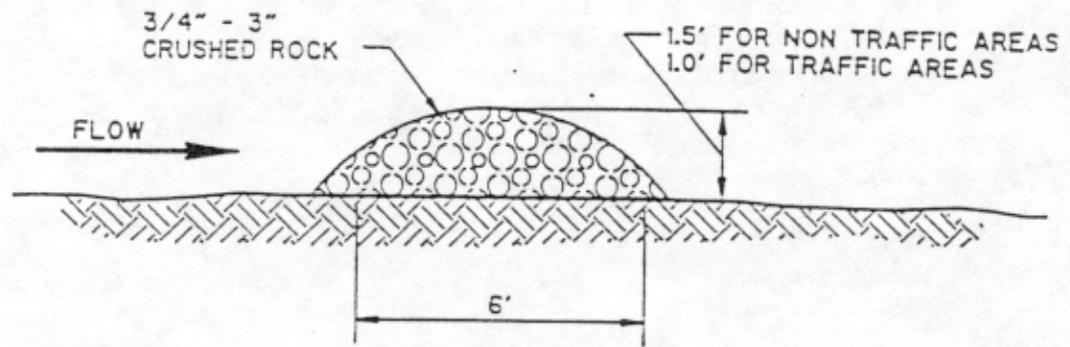
### LIMITATIONS

- 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.

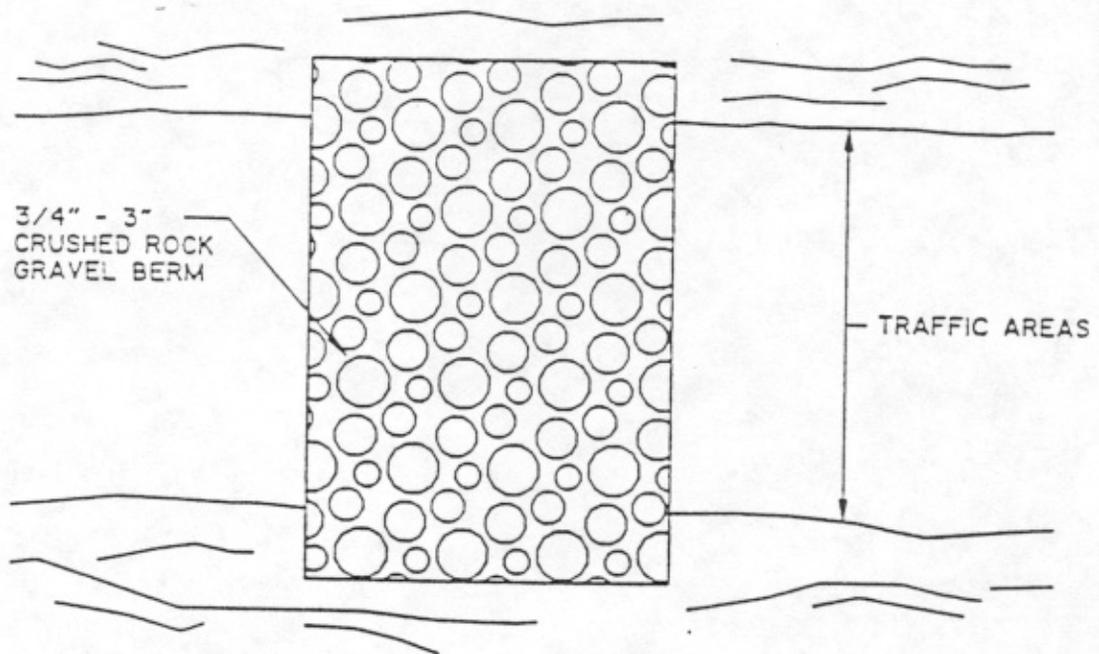
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# Additional Information — Brush or Rock Filter



SECTION



PLAN

## GRAVEL FILTER BERM

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 grubbing. 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.

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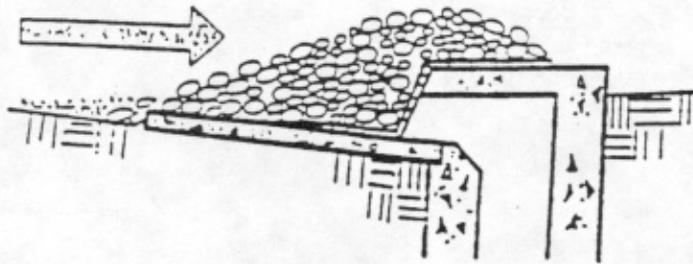
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ESC53



# 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 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 device, 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 ESC 55).
- 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



## BMP: STORM DRAIN INLET PROTECTION (Continue)

### 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 ESC 56). 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 local storm water management agency.

#### General Design and sizing criteria:

- Grates and spaces around all inlets should be sealed 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 ESC 50) 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



## Additional Information — Storm Drain Inlet Protection

- 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.

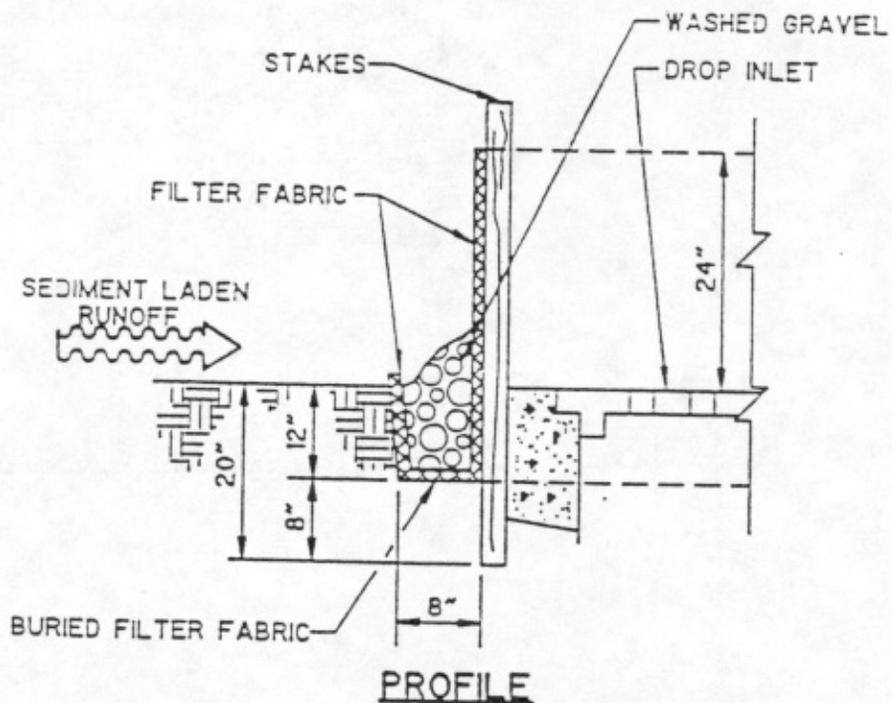
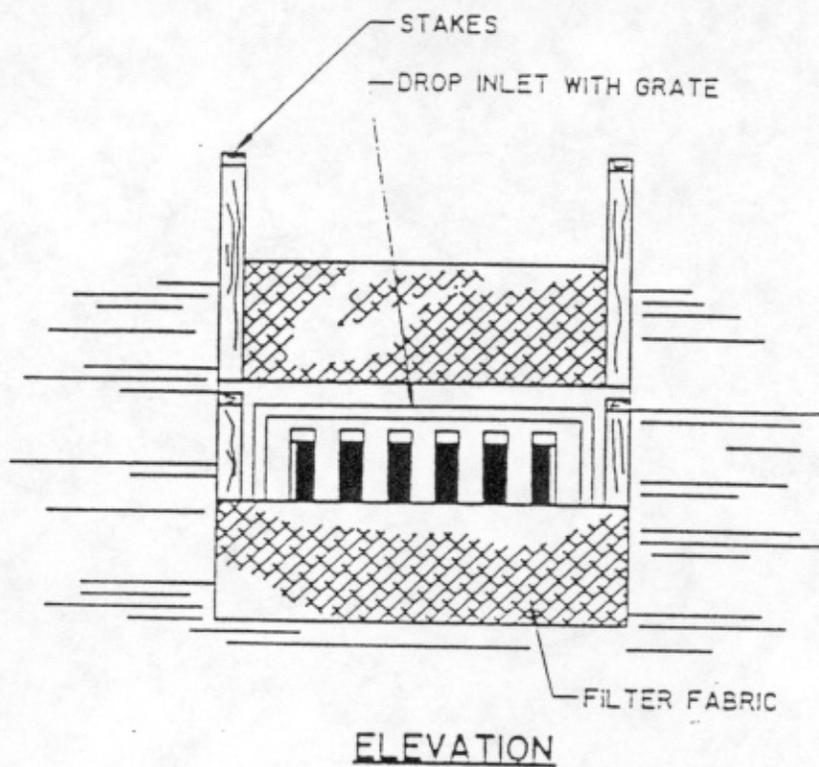
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# Additional Information — Storm Drain Inlet Protection

