INTERIM

CONSTRUCTION

BEST MANAGEMENT PRACTICES (BMP'S)

FOR

SEDIMENT AND EROSION CONTROL

FOR THE

COUNTY OF KAUA'I

Department of Public Works

County of Kaua'i

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County of Kaua'i, Department of Public Works, hereby adopts the Interim Construction Best Management Practices (BMPs) for Sediment and Erosion Control for the County of Kaua'i this the 2nd day of April, 2004.

LADYE H. MARTIN
Deputy County Engineer

Foreword

The purpose of this manual is to provide a guide for the selection of site-specific Best Management Practices (BMP's) that need to be employed in all grading, grubbing, and stockpiling work as mandated by the Grading, Grubbing and Stockpiling Ordinance of the Kauai County Code, now known as Sediment and Erosion Control Ordinance No. 808.

The BMP's shown in this manual are not exclusive and are not the only types of practices that can be used in construction to prevent pollution, control sedimentation and soil erosion, and protect our environment. Other types of BMP's not shown in this manual may be considered if deemed effective and appropriate, as all BMP's will not work in all situations all the time.

The Department of Public Works, County of Kauai, wishes to acknowledge the indirect contributions made by the County of Maui through the use of materials in their manual.

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Erosion Control Planning

A. Development of erosion and sediment control plans

Erosion and sediment control plans may be developed as a separate submittal or may be a part of the project construction plans, but in any case, the plan shall be identified as the "Erosion and Sediment Control Plan" for the project.

The Erosion and Sediment Control Plan shall be prepared as described in Section 2 - "Guidelines" of this manual.

A copy of the County approved stamped erosion and sediment control plan shall be available at the job site at all times.

B. Sequencing and Timing of Operations

The preparation of the construction schedule is an integral part of the erosion control planning process. A detailed sequence of the construction activities should be included as part of the plan. When changes beyond the control of the developer or contractor require changes in the schedule, an amended or revised schedule shall be submitted for approval.

The following is generally the most desirable sequence of operations in a normal development and should be followed unless conditions prove impractical. If this is the case, the narrative should explain the reasons for deviating from this sequence.

1. Install sediment basins, dust barriers, silt screens, drain inlet protection, and construction entrances/exits, and any other preliminary structural BMP's, as planned or needed.

2. Clear and grub the first phase or increment of grading. Where vegetation along drainage ways and the lower boundary are suitable to serve as a filter strip (thick sod or tall grass is best), leave a strip or strips 15-feet wide or wider in place as long as possible. Future phases may also function as filter strips.

3. Immediately upon clearing, construct temporary interceptor ditches, dikes, or berms as needed to direct runoff into sediment basins. Runoff interceptors must be modified throughout the project as clearing and grading progresses to ensure they are functional at all times.

4. Construct critical drainage improvements to accommodate grading activities. Provide BMP's at new drainage structures.

5. Complete grading of the first phase or increment as planned. Modify BMP's as needed.

6. Temporarily stabilize on the fourteenth day after disturbance all cleared and graded areas which will not be worked on within 7 days. Temporary stabilization may include mulching with or without grass seed, installing erosion control blankets, and temporary grassing.

7. Install the temporary or permanent irrigation system for this phase as soon as grading is complete.

8. Plant temporary or permanent vegetation according to the landscaping plan on terraces, benches, steep slopes, and all other areas where foundations or paving will not occur. In areas of buildings or paving, temporary stabilization must be maintained until such time the permanent stabilization measures are installed. If building construction or paving will not be performed within 90 days, temporary grassing and irrigation shall be provided.

9. Proceed with construction in remaining areas with the least possible disturbance to vegetated areas and structural BMP's.

10. Remove temporary structural BMP's only upon completion of drainage improvements and establishment of permanent stabilization measures.

Guidelines for the Preparation of The Erosion and Sediment Control Plan

There are many levels of erosion and sediment control plans which depend on the scope of the project. For small developments on relatively flat land, a simple non-engineered erosion and sediment control plan may be submitted. For larger sensitive projects with cuts or fills of 15-feet or greater, or grubbing or grading areas of 1-acre or larger, or any project within the Special Management Area (SMA), a detailed engineered erosion control plan is required.

The guidelines for the erosion control plan that follows is primarily for the larger or sensitive projects.

A. Plan Preparer

The plan shall be prepared, sealed, and signed by a Civil Engineer licensed in the State of Hawaii.

B. Content

The plan should consist of three parts, a narrative, calculations, and a map with details.

1. Narrative

This narrative is intended to summarize for the plan reviewer the project aspects important only for erosion and sediment control. Any SMA or other developmental permit conditions pertinent to erosion and sediment control should also be discussed in the narrative.

The narrative should describe the following:

a. the proposed project or proposed land disturbing activities.

b. the existing site conditions including soil type and its erodibility properties, the existing vegetation, and the current use of the site.

c. the critical areas of the site, including areas subject to serious erosion problems. Discuss the site topography, the location of drainage ways within and near the project site, the direction of

the prevailing winds, and the potential impacts of seasonal weather conditions.

d. the condition of the adjacent areas such as offsite flows entering the site, and the proximity of a shoreline, the established shoreline setback, wetland, roadway or neighboring structure which may be affected by the land disturbance.

e. the project requirements from development permits issued by other departments or agencies that pertain to erosion. Attach copies of the approved national pollutant discharge elimination system (NPDES) and special management area (SMA) permits, if required.

f. the temporary and permanent best management practice (BMP) measures which will be used to provide erosion control and sediment control on the site.

g. the date grubbing and grading of the site will begin, the expected dates of temporary and permanent stabilization, and the expected date of project completion.

h. a maintenance program with provisions for frequency of inspection, reseeding of vegetated areas, repair or reconstruction of damaged structures, cleaning procedures and frequency, disposal of waste materials, and disposition of control measures after they have served their purposes.

2. Calculations

Submit the design assumptions and calculations for structural measures such as sediment basins, channels and outlet protection.

The calculations should reference applicable standards such as the County of Maui Drainage Standards, and the State Clean Air and Clean Water Quality Standards.

3. Map and Details

Submit a map and details showing the following:

a. the existing site contours at an interval and scale sufficient for distinguishing runoff patterns before and after disturbance.

b. the surface extent of each soil type and the relative erodibility of the soil.

c. the existing vegetation such as grassy areas and trees. The plan shall identify the areas where the natural vegetation will be preserved.

d. the grubbing and grading limits of the project development.

e. the proposed finish contours.

f. the location of critical areas within or near the project site such as the shoreline and setbacks, streams, wetlands, and any known historic sites.

g. the location and types of temporary and permanent erosion and sediment control measures. Use the standard symbols shown in table 1 of section 5 – Standard Symbols.

h. the construction sequence for the installation of the BMPs.

i. a vicinity map showing the location of the project site relative to roadways, gulches, and other identifiable landmarks.