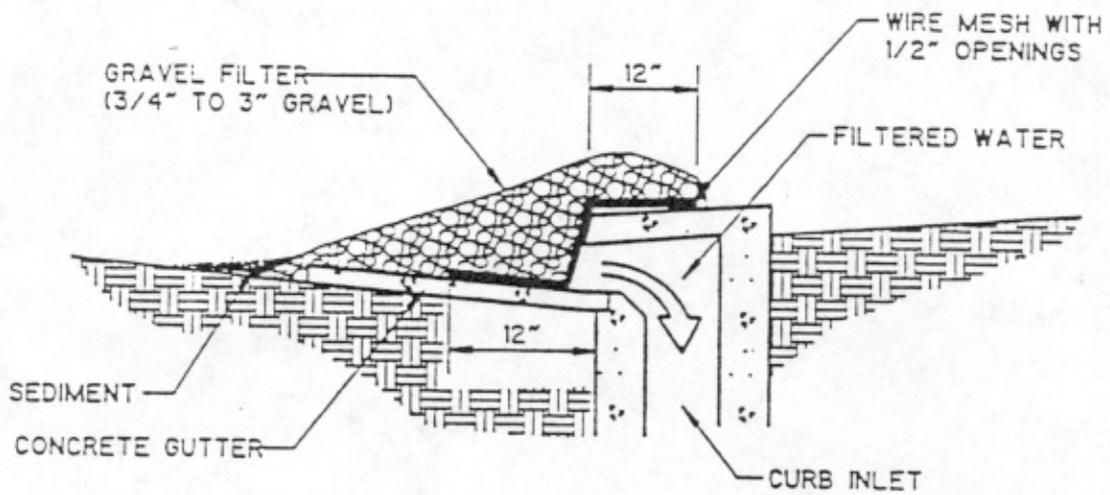
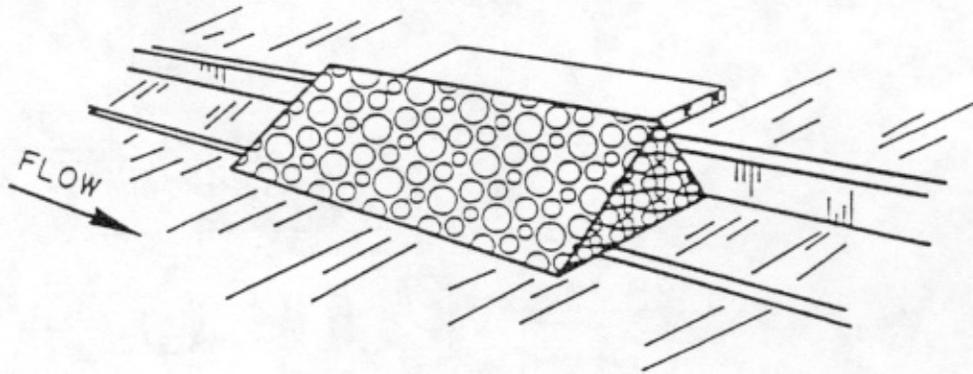


**FILTER FABRIC FENCE DROP INLET FILTER**

ESC54



# Additional Information — Storm Drain Inlet Protection

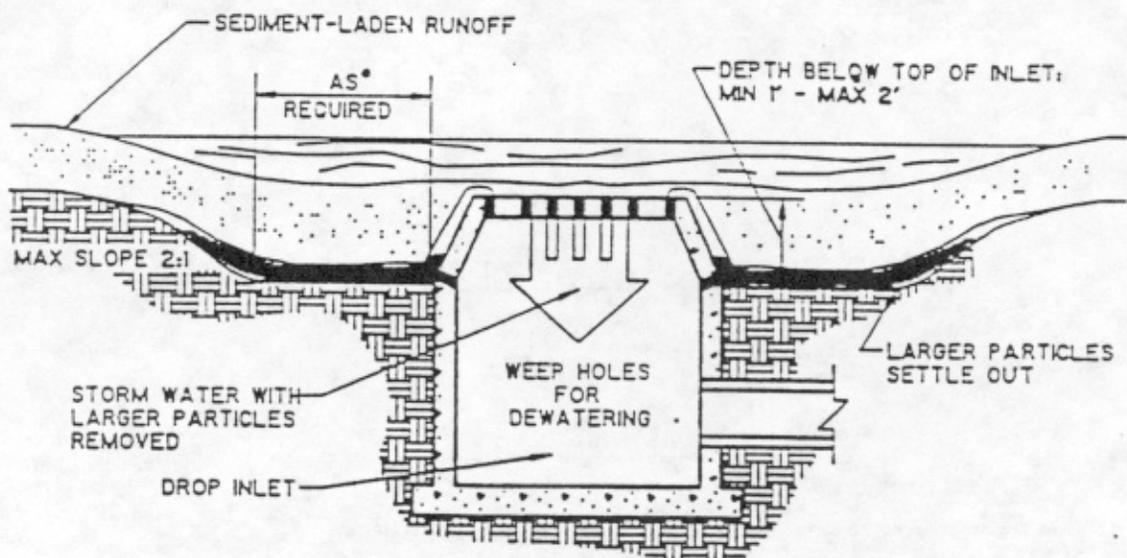
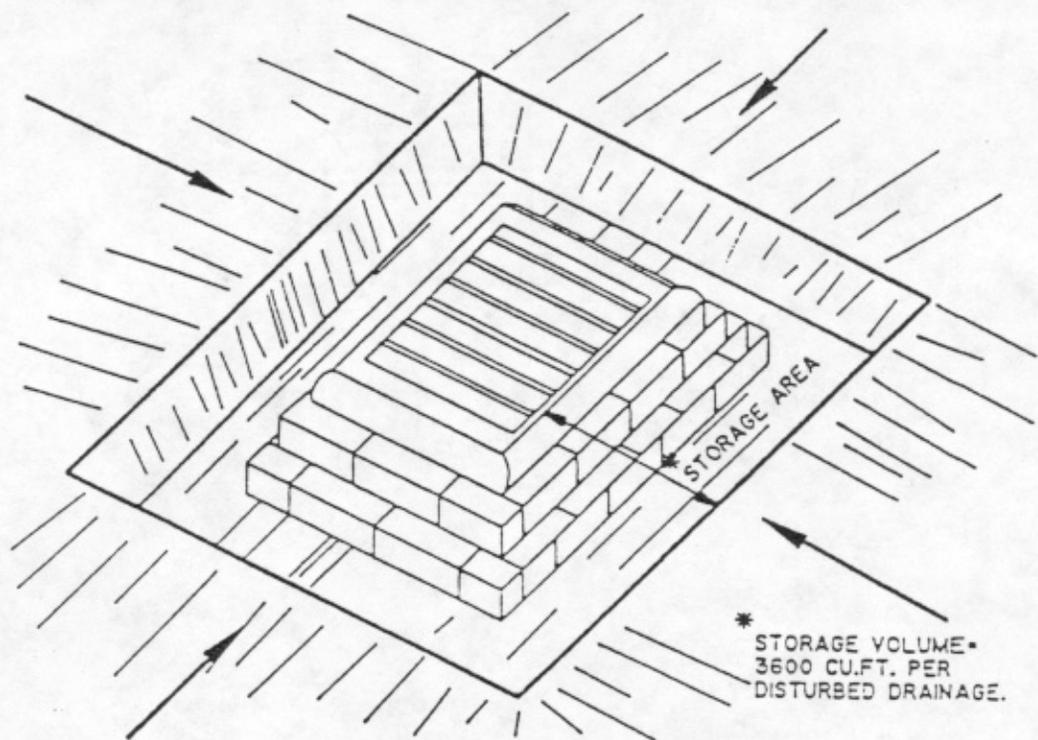


GRAVEL AND WIRE MESH FILTER FOR CURB INLET

ESC54



## Additional Information — Storm Drain Inlet Protection



### SPECIFIC APPLICATION

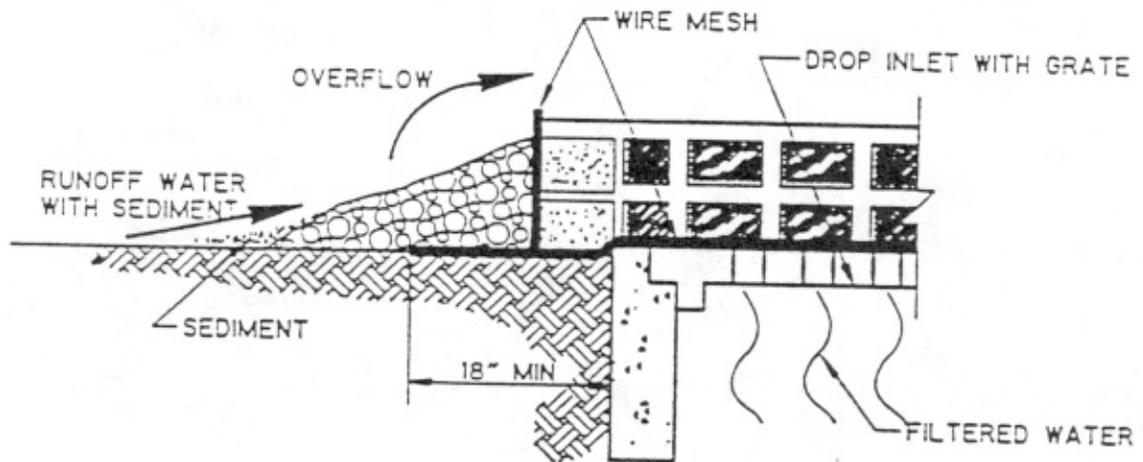
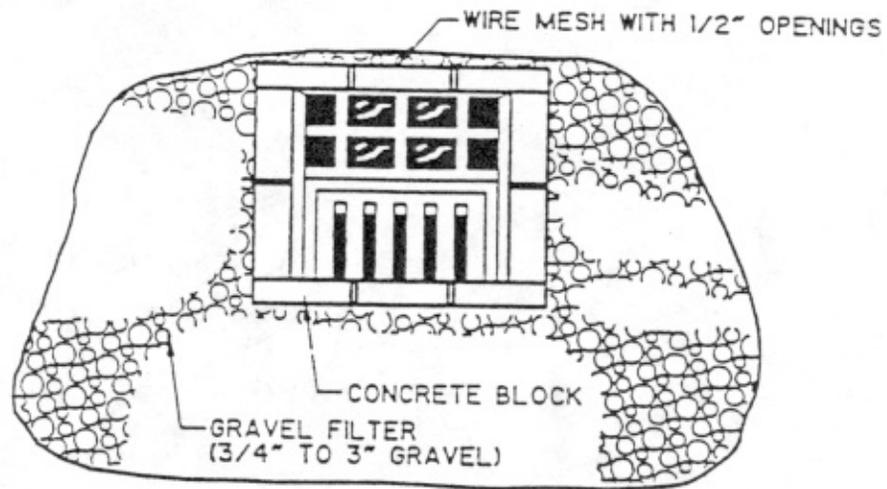
THIS METHOD OF INLET PROTECTION IS APPLICABLE WHERE HEAVY FLOWS ARE EXPECTED AND WHERE AN OVERFLOW CAPABILITY AND EASE OF MAINTENANCE ARE DESIRABLE.

## EXCAVATED DROP INLET SEDIMENT TRAP

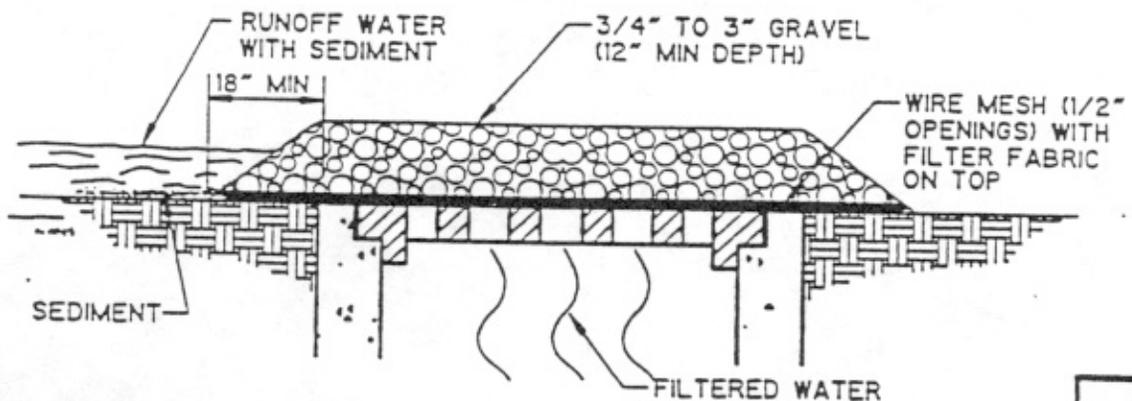
ESC54



# Additional Information — Storm Drain Inlet Protection



BLOCK AND GRAVEL FILTER AT DROP INLET



GRAVEL AND WIRE MESH FILTER FOR DROP INLET

ESC54



## 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 Basins (ST8), 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 Sedimentation Basin ESC56). As a rule of thumb, the larger the basin volume the greater the sediment removal efficiency. Sizing criteria are typically established under the local grading ordinance or equivalent. The runoff volume from a two-year, 24-hour storm is a common design criteria for sedimentation trap. The sizing criteria below assume that this runoff volume is 0.042 ac-ft/ac (0.5 inches of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of California.