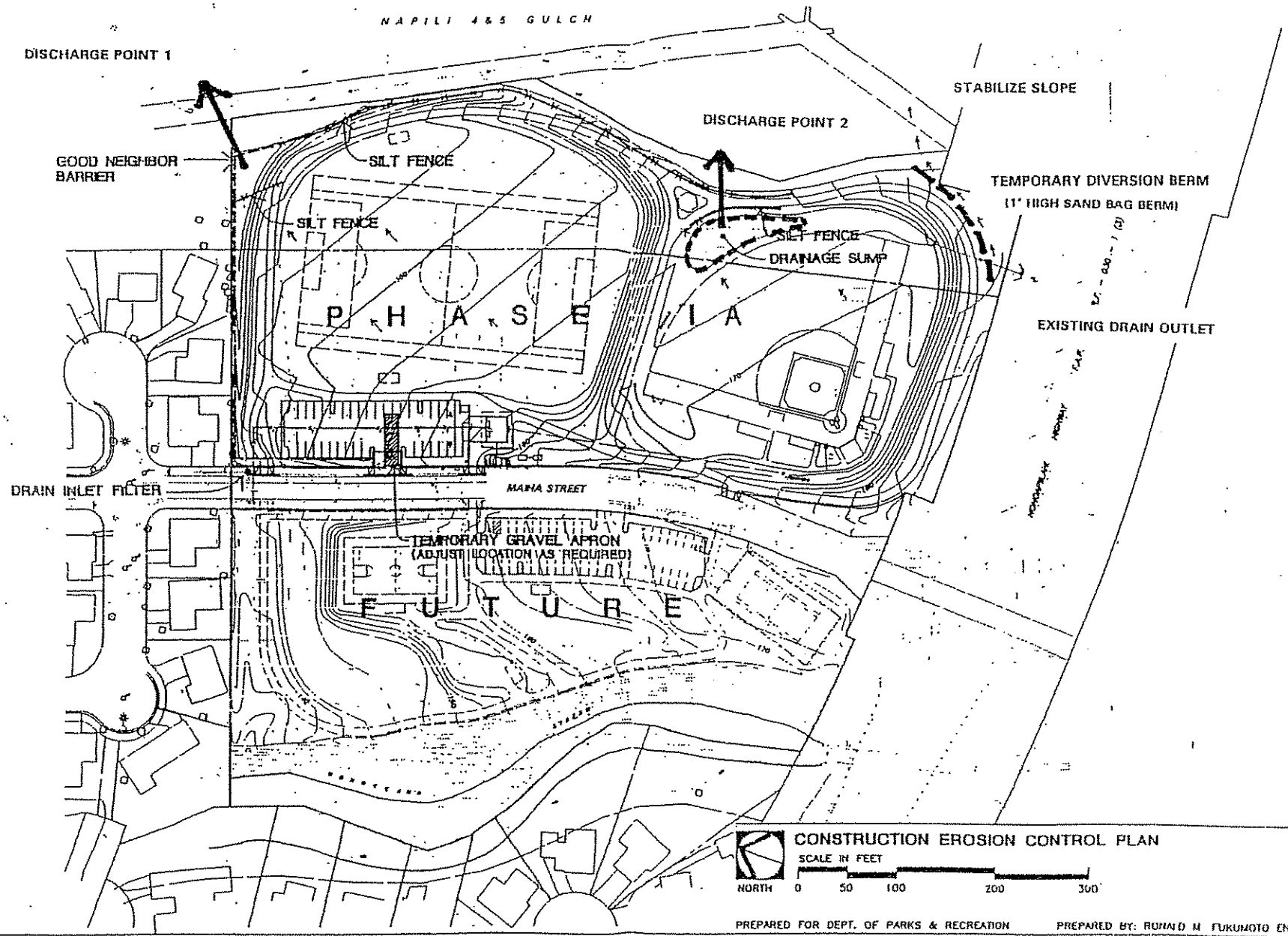
j. detailed drawings of erosion and sediment control structures including dimensions and material specifications.

k. detailed notes regarding the maintenance of the control structures.

Section 3

Sample Erosion Control Plan

The construction best management practices shown on this sample plan are not the only types of practices that can be used in an erosion and sediment control plan. Other types of BMPs not shown on this plan should be considered if the designer feels other practices are more appropriate or effective.



CONSTRUCTION EROSION CONTROL PLAN

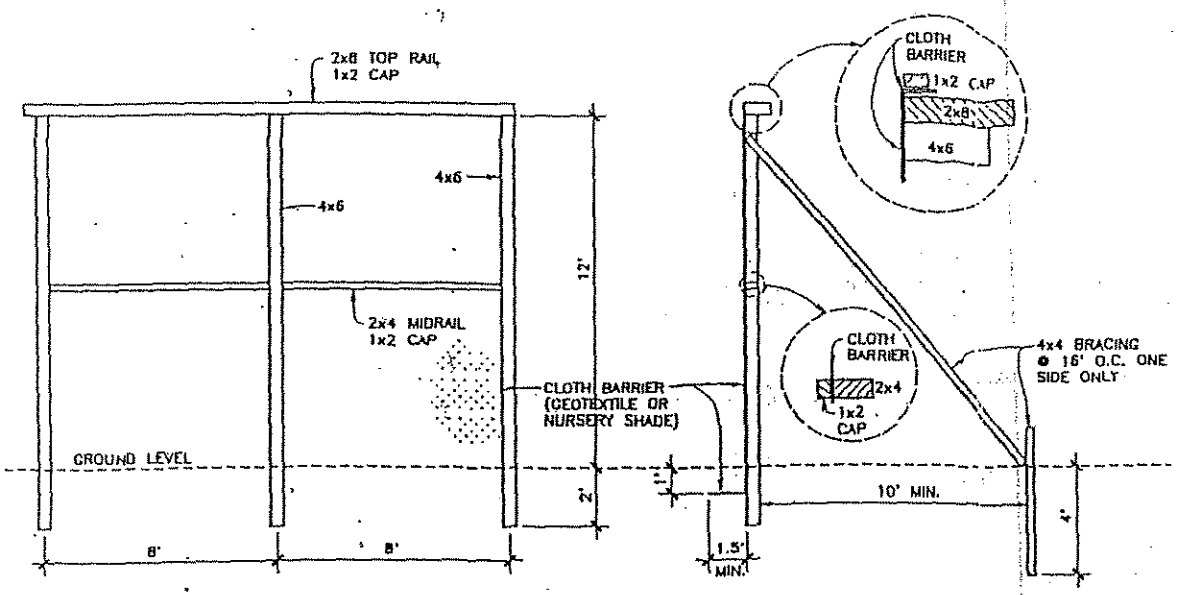
SCALE IN FEET

Figure A

DATE: 1/26/99

PREPARED FOR DEPT. OF PARKS & RECREATION

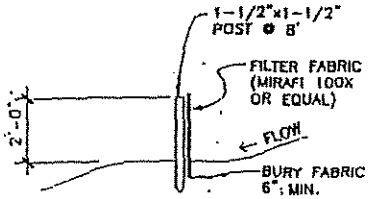
PREPARED BY: RONALD M. FUKUMOTO ENGINEERING, INC.



NOTE:
1. FABRIC SHALL NOT HAVE HORIZONTAL SEAMS.
2. FABRIC VERTICAL SEAMS SHALL BE ON UPRIGHTS ONLY.