- Trap settling volume at least 67 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

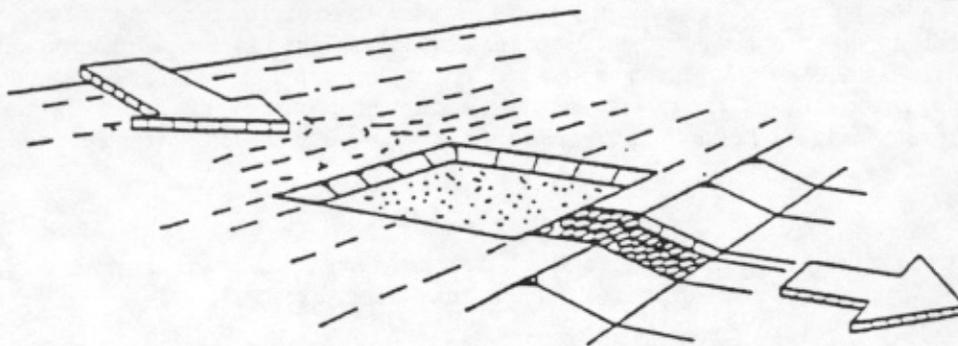
Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a barrier or low-head dam. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize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

1. The area under the embankment 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.

ESC55



## 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 Basins, 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 your local flood control agency).

### 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.<sup>3</sup> (\$1,300 per drainage acre).

### LIMITATIONS

- Only use for drainage areas up to 5 acres (see Sedimentation Basin BMP ST8 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

## ESC 55



## Additional Information — Sediment Trap

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 1/2-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 used 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.

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

"Environmental Criteria Manual", City of Austin, Texas.

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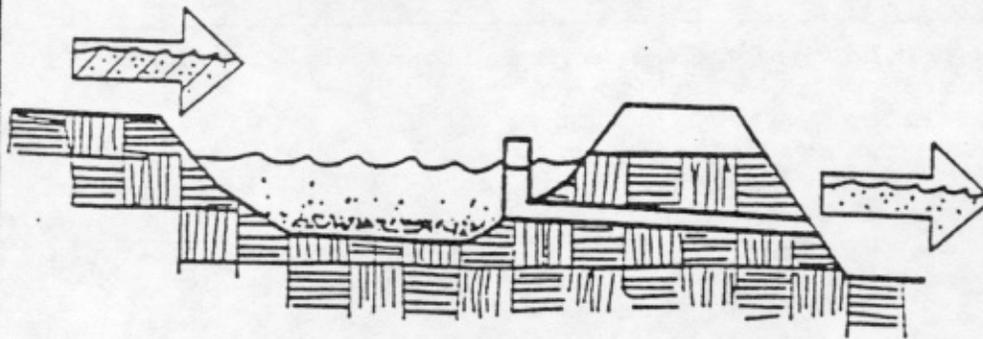
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ESC55



## 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 an 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 **not** 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 capture runoff from a 2-year, 24-hour storm, or other appropriate design storms specified by the local agency. 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 rain.
  - 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.<sup>3</sup>: \$0.40 per ft.<sup>3</sup> (\$700 per drainage acre)
  - Basin size greater than 50,000 ft.<sup>3</sup>: \$0.20 per ft.<sup>3</sup> (\$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

## ESC56



## 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.

Many development projects in California will be required by local ordinances to provide a storm water detention basin for post-construction flood control, desiltation, or storm water pollution control. A temporary sediment basin may be 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 are 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 riser pipe with an anti-seep collar is the principal outlet, along with an emergency overflow spillway. A solid riser pipe with two 1-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

ESC56



## BMP: SEDIMENT BASIN (Continue)

### 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 Division of Safety of Dams.
- Standing water may cause mosquitos or other pests to breed.
- Basins in excess of certain depth and storage volume criteria must meet State Division of Safety of Dams (DSOD) and local safety requirements.

ESC56



## 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 (e.g., a 2-year, 24-hour duration design storm event) from the tributary drainage area as computed using the methods required by the local flood control agency. Provide a minimum of 67 cubic yards of settling volume per acre of drainage if a design storm is not specified.

$V_{SED}$  = 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:

- The details shown in the attached figure may be useful in designing the sediment basin.
- 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.
- Extend the basin side slopes (at 3:1 max.) as necessary to obtain the settling zone volume as determined above.
- 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.
- Provide an emergency spillway with a crest elevation one foot above the top of the riser pipe.
- 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.

ESC56



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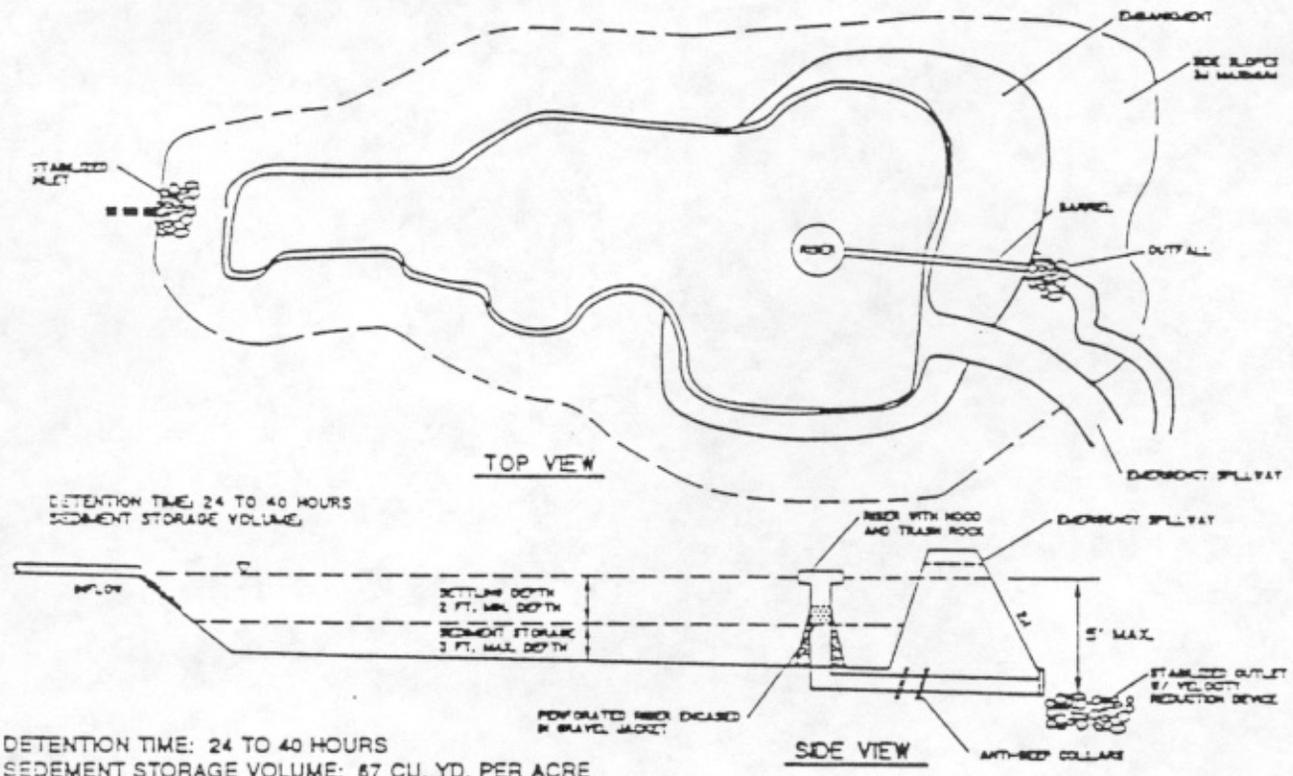
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Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency - November 1988.