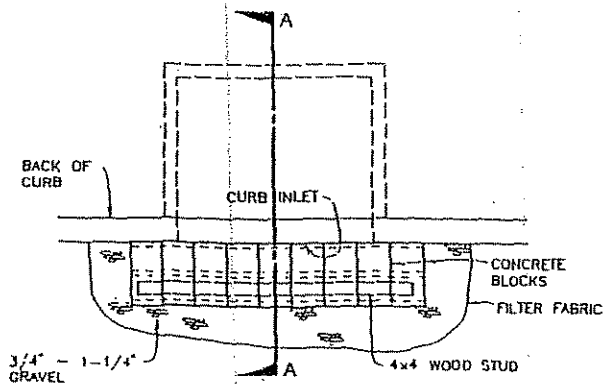
GOOD NEIGHBOR BARRIER (TYPICAL SECTION)

NOT TO SCALE

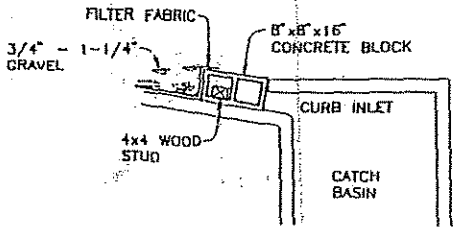


SILT FENCE SECTION

NOT TO SCALE



PLAN VIEW



SECTION A-A

DRAIN INLET FILTER

NOT TO SCALE

EROSION CONTROL DETAILS

SCALE AS SHOWN

Figure B
DATE: 1/26/99

PREPARED FOR DEPT OF PARKS & RECREATION

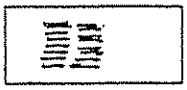
PREPARED BY RONALD M FUKUI

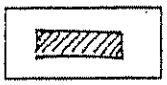
ENGINEERING, INC.

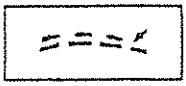
DRAINAGE AND EROSION CONTROL PLAN FOR NAPILI PARK

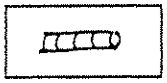
Standard Symbols for Erosion and Sediment Control Plans

There are many symbols used on plans to depict erosion and sediment control measures. The following is a sample of a few mapping symbols:


Surface Roughening


Temporary Gravel Construction Entrance/Exit


Temporary Diversions


Temporary Slope Drains

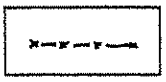

Preservation of Existing Vegetation

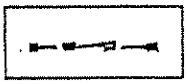

Protection of Stockpiles

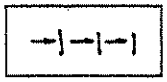

Drop Inlet Protection


Temporary Sediment Trap


Sediment Basin


Sediment Fence


Good Neighbor Barrier


Check Dam


Discharge Point


Waste Management Area

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BMP Details and Specifications

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6.33 Protection of Stockpiles
6.40 Construction Road Stabilization

SEDIMENT CONTROLS

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6.52 Temporary Block & Gravel Drop Inlet Protection
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Surfacing Roughening

Definition — Roughening the surface of bare soil with horizontal groves across a slope by construction equipment tracking, terracing, or other methods.

Purpose — To reduce runoff velocity and increase infiltration, to reduce erosion and provide for sediment trapping, and to aid in the establishment of vegetal cover.

Where Applicable — On all existing or newly graded slopes.

Planning Consideration — Rough sloped surfaces are preferred to decrease runoff velocity, increase water infiltration, and aid the establishment of vegetal growth. Graded smooth, hard slopes are attractive, however, increase the erosion potential.

A rough, loose soil surface provides a mulching effect to protect seed and fertilizer to assist with seed germination.

Consideration, however, should be given to maintenance of the finished landscaped surface. The slope will require several mowings for a level finish.

Construction Specifications — Operate tracked construction equipment up and down the slope leaving loose horizontal depressions in the soil. Do not back-blade to smooth finish.

Immediately seed and mulch, or plant the roughened slope for best results.

Maintenance — Periodically check the vegetated slopes for rills and washes. Fill these areas and immediately replant.

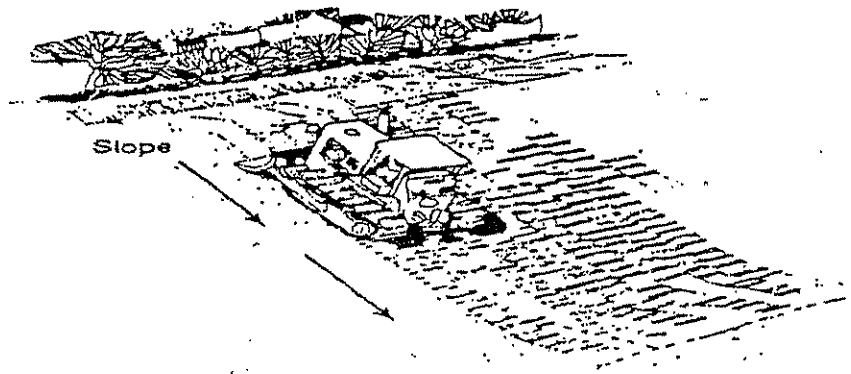


Figure 6.03a Surface Roughening with Tracked Construction Equipment

Temporary Gravel Construction Entrance/Exit

Definition

A graveled area or pad located where vehicles enter and leave a construction site.

Purpose

To provide an entrance/exit to remove mud and sediment from vehicles prior to leaving the construction site, to control erosion from surface runoff, and control dust from construction vehicles.

Where Applicable

Wherever vehicular traffic will leave a construction site onto a public street or other paved off-site area. Construction plans and best management practices plans should limit traffic leaving the site to properly constructed exits.

Design Criteria

Aggregate Size – Use 2 – 3 inch washed stones or crushed rock.

Dimensions of gravel pad –

Thickness:	6 inches minimum
Width:	12-feet minimum or full width at all points of the vehicular entrance and exit areas, whichever is greater
Length:	50-feet minimum

Location – Select construction entrances and exits to limit sediment from leaving the site, and to provide for maximum utility by all construction vehicles. Avoid steep grades and entrances with limited sight distance.

Washing – If mud and sediment are not removed by vehicles traveling over the gravel pad, the vehicle tires should be washed prior to leaving the site. Washing should be done on a stabilized area with crushed stone draining into a sediment trap or other suitable disposal area. A wash rack or pit may also be used to make washing more convenient and effective.

Construction Specifications

1. Clear the entrance/exit area of all vegetation, roots, and other objectionable materials and properly grade, or select a location with suitable grades and maintain the existing vegetation.

2. Place the stones or gravel to the specific grade and dimensions shown on the plans.

3. Provide drainage to direct runoff to a sediment trap or other suitable outlet.

4. Use geotextile fabrics to improve foundation stability in areas subject to seepage or high water table.

Maintenance

Maintain the gravel pad to prevent mud or sediment from leaving the construction site. Periodically top-dress the pad with additional stone or gravel. Inspect the sediment trap after each rainfall event and remove sediment as necessary. Immediately clean and remove sediment and gravel spilled, washed or tracked onto the public roadway.

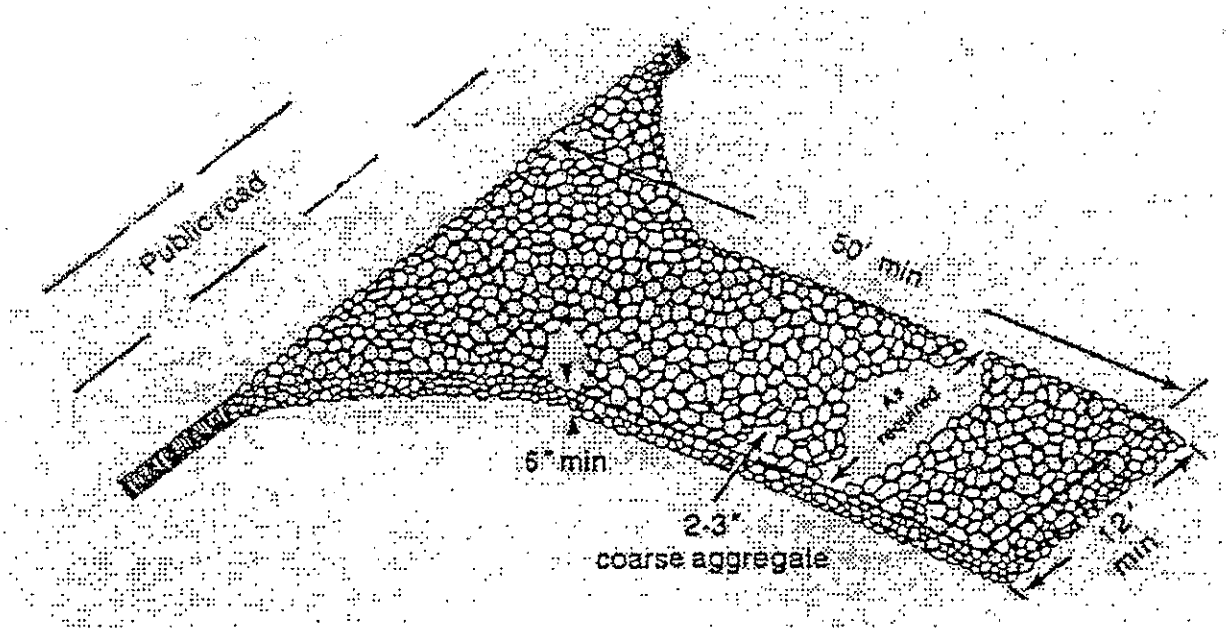


Figure 6.06a Temporary Gravel Construction Entrance/Exit

Seeding

Definition — Planting rapid-growing annual and perennial grasses, small grains, or legumes to provide temporary or permanent cover for erosion control on disturbed areas.

Purpose — To temporarily stabilize disturbed areas that will not be brought to final grade for a period of more than 30 days, or to reduce erosion and sediment from disturbed areas in an economical manner.

Where Applicable — On any cleared, un-vegetated, or sparsely vegetated soil surface where vegetative cover is needed for temporary stabilization or permanent stabilization. Applications of this practice include diversions, temporary sediment basins, road banks, stockpiles, and finish lawn areas.

Planning Considerations — Annual plants which sprout and grow rapidly and survive for only one season are suitable for establishing initial or temporary vegetative cover. Temporary seeding preserves the integrity of earth structures such as berms, diversions and sediment basins, and reduces the maintenance of these structures.

Vegetation controls erosion by protecting bare soil surfaces from raindrop impact and by reducing the velocity of surface runoff. The most common and economical method of stabilizing disturbed soils is by grass seeding. The advantages of seeding over other means of establishing plants include the low initial cost, lower labor input, and flexibility of application. Disadvantages include potential erosion during establishment, seasonal and temperature germination limitations, and the volume of water required for establishment.

The probability of successful plant establishment can be maximized through good planning, knowledge of the soil characteristics, selection of suitable plant material for the site, good seedbed preparation, adequate liming and fertilization, and timely planting and maintenance.

Specifications — Complete grading before preparing topsoil and install all necessary erosion control practices such as berms, waterways and basins. Minimize steep slopes and scarify compacted soil to a depth of 4 to 6 inches.

TOPSOIL PREPARATION – Good topsoil preparation is essential to successful plant establishment. Topsoil should be loose and uniform.

Apply lime and fertilizers according to the soil test recommendations. Soil testing is performed for a charge by the University of Hawaii Cooperative Extension Service located on the Maui Community College Campus. Directions on sampling and information sheets are available through the UH Cooperative Extension Office. Because the University of Hawaii at Manoa soil testing lab requires 1 to 6 weeks for sample turn-around, sampling must be planned in advance of final grading. Soil testing is also available through commercial laboratories.

When soil tests are not available, application rates of lime and fertilizer usually fall in the following ranges:

- Ground agricultural limestone:
  Light-textured, sandy soils: 1 to 1-1/2 tons/acre
  Heavy-textured, clayey soils: 2 to 3 tons/acre

- Fertilizer:
  Grasses: 500 lb/acre of 10-30-10 (or equivalent)
  Grass-legume mix: 500 lb/acre of 10-30-10 (or equivalent)

Apply lime and fertilizer evenly and incorporate into the top 4 to 6 inches of soil by disking or other suitable means by operating the equipment along the contour.

Complete topsoil preparation by breaking up large clods and raking into a smooth, uniform surface on flat slopes (less than 3:1), or on terraced or roughened slopes.

PLANT SELECTION – Select an appropriate species or mixture of species for the application. See the *List of Species Suitable for Temporary and Permanent Seeding or Planting* included in this section.

SEEDING – Evenly apply seed using a cyclone broadcast seeder or hydroseeder. Hand broadcasting is not recommended because of the difficulty in achieving a uniform distribution. Use seeding rates identified in the *List of Species Suitable for Temporary and Permanent Seeding or Planting*.

Small grains should be planted no more than 1 inch deep, and grasses no more than 1/2 inch deep. Broadcast seed must be covered by raking or chain dragging, and then lightly rolled. Hydroseeded mixtures should include a wood fiber or paper mulch.

STEEP SLOPES – Where steepness prohibits the use of machinery, seeding methods are limited to broadcasting or hydroseeding. Vegetation chosen for these slopes should not

require excessive mowing or intensive maintenance. Good mulching or soil stabilization practices are critical to protect against erosion on steep slopes.

Maintenance Reseed areas where seeding emergence is poor, or where erosion occurs as soon as possible. Protect seeded areas from traffic.

List of Species Suitable for Temporary & Permanent Seeding or Planting

Common Name/ Cultivar	Scientific Name	Elevation (ft.)	Rainfall (in.)	Seeding Rate (lbs/PLS/ac)
Grasses/Non-legumes:				
'aki-'aki	Sporobolus virginicus	0 – 1000	30+	(a)
Australian saltbush 'Corto'	Atriplex semibaccata	0 – 1000	20+	20
bahiagrass	Paspalum noratum	0 – 4500	40+	40
'Pensacola' barley (small grain)	Hordeum vulgare	0 – 4000	40+	100
bermudagrass common 'NK–37'	Cuodon dactylon	0 – 3000	20 – 50	35
buckwheat (small grain)	Pagopvrum esculentum	0 – 4000	40+	100
buffelgrass	Cenchrus ciliaris			
'T-4464'		0 – 1000	10 – 30	20
'Gayndah'		0 – 1000	10 – 30	20
'Biloola'		0 – 1500	10 – 30	20
'Molopo'		0 – 3000	10 – 30	20
carpetgrass (narrowleaf)	Axonopus affinis	0 – 2000	50+	40

Common Name/ Cultivar	Scientific Name	Elevation (ft.)	Rainfall (in.)	Seeding Rate (lbs/PLS/ac)
carpetgrass (broadleaf)	Axonopus compressus	0 –2000	50+	
centepedegrass	Eremochloa ophiuroides	0 – 2500	35+	20
dallisgrass	Paspalum dilatatum	0 – 2500	40+	20
hairy chess	Bromus catharticus	3000 – 7000	40 – 100	20
kikuyugrass 'Whittet' 'Noonan' 'Hosaka' common	Pennisetum clandestinum	0 – 6000	35+	10
oats (small grain)	Avena sativa	0 – 7000	40+	70
orchardgrass	Dactylis glomerate	3000 – 7000	40 – 100	20
pangolagrass 'Mealani' 'Transvala' common	Digitaria decumbens	0 –2500	40+	(a)
paragrass/californiagrass	Brachiaria mutica	0 – 2000	35+	10
paspalum 'Tropic Lalo'	Paspalum hieronymii	0 – 3000	40+	(a)
ryegrass perennial	Lolium perenne	1500 – 7000	40+	40