ESC56



# Additional Information — Sediment Basin



TEMPORARY SEDIMENT BASIN



## **Appendix E**

### **Erosion Control Plan Report for Permanente Quarry East Materials Storage Area**

**EROSION CONTROL PLAN REPORT**  
**FOR**  
**PERMANENTE QUARRY**  
**EAST MATERIALS STORAGE AREA**

**April 16, 2009**

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**FOR REVIEW ONLY**

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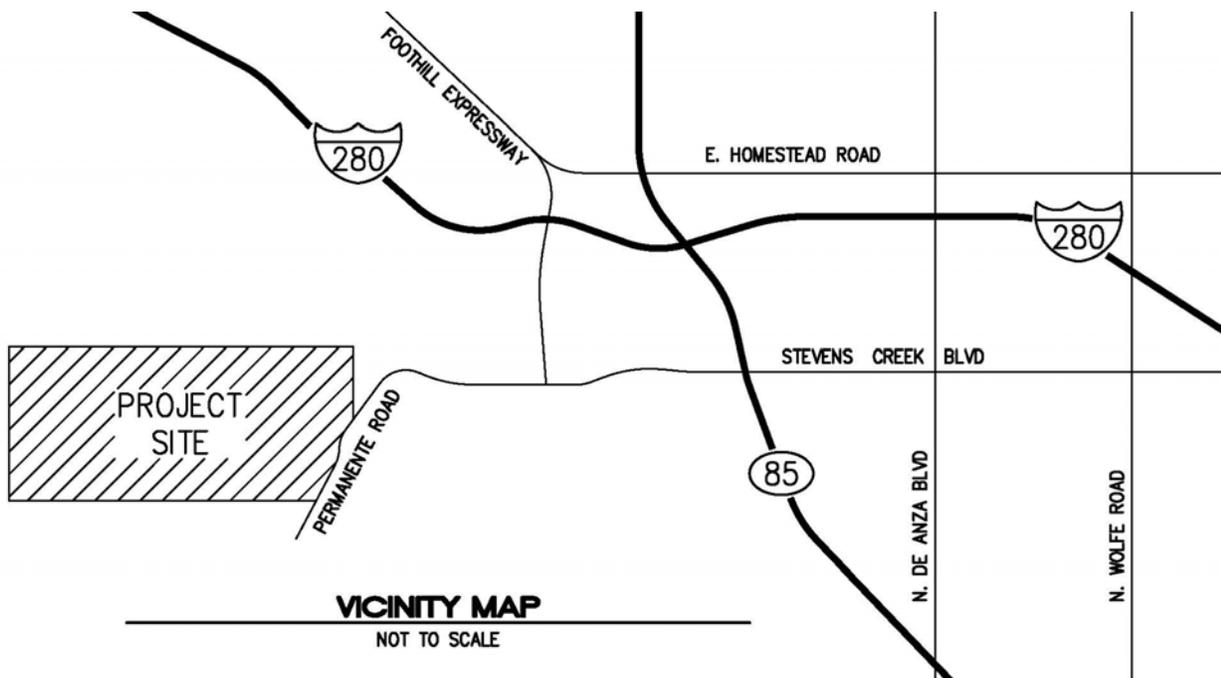
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## MAP POCKET

- Erosion Control Measures 1-Year Following Reclamation Completion
- Erosion Control Measures Following Final Revegetation Exhibit

## INTRODUCTION

Lehigh Southwest Cement Company operates the Permanente Quarry, which is located west of the city of Cupertino in Santa Clara County (see the Vicinity Map). Quarrying operations have occurred at the site since the early 1900's. This report is for a portion of the site known as the East Materials Storage Area (EMSA). This report has been prepared for the proposed activities in the EMSA. The EMSA is a large fill area primarily used for storing overburden material. The EMSA will generally be reclaimed with 2 to 1 (horizontal to vertical) inter-bench slopes (approximately 2.6 to 1 slope overall), and be constructed from an elevation of just over 550 feet to just over 900 feet. Benches will lie at approximately 40-foot vertical intervals, and a perimeter road will be graded around the EMSA. A series of drainage ditches and swales will serve the EMSA. The EMSA slopes will be reclaimed with native grasses and shrubs. The north and east facing benches will also contain trees (oaks), while the south facing benches will contain some pines. The uppermost pad area will be planted with grasses, shrubs, and some trees (pines).



This report contains the erosion control plan for the EMSA. The State Water Resources Control Board (SWRCB), Regional Water Quality Control Board (RWQCB), Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), and Surface Mining and Reclamation Act (SMARA) require best management practices to control erosion. This erosion control plan has been prepared to meet the requirements of these agencies. Initially, temporary erosion control measures will be installed during the course of reclamation activities. The measures will include hydroseeding, desiltation basins, silt fencing, and drainage conveyance facilities. The temporary measures will be installed as reclamation occurs and are anticipated to remain in place until approximately one year following completion of reclamation. After this point, the revegetation throughout the EMSA will begin to establish. Approximately three years after reclamation, the final revegetation is anticipated to be completely

established and the temporary erosion control measures will no longer be necessary. The desiltation basins, silt fencing, and other temporary measures will be removed, and only the permanent revegetation and drainage controls will remain. The following discusses the temporary and permanent measures that form the erosion control plan for the EMSA.

**TEMPORARY EROSION CONTROL MEASURES**

During the course of and immediately following reclamation, temporary erosion control measures will be used at the site. The primary water quality pollutant generated from the EMSA will be sediment. Consequently, the temporary measures must focus on sediment control. The measures are illustrated on the “Erosion Control Measures 1-Year Following Reclamation Completion” exhibit in the map pocket, and include hydroseeding, desiltation basins, silt fencing, and drainage ditches.

Hydroseeding will be used on the reclaimed slopes, benches, and pads. The seed mix has been specified in the April 2009 Reclamation Plan. The preliminary erosion control stage incorporated prior to the revegetation tasks will consist of the native seed mix shown in Table 1. The mix includes species that have proven successful in other revegetation efforts in the quarry, and are recommended to provide erosion control and initial establishment of native grasses and herbaceous species until a more specific revegetation plan is developed based on test plot data and plant and seed availability.

Table 1. Proposed erosion control seed mix.		
SCIENTIFIC NAME	COMMON NAME	PURE LIVE SEED (lb /acre)
<i>Bromus carinatus</i>	California brome	16.00
<i>Elymus glaucus</i>	blue wildrye	10.00
<i>Lupinus nanus</i>	sky lupine (innoc.)	5.00
<i>Nassella pulchra</i>	purple needlegrass	8.00
<i>Plantago erecta</i>	California plantain	3.00
<i>Trifolium wildenovii</i>	tomcat clover (innoc.)	3.00
<i>Vulpia microstachys</i>	three weeks fescue	8.00
<b>TOTAL</b>		<b>53.00</b>

A series of desiltation basins and silt fencing will also be installed around the perimeter of the EMSA. The silt fencing is shown in light blue and the desiltation basins are highlighted in yellow on the “1-Year” exhibit in the map pocket. Silt fencing and desiltation basin details are included on the exhibit. The silt fencing will generally be placed at the toe of the perimeter 2 to 1 (horizontal to vertical) slopes to prevent sediment from being conveyed beyond the EMSA. Straw waddles can be used as an alternative to silt fences on slopes that are 3 to 1 or flatter. The straw waddles should be installed along the toe of the slopes as well as at vertical intervals of 25 feet maximum. The waddles on slope faces shall be installed along contours of equal elevation and can be secured with wood stakes, as needed. The desiltation basins have been sized based on SCVURPPP’s volume-based treatment control requirements from their *C.3. Stormwater Handbook* as well as the criteria in the State Water Resources Control Board’s (SWRCB) *Water Quality Order 99-08-DWQ*. The sizing calculations are contained in Chang Consultants’ April 14, 2009, *Drainage Report for Permanente Quarry East Materials Storage Area*. The

report also contains engineering analyses for the outlet works and emergency spillway at each desiltation basin.