Common Name/ Cultivar	Scientific Name	Elevation (ft.)	Rainfall (in.)	Seeding Rate (lbs/PLS/ac)
ryegrass annual	Lolium multiflorum	0 – 7000	40+	40
St. Augustinegrass	Stenotaphrum secundatum	0 – 3000	40+	(a)
seashore paspalum 'Tropic Shore'	Paspalum vaginatum	0 – 2000	40+	(a)
stargrass 'Florico' ("Puerto Rican")	Cnodon nlemfuenisis	0 – 3000	20 – 80	(a)
"South Point"	Cynodon plectostachyus	0 – 3000	20 – 80	(a)
LEGUMES:				
big trefoil 'Grasslands Maku'	Lotus pedunculatus	1500 – 6000	50+	25
desmodium 'Kuiaha' 'Greenleaf'	Desmodium aparines (syn. Desmodium intortum)	0 - 2500	35+	20
dolichos (lablab) 'Rongai'	Lablab purpureus	0 – 3000	20 – 60	60
torage peanut	Arachis glabrata	0 – 2500	40+	(a)
glycine 'Tinaroo' 'Clarence' 'Cooper'	Clycine wightii (syn. Neonotonia wightii)	0 – 3000	15 – 60	40

Common Name/ Cultivar	Scientific Name	Elevation (ft.)	Rainfall (in.)	Seeding Rate (lbs/PLS/ac)
hetero	Desmodium heterophyllum	0 – 2500	60+	20
kaimi clover	Desmodium canum	0 – 3000	35+	20
nanea	Vigna marina	0 – 1000	20+	40
siratro	Macroptilium atropurpureum	0 – 2500	15 – 60	40
style 'Cook' 'Endeavour' 'Oxley' 'Schofield'	Stylosanthes guyanensis	0 – 3000	60+	25
three-flowered beggarweed	Desmodium triflorum	0 – 2500	35+	(a)
white clover 'Haifa' 'Grasslands Huia' (New Zealand)	Trifolium repens	1500 – 7000	35 – 80	25

(a) vegetative planting

Temporary Diversions

Definition

A temporary berm or excavated channel or a combination berm and channel constructed across sloping land.

Purpose

To protect work areas from up-slope runoff and to divert sediment-laden runoff to appropriate traps or stable outlets. Temporary diversions may also serve as sediment traps when installed at a flat grade.

Where Applicable

This practice applies to construction areas where runoff can be diverted and disposed of properly to control erosion, sedimentation, or flood damage. Specific locations and conditions include:

- upstream of existing slopes, and above cut and fill slopes to prevent runoff from mauka areas over the slope
- below slopes to divert excess runoff to stabilized areas
- where needed to divert sediment-laden runoff to sediment traps
- at or near the perimeter of the construction site to keep sediment from leaving the site
- mauka of disturbed areas before stabilization to prevent erosion and maintain acceptable working conditions.

Planning Consideration

Temporary diversions concentrate flow and increase erosion potential. It is therefore important that diversions be properly designed, constructed and maintained. Excessive slopes can result in erosive velocities, while a flat slope can result in deposition of suspended solids reducing the capacity and causing overtopping. Frequent inspections and timely maintenance are essential to the proper function of diversions.

Sufficient area must be available to construct and properly maintain diversions.

Construction Specifications

Construct temporary diversions by excavating a channel and using the spoil to form a berm (see figure 6.20a). In areas where space is limited, a silt fence may replace the berm. Imported gravel or course aggregate may be used for the berm at vehicular crossings (see figure 6.20b).

Channel design – Diversion design sections may be parabolic, trapezoidal or V-shaped. See BMP 6.21, *Grass-Lined Channels*. Diversions planned to remain longer than 30 calendar days shall be grassed.

Grades – A uniform or gradually increasing grade is preferred. A sudden decrease or flattening of the diversion slope will accumulate sediment and decrease the capacity of the diversion. A large increase in channel slope may cause erosion.

Outlet – Direct sediment-laden diverted runoff to a sediment-trapping device. See BMP 6.60, *Temporary Sediment Trap*. Diverted runoff from undisturbed areas can be dispersed by a level spreader. See BMP 6.23, *Level Spreader*.

Maintenance Inspect temporary diversions once a week and after every rainfall. Immediately remove sediment from the flow area and repair the diversion berm as necessary. Remove the temporary diversion and blend with the finish grade when the protected area is permanently stabilized.

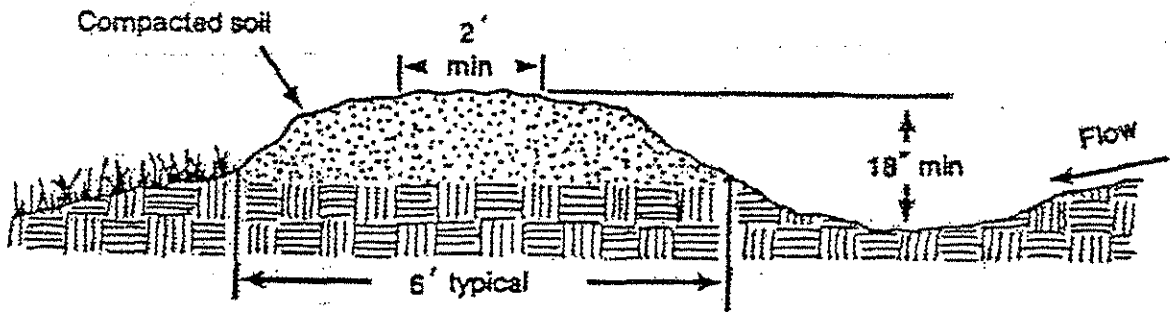
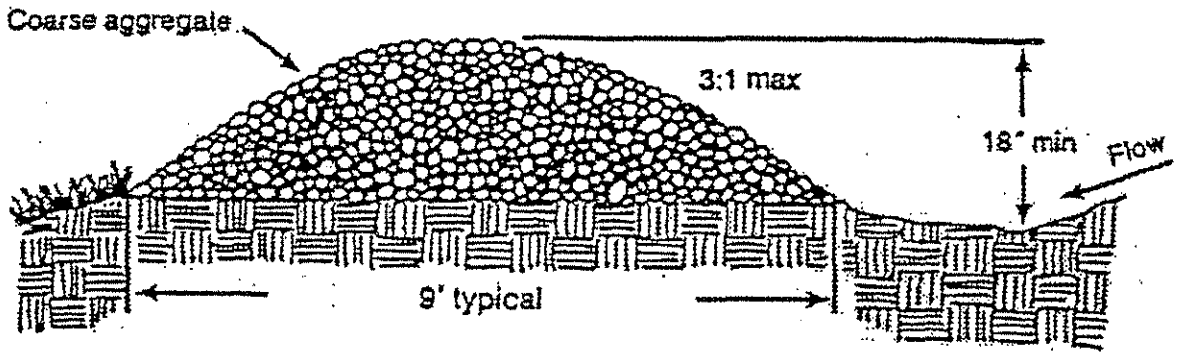


Figure 6.20a Temporary earth diversion channel and dike



ure 6.20b Temporary course aggregate diversion for vehicular crossing

Grassed-Lined Channels

Definition A channel planted with grass or groundcover designed to a specific cross-section and slope for conveyance of runoff.

Purpose To convey and dispose of concentrated surface runoff without damage from erosion, sedimentation, or flooding.

Where Applicable This practice applies to construction sites where:

- concentrated runoff will cause damage from erosion, sedimentation or flooding;
- a grass-lined channel will provide sufficient stability for the anticipated runoff;
- slopes are generally less than 5%;
- space is available for a relatively large cross section.

Typical uses include roadside ditches, channels at property boundaries, and outlets for diversions.

Planning Considerations Channels should be located to conform with the natural drainage system. Channels may also divert runoff along development boundaries, roadways, and backlot lines.

Plan the course of the channel to avoid sharp changes in direction or grade. Diversions should conform to natural features of the land and use natural drainageways rather than drastically reshape the land surface.

Establishment of dense, flow resistant vegetal growth is essential. Construct, vegetate and maintain grass-lined channels early in the construction schedule for best results.

Geotextile fabrics or special mulch protection such as fiberglass, straw and netting provide stability until the vegetation is established. These protective liners should be used whenever design velocities exceed 2 ft./sec. for bare soil conditions. It may also be necessary to line the channel with sod. Sediment traps should be considered at channel inlets and outlets.

V-shaped grass channels generally apply where the quantity of runoff is small. The V-shaped cross section is least desirable because of the concentrated flows at the channel bottom.

Parabolic grass channels are often used where larger flows are expected and space is available. The swale-like shape avoids the concentrated flow condition. Trapezoidal grass channels are used where runoff volumes are large (Figure 6.21a).

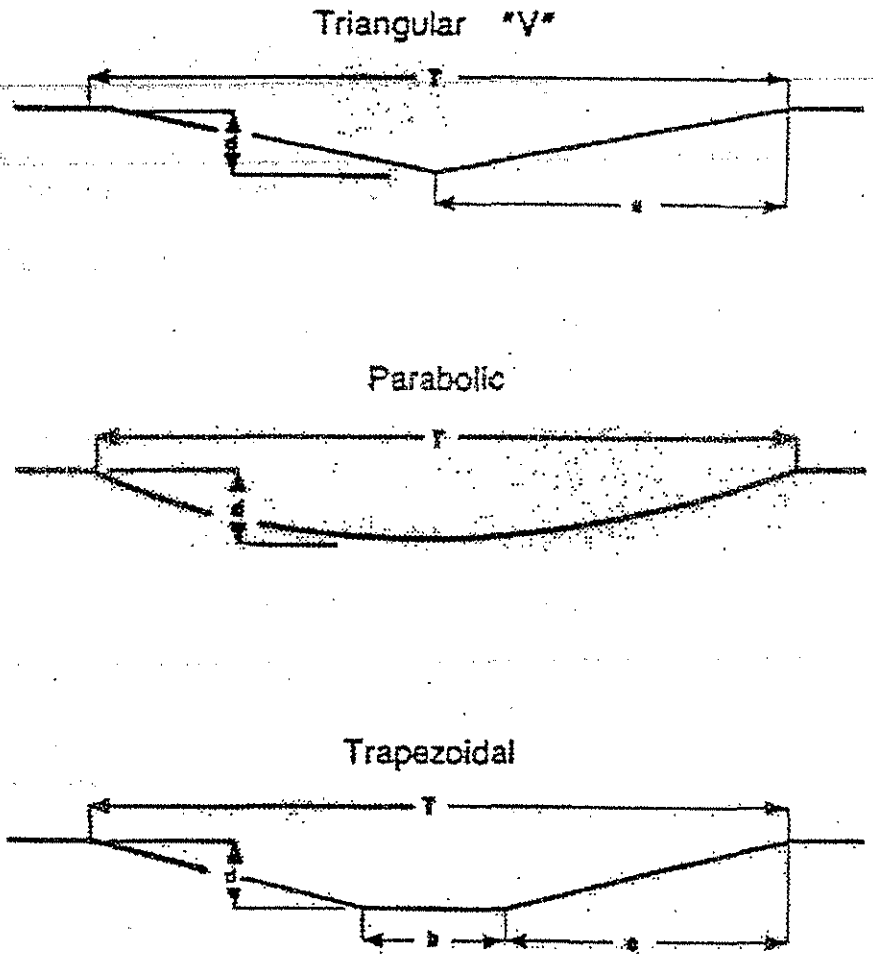


Figure 6.21a Typical channel cross-sections

Channel outlets must be stable. Where channel improvements end, the exit velocity for the design flow must be non-erosive for the existing field conditions. Stability beyond the property boundary must always be considered (Practice 6.24, *Outlet Stabilization Structure*).

Design Criteria

Grass-lined channels should carry peak runoff from the design recurrence storm without eroding. Where flood hazard exists, increase the capacity according to the potential damage.

Examine the design water surface or hydraulic grade line if the channel system becomes complex. Provide reasonable freeboard.

Grassed channel side slopes are generally constructed at 3:1 or flatter to aid in the establishment of vegetation and for maintenance. Side slopes of V-shaped channels are usually constructed 6:1 or flatter along roadways for safety.

Channel slopes should be either uniform or gradually increasing to avoid sedimentation. Where the grade is excessive, grade stabilization structures may be required.

The outlets of all channels should be evaluated for carrying capacity and stability. Exit velocities should be reviewed to control erosion (Practice 6.24, *Outlet Stabilization Structure*). Sediment controls must also be reviewed (Practice 6.60, Temporary Sediment Trap).

Construction Specifications

1. Remove trees, brush, stumps, and other objectionable material from the channel alignment and dispose of properly.

2. Excavate and shape the channel to the lines, grades, and dimensions shown on the plans.

3. Remove and properly dispose of all excess soil so that surface water may enter the channel freely.

4. Establish grass or groundcover in the channel. Protect the channel with mulch or a temporary liner sufficient to withstand anticipated velocities during the establishment period.

Maintenance

During the establishment period, check grass-lined channels regularly and after every rainfall event. After grass is established, periodically and after every rainfall event check the channel for sedimentation or damage. Remove all significant sediment accumulation and immediately make repairs to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times.

Temporary Slope Drains

Definition A flexible tubing or conduit extending from the top of a slope to the bottom.

Purpose To convey runoff down the face of a cut or fill slope without causing erosion.

Where Applicable Construction areas where storm water runoff above a cut or fill slope will cause erosion if allowed to flow over the slope. Temporary slope drains are generally used in conjunction with diversions to convey runoff down a slope until permanent water disposal measures can be installed.

Planning Considerations There is often a lag between the time a cut or fill slope is graded and the time it is permanently stabilized. During this period, the slope is very vulnerable to erosion, and temporary slope drains together with temporary diversions can provide valuable protection (Practice 6.20, *Temporary Diversions*).

It is important that these temporary structures be sized, installed, and maintained properly. Failure of the system will usually result in severe erosion of the slope. The entrance section to the drain should be well entrenched and stable so that surface water can enter freely. The drain should extend downslope beyond the toe of the slope to a stable area or appropriately stabilized outlet.

Design Criteria Slope drains should carry peak runoff from a 10-year recurrence interval storm event.

Construct the slope drain from heavy-duty, flexible materials such as non-perforated, corrugated plastic pipe or specially designed flexible tubing (Figure 6.22a). Install reinforced, hold-down grommets or stakes to anchor the conduit at intervals not to exceed 10 ft. with the outlet end securely fastened in place. The conduit must extend beyond the toe of the slope.

Construct the entrance to the slope drain with a standard flared-end section of pipe with minimum 6-inch metal toe plate, or other appropriate inlets. Make all fittings watertight.

Use a temporary diversion with a bermed ridge to direct surface runoff into the temporary slope drain. Make the height of the ridge over the drain conduit a minimum of 1.5 ft. and at least 6 inches higher than the adjoining ridge on either side. The lowest point of

the diversion ridge should be a minimum of 1 ft. above the top of the drain so that design flow can freely enter the pipe.