The majority of the EMSA runoff will be conveyed to one of the perimeter desiltation basins by a series of ditches and downdrains. These drainage facilities have been sized to convey the tributary 100-year flow. The hydrologic and hydraulic analyses used to design the facilities are contained in Chang Consultants' *Drainage Report*. Portions of the ditches within the perimeter road and the downdrains will have a steep gradient. As a result, these will be lined with riprap or other erosion-resistant material to prevent erosion.

Inspections and maintenance of the temporary erosion control measures will be performed, as needed. Silt fencing and straw wattles can either be repaired or replaced depending on their condition. Sediment and debris that accumulates in the desiltation basins and their outlet works will be removed. Similarly, sediment and debris will be removed from the ditches and downdrains and these drainage facilities will be inspected for erosion. The inspections and maintenance will ensure that the temporary measures provide adequate erosion control for the EMSA until the permanent measures are established.

## **PERMANENT EROSION CONTROL MEASURES**

The permanent erosion control measures will include the drainage ditches and downdrains described in the previous section as well as revegetation. The temporary desiltation basins and silt fencing will be removed as revegetation allows. The "Erosion Control Measures Following Final Revegetation Exhibit" in the map pocket of this report illustrates the permanent erosion control measures including the permanent revegetation plan.

The objective of the revegetation plan is to provide native vegetative cover for final contours, thus controlling erosion and stabilizing slopes, using plant materials capable of self-regeneration without continued dependence on irrigation, soil amendments, or fertilizer in accordance with the reclamation standards. Revegetation will be sufficient to stabilize the surface against the effects of long-term erosion and is designed to meet the post-extractive land use objectives of the site. Hydroseeding of the finished slopes with a mixture of native grasses, herbaceous plants, and shrubs will provide surface cover and erosion control for the new slopes. Tree and shrub planting areas will be located on benches of the revegetation areas to encourage the long-term development of an oak savannah on north-facing slopes, or native scrub community on south-facing slopes. These communities will provide visual integration of the EMSA with the surrounding hillsides. The following sections outline the revegetation. The revegetation pursuant to the Reclamation Plan will include a test plot program, soil treatment and plant installation, maintenance and adaptive management guidelines, and verifiable monitoring standards to assure success of revegetation.

### *Hydroseeding*

Contoured surfaces will be covered with native grass, herbaceous, and shrub species via hydroseeding homogenous slurry of mulch, fertilizer, seed, and a binding agent over the areas to be revegetated. Drainage ditches and access roads will be left bare until the completion of the stockpiling at which time the roads will be revegetated. Local seed suppliers have been working with Lehigh staff to develop an appropriate native seed mix for reclamation, and are testing several mixes in the test plots. Adaptive

management will continue to be used in the future to determine what seed mixes and slurry amendments are most effective for achieving revegetation goals. A preliminary hydroseed mix of shrubs and grasses is shown in Table 2, which includes species known to thrive in undisturbed quarry areas or known to perform well in previous revegetation areas. These species should be used, pending availability, for the earliest stages of the proposed reclamation project, until test plot results can be used to further refine and expand the species selection.

*Trees and Shrubs*

The interslope benches will have deeper soils and will be planted with tree and shrub species. The north and east facing benches will support the greatest diversity of trees and shrubs since they have less solar radiation and less intense temperatures. South-facing benches will generally be planted with shrubs, however, grey pine (*Pinus sabiniana*), a native tree species that is tolerant of very dry conditions, will also be used in these areas.

Table 2. Preliminary species for general slope hydroseeding.		
SCIENTIFIC NAME	COMMON NAME	Suitable aspect (different mixes may be utilized on north-facing [N] vs. south-facing [S] areas)
<b>SHRUBS</b>		
<i>Adenostoma fasciculatum</i>	chamise	S
<i>Artemisia californica</i>	California sagebrush	N and S
<i>Baccharis pilularis</i>	coyote brush	N and S
<i>Ceanothus cuneatus</i>	buckbrush	N and S
<i>Eriogonum fasciculatum</i>	California buckwheat	S
<i>Heteromeles arbutifolia</i>	toyon	N
<i>Mimulus aurantiacus</i>	sticky monkeyflower	N
<i>Salvia leucophylla</i>	purple sage	S
<i>Salvia mellifera</i>	black sage	S
<b>GRASSES AND HERBS</b>		
<i>Elymus glaucus</i>	blue wildrye	N and S
<i>Eschscholzia californica</i>	California poppy	N and S
<i>Heterotheca grandiflora</i>	telegraph weed	N and S
<i>Lotus scoparius</i>	deerweed	N and S
<i>Lupinus nanus</i>	sky lupine (innoc.)	N and S
<i>Nassella pulchra</i>	purple needlegrass	N and S
<i>Plantago erecta</i>	California plantain	N and S
<i>Vulpia microstachys</i>	three weeks fescue	N and S

Trees and shrubs will be planted as container plants or acorns in the revegetation areas to encourage re-establishment of a vegetative community similar in structure to that of the surrounding areas. Plantings will occur on the benches where a deeper layer of soil treatment materials is applied to ensure adequate space for root development. These deeper soils with container plantings will be prepared on contoured benches, while slopes will be covered with shallower soils and hydroseeded. To the extent practicable,

trees and shrubs to be planted will be obtained from seeds collected on-site or from local sources. At least 10% of the total restoration area will be planted in tree and/or shrub planting areas. Shrubs will be planted at approximately 4.5-foot spacing (680 shrubs per acre) and trees at 9-foot spacing (up to 170 trees per acre) in the designated areas.

As with hydroseeding, adaptive management will be used to determine which tree and shrub species will be planted, the most effective spacing and location, and species to use in replacement plantings if necessary. A preliminary list of trees and shrubs to be planted on benches of the RPA Area is provided in Table 3. Species selection and numbers will depend on propagule collection and availability, as well as on test plot results.

Table 3. Preliminary list of trees and shrubs for planting on RPA Area benches.		
SCIENTIFIC NAME	COMMON NAME	Potential <i>P. ramorum</i> host?
TREES (may use acorns instead of container planting for some oaks)		
<i>Arbutus menziesii</i>	Pacific madrone	yes
<i>Pinus sabiniana</i>	grey pine	no
<i>Quercus agrifolia</i>	coast live oak	yes
<i>Quercus chrysolepis</i>	canyon live oak	yes
<i>Quercus douglasii</i>	blue oak	no
<i>Quercus lobata</i>	Valley oak	no
<i>Quercus wislizenii</i>	interior live oak	no
SHRUBS*		
<i>Cercocarpus betuloides</i>	mountain mahogany	no
<i>Heteromeles arbutifolia</i>	toyon	yes
<i>Quercus berberidifolia</i>	scrub oak	no
<i>Rhamnus californica</i>	California coffeeberry	yes
<i>Rhamnus crocea</i>	redberry	no
<i>Ribes californicum</i>	hillside gooseberry	no
<i>Ribes malvaceum</i>	chaparral currant	no

\* Shrub species selection may change based on the success of seeded shrubs in test plots. Seeding of coyote brush, chamise, California sagebrush, buckbrush, and sticky monkeyflower will be evaluated in test plots in 2009-2010, and if seed germination and establishment success is poor, these species will be tested as container plants. These species are expected to perform well in Quarry revegetation areas once an effective establishment method is identified.

### Timing

All hydroseeding should be performed and completed between October 1 and December 1 to take advantage of warm soil temperatures and winter rains for successful germination and establishment. Container planting should be performed during the winter season and completed by approximately the end of January to improve successful establishment.

## CONCLUSION

This erosion control plan has been developed for the East Materials Storage Area proposed at the Permanente Quarry. The EMSA will be used to store overburden material and will ultimately be planted with native materials. There are no impervious areas proposed at the EMSA. As a result, the proposed reclamation will have a low runoff potential. Temporary best management practices will be used at the site until the revegetation is established. The temporary erosion control measures include desiltation basins, which have been sized with a greater capacity than required by the SCVURPPP and SWRCB guidelines, hydroseeding, silt fencing, and drainage facilities. The permanent erosion control measures will include the drainage facilities and a detailed revegetation plan in accordance with the Reclamation Plan. This combination of temporary and permanent erosion control best management practices will be used to treat the primary pollutant of concern from the EMSA, which is sediment. The level of treatment has been established to meet or exceed the erosion control criteria of SMARA, SWRCB, and SCVURPPP.

Table 4. Qualitative descriptions of soil surface status	
CLASS 1:	No soil loss or erosion; topsoil layer intact; well-dispersed accumulation of litter from past year's growth plus smaller amounts of older litter.
CLASS 2:	Soil movement slight and difficult to recognize; small deposits of soil in form of fans or cones at end of small gullies or fills, or as accumulations upslope of plant crowns or behind litter; litter not well dispersed or no accumulation from past year's growth.
CLASS 3:	Soil movement or loss more noticeable; topsoil loss evident, with some plants on pedestals or in hummocks; rill marks evident, poorly dispersed litter and bare spots not protected by litter.
CLASS 4:	Soil movement and loss readily recognizable; topsoil remnants with vertical sides and exposed plant roots; roots frequently exposed; litter in relatively small amounts and washed into erosion protected patches.

Prior to the release of financial assurances, disturbed slopes in the EMSA must meet revegetation and erosion control performance standards. These standards have been designed to minimize the potential for stormwater runoff and erosion. Maintenance and monitoring will include identification and repair of erosion damage in order to maintain the standards. Performance criteria and additional slope treatment for erosion control are based on the qualitative descriptions and remedial measures described in Tables 4 and 5, respectively. The need for remedial measures will be determined by field observations. In general, areas receiving an average score of Class 3 or 4 will receive additional slope treatment. Any observable reason for failure will be noted and the appropriate remedial measure stated as part of the annual monitoring report.

Table 5. Remedial measures for erosion control	
CLASS 1:	No action necessary.
CLASS 2:	Monitor to see if any further deterioration and action is required.
CLASS 3:	Any rills or gullies in excess of 8 square inches in cross-sectional area and more than 10 linear feet located on finished slopes shall be arrested using straw mulch or equivalent.
CLASS 4:	Replant and cover with straw mulch and install silt fences. If necessary, regrade and compact with equipment.

**EROSION CONTROL LEGEND**

- PERIMETER ROAD DITCH
- BENCH DITCH
- DOWNDRAIN
- SILT FENCE
- SLOPES
- PADS/BENCHES
- DESILTATION BASINS

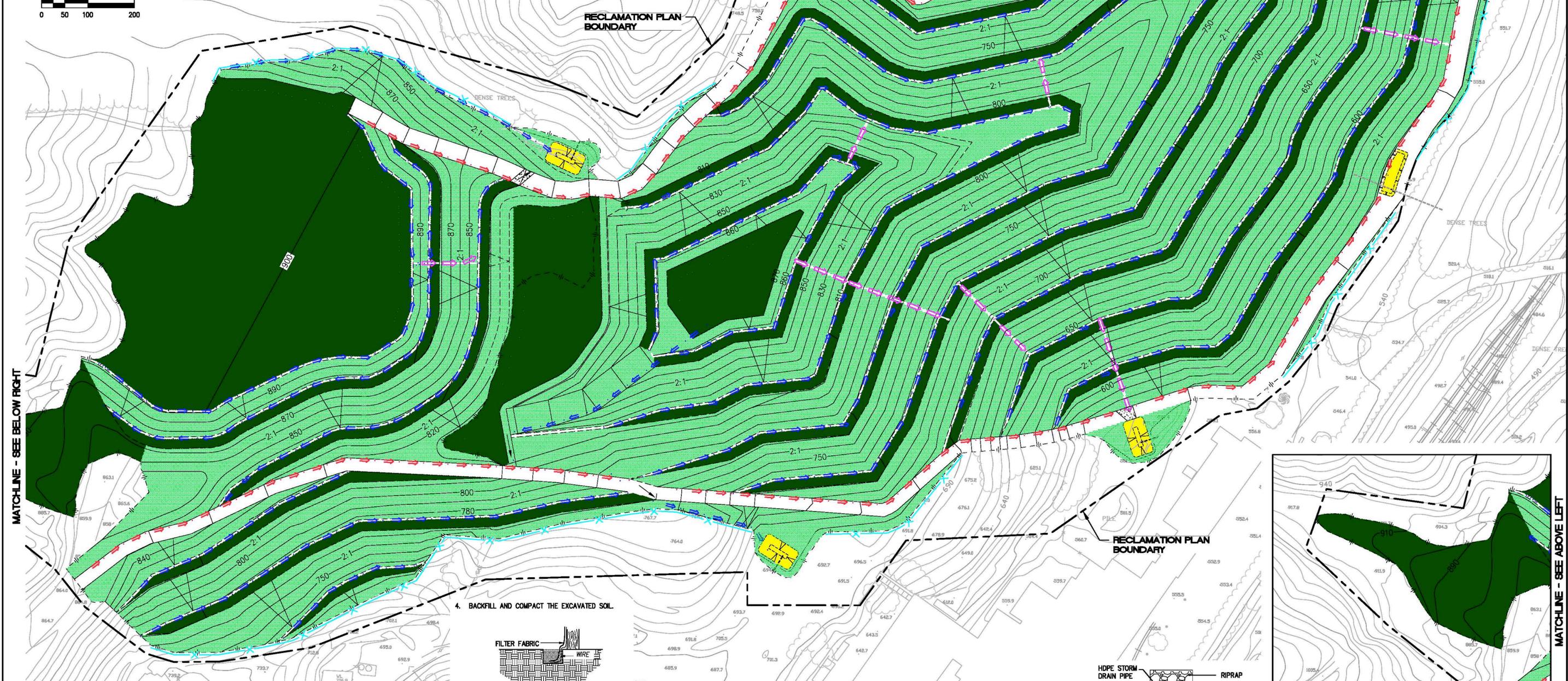
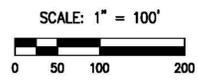
NOTE: DOWNDRAINS AND PERIMETER ROAD DITCHES SHALL BE LINED TO PREVENT EROSION

**EROSION CONTROL SEED MIX**

SCIENTIFIC NAME	COMMON NAME	PURE LIVE SEED (LB / ACRE)
BROMUS CARINATUS	CALIFORNIA BROME	16.00
ELYMUS GLAUCUS	BLUE WILDRIE	10.00
LUPINUS NANUS	SKY LUPINE (INNOC.)	5.00
NASSELLA PULCHRA	PURPLE NEEDLEGRASS	8.00
PLANTAGO ERECTA	CALIFORNIA PLANTAIN	3.00
TRIFOLIUM WILDENOVII	TOMCAT CLOVER (INNOC.)	3.00
VULPIA MICROSTACHYS	THREE WEEKS FESCUE	8.00