Protect the outlet of the slope drain from erosion (Practice 6.24, *Outlet Stabilization Structure*).

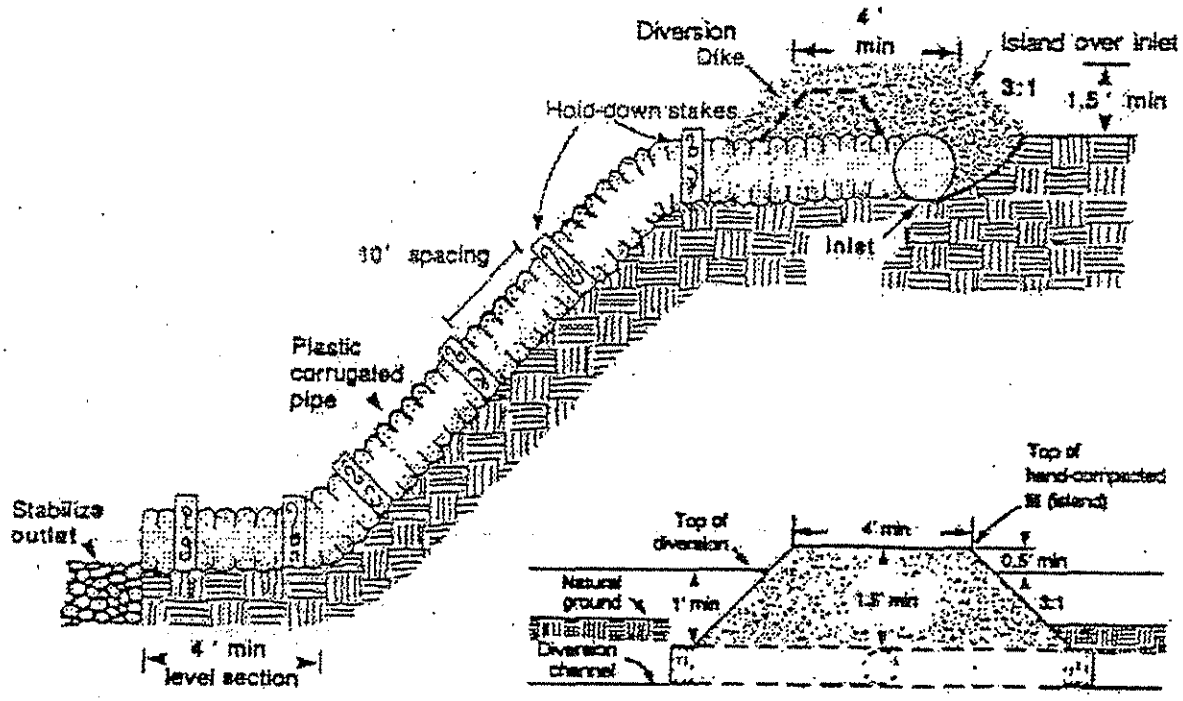


Figure 6.22a Temporary Slope Drain

Construction Specifications

A common failure of slope drains is caused by water saturating the soil and seeping along the pipe. This creates voids from consolidation and causes washouts. Properly backfill around the pipe with stable soil material and hand compact in 6-inch lifts. Ensure firm contact between the pipe and the soil at all points.

1. Place slope drains on undisturbed soil or well compacted fill.

2. Hand tamp the soil under and around the entrance section in lifts not to exceed 6 inches and form the entrance.

3. Ensure that all slope drain connections are watertight.

4. Ensure that all fill material is well-compacted. Securely fasten the exposed section of the drain with grommets or stakes spaced no more than 10 ft. apart.

5. Extend the drain beyond the toe of the slope and protect the outlet from erosion.

6. Compact the berm ridge no less than 1 ft. above the top of the pipe at every point.

7. Immediately stabilize all disturbed areas following construction.

Maintenance Inspect the slope drain and supporting diversion after every rainfall and promptly make necessary repairs. When the protected area has been permanently stabilized, temporary measures may be removed, materials disposed of properly, and all disturbed areas stabilized appropriately.

Level Spreader

Definition

An outlet constructed to disperse concentrated runoff uniformly across a slope.

Purpose

To convert concentrated flow to sheet flow and release it uniformly over a stabilized area.

Where Applicable

Where relatively sediment-free storm runoff can be released in sheet flow down a stabilized slope without causing erosion.

Where the area below the spreader lip is uniform and is stable for the anticipated flow conditions.

Where the runoff water will not re-concentrate after release.

Planning Considerations

The level spreader is a relatively low-cost structure to release small volumes of concentrated flow where site conditions are suitable (Figure 6.23a). The outlet area must be uniform and well-vegetated. Particular care must be taken to construct the outlet lip completely level in a stable, undisturbed, and well vegetated area. Any depressions in the lip will concentrate the flow, resulting in erosion. Evaluate the outlet system to be sure that flow does not concentrate below the outlet. The level spreader is most often used as an outlet for temporary or permanent diversions and diversion dikes. Runoff water containing high sediment loads must be treated in a sediment trapping devices before release in a level spreader.

Design Criteria

Determine the capacity of the spreader by estimating peak flow from the 10-yr storm.

Construct a 20-ft. transition section in the diversion channel so the width of the diversion will smoothly meet the width of the spreader to ensure uniform outflow. Grade the last 20 feet of the diversion channel to provide a smooth transition from channel grade to level at the spreader. The grade of the spreader should be 0%.

Construct a level lip on undisturbed soil to a uniform height and zero grade over the length of the spreader. Protect it with an erosion-resistant matting material to prevent erosion and allow vegetation to become established.

The outlet disposal area must be smooth and well-vegetated.

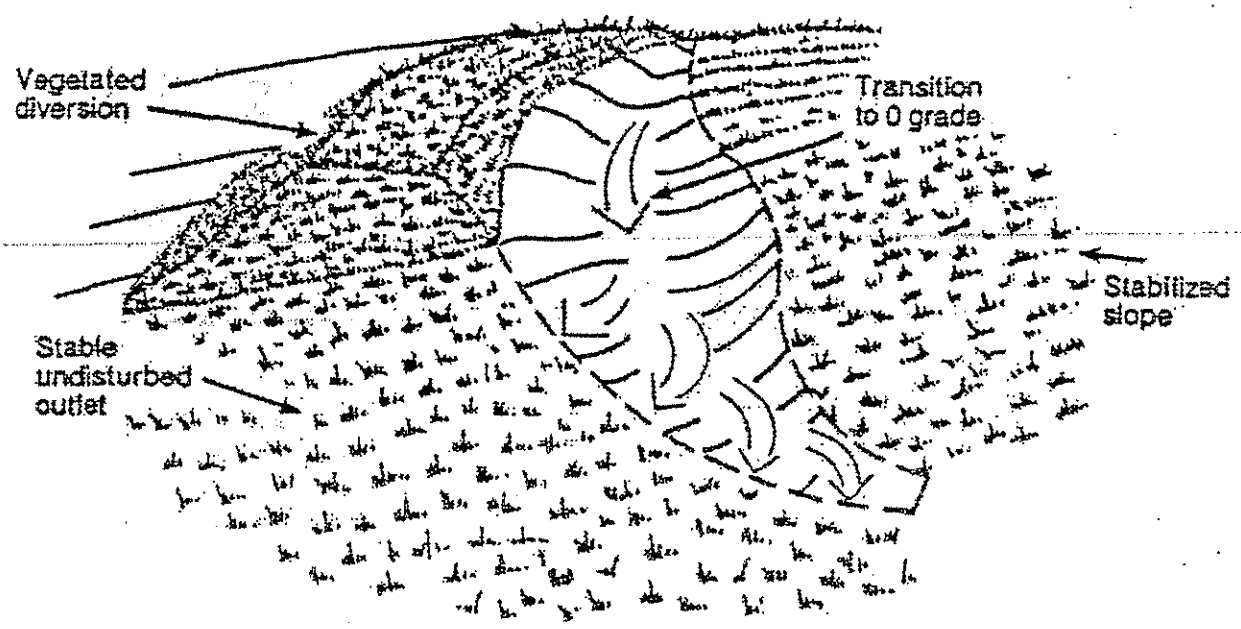


Figure 6.23a Level Spreader

Construction Specifications

1. The matting should be a minimum of 4 ft. wide extending 6 inches over the lip and buried 6 inches deep in a vertical trench on the lower edge. The upper edge should butt against smoothly cut sod and be securely held in place with closely spaced heavy duty wire staples at least 12 inches long.