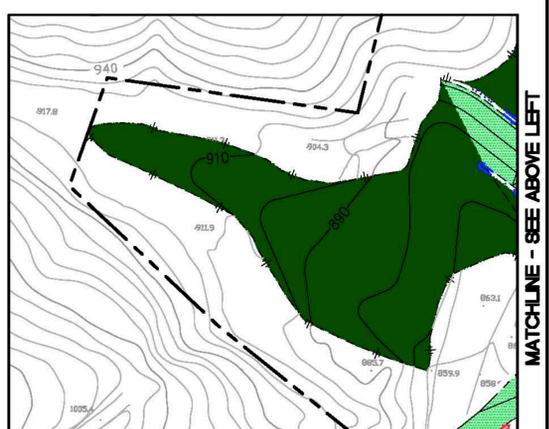
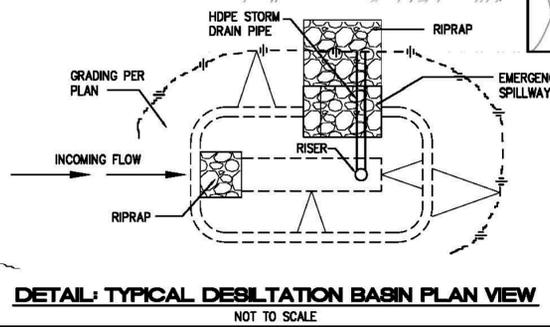
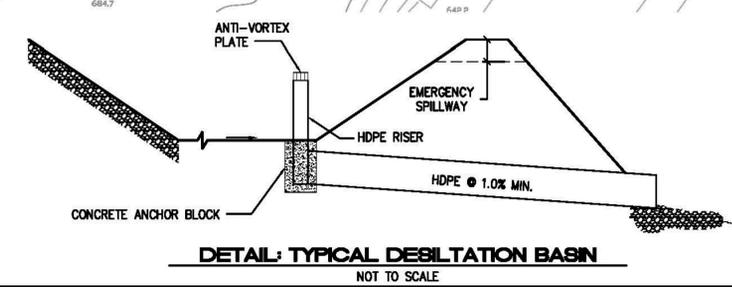
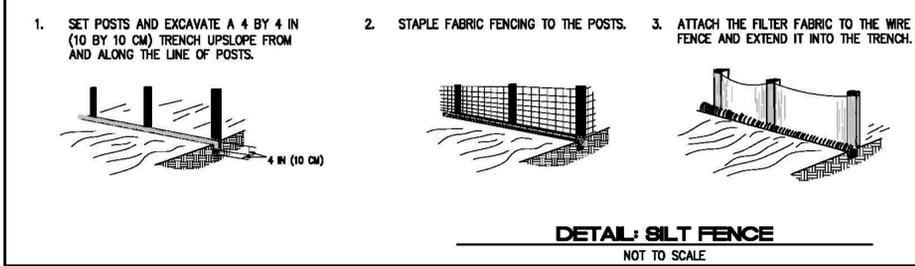
NOTE: EROSION CONTROL SEED MIX SHALL BE USED ON SLOPES AND PAD/BENCHES IDENTIFIED BY LEGEND.

GROUND OBSCURED BY DENSE TREES



MATCHLINE - SEE BELOW RIGHT

MATCHLINE - SEE ABOVE LEFT



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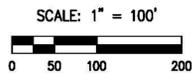
**PERMANENTE QUARRY  
EAST MATERIALS STORAGE AREA  
EROSION CONTROL MEASURES  
1-YEAR FOLLOWING RECLAMATION COMPLETION**

CHANG CONSULTANTS  
858.692.0760

**EROSION CONTROL LEGEND**

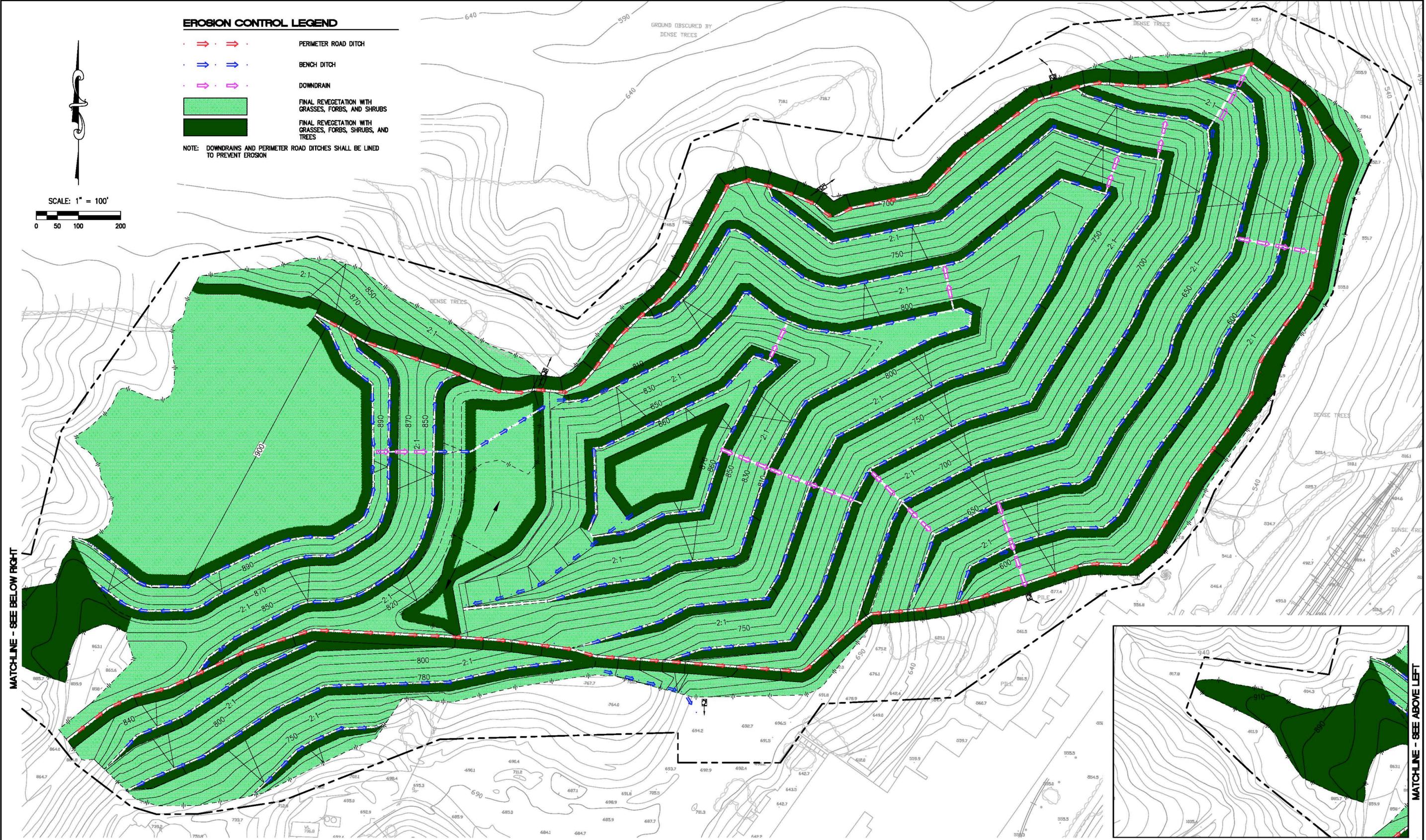
-  PERIMETER ROAD DITCH
-  BENCH DITCH
-  DOWNDRAIN
-  FINAL REVEGETATION WITH GRASSES, FORBS, AND SHRUBS
-  FINAL REVEGETATION WITH GRASSES, FORBS, SHRUBS, AND TREES

NOTE: DOWNDRAINS AND PERIMETER ROAD DITCHES SHALL BE LINED TO PREVENT EROSION



MATCHLINE - SEE BELOW RIGHT

MATCHLINE - SEE ABOVE LEFT



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**PERMANENTE QUARRY  
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 FOLLOWING FINAL REVEGETATION