2. Ensure that the spreader lip is level for uniform spreading of storm runoff.

3. Construct the level spreader on undisturbed soil (not on fill).

4. Construct a 20-ft. transition section from the diversion channel to blend smoothly to the width and depth of the spreader.

5. Disperse runoff from the spreader across a properly stabilized slope not to exceed 10%. Make sure the slope is sufficiently smooth to keep flow from concentrating.

6. Immediately after its construction, appropriately seed and mulch the entire disturbed area of the spreader.

Maintenance

Inspect level spreaders after every rainfall event and promptly make needed repairs. After the area has been stabilized, make periodic inspections and keep vegetation in a healthy, vigorous condition.

Outlet Stabilization Structure

Definition — A structure designed to control erosion at the outlet of a channel or drainpipe.

Purpose — To prevent erosion at the outlet of a channel or drainpipe by reducing the velocity of flow and dissipating the energy.

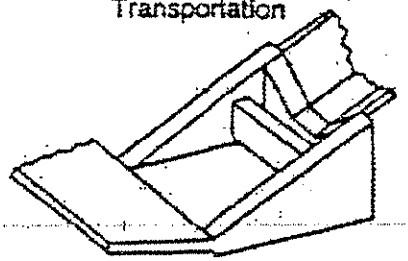
Where Applicable — This practice applies where the discharge velocity of a pipe, box culvert, diversion, open channel, or other water conveyance structure exceeds the permissible velocity of the receiving channel or disposal area.

Planning Considerations — The outlets of channels, conduits, and other structures are points of high erosion potential because they frequently carry flows at velocities that exceed the allowable limit for the area downstream. To prevent scour and undermining, an outlet stabilization structure is needed to absorb the impact of the flow and reduce the velocity to non-erosive levels. A riprap-lined apron is the most commonly used practice for this purpose because of its relatively low cost and ease of installation. The riprap apron should be extended downstream until stable conditions are reached even though this may exceed the length calculated for design velocity control.

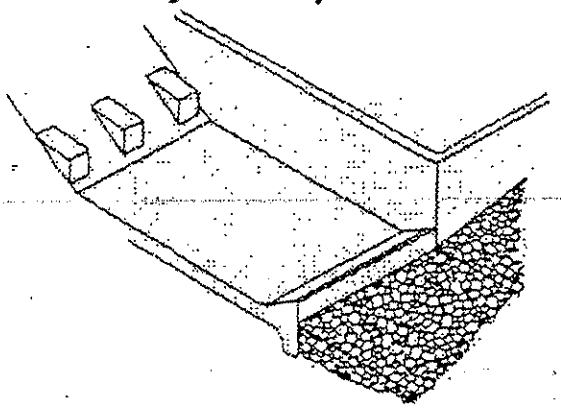
Riprap-stilling basins or plunge pools reduce flow velocity rapidly. They should be considered in lieu of aprons where overfalls exit at the ends of pipes or where high flows would require excessive apron length. Consider other energy dissipators such as concrete impact basins or paved outlet structures where site conditions warrant, (Figure 6.24a).

Design Criteria — 10-year recurrence storm event peak runoff or the design discharge of the water conveyance structure, whichever is greater.

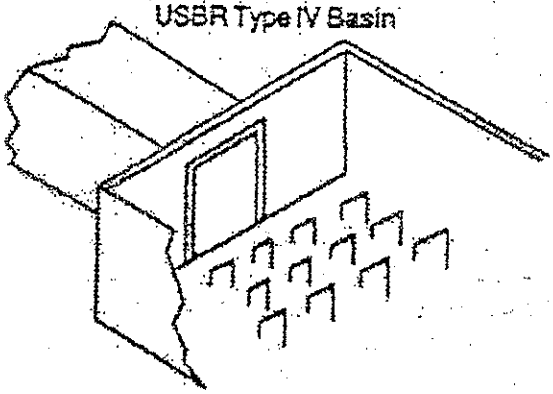
Virginia Department of Highways and Transportation



Colorado State University Rigid Boundary Basin

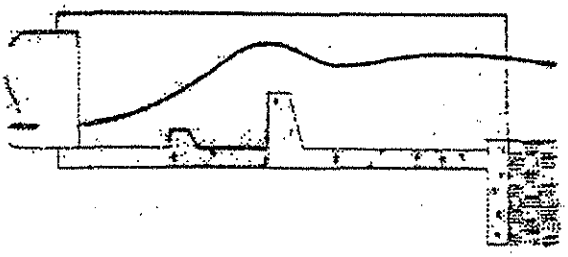


USBR Type IV Basin

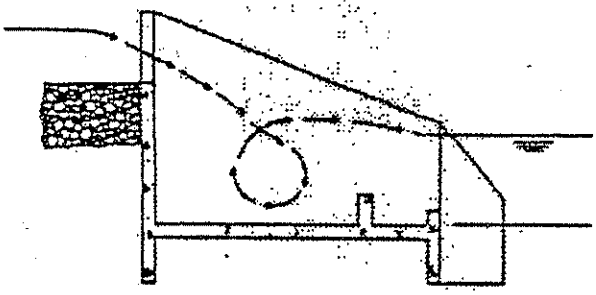


St. Anthony Falls Stilling Basin

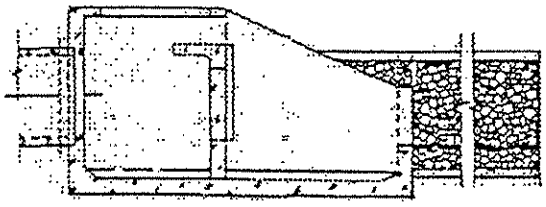
Contra Costa County, Calif.



Straight Drop Spillway Stilling Basin



USBR Type VI Baffle Wall Basin



T-fitting on CMP Outlet

jure 6.24a Energy Dissipation Structures

Determine the depth of tailwater immediately below the pipe outlet based on the design discharge plus other contributing flows. If the tailwater depth is less than half the diameter of the outlet pipe and the receiving stream is sufficiently wide to accept the divergence of flow, it is classed as a minimum tailwater condition. If the tailwater depth is greater than half the pipe diameter, it is classed as maximum tailwater condition. Pipes that outlet onto broad flat areas with no defined channel may be assumed to have a minimum tailwater condition unless site conditions indicate otherwise.

The apron length and width can be determined according to the tailwater condition. If the water conveyance structure discharges directly into a well-defined channel, extend the apron across the channel bottom and up the channel bank to an elevation of 0.5 ft. above the maximum tailwater depth or to the top of the bank, whichever is less (Figure 6.24b)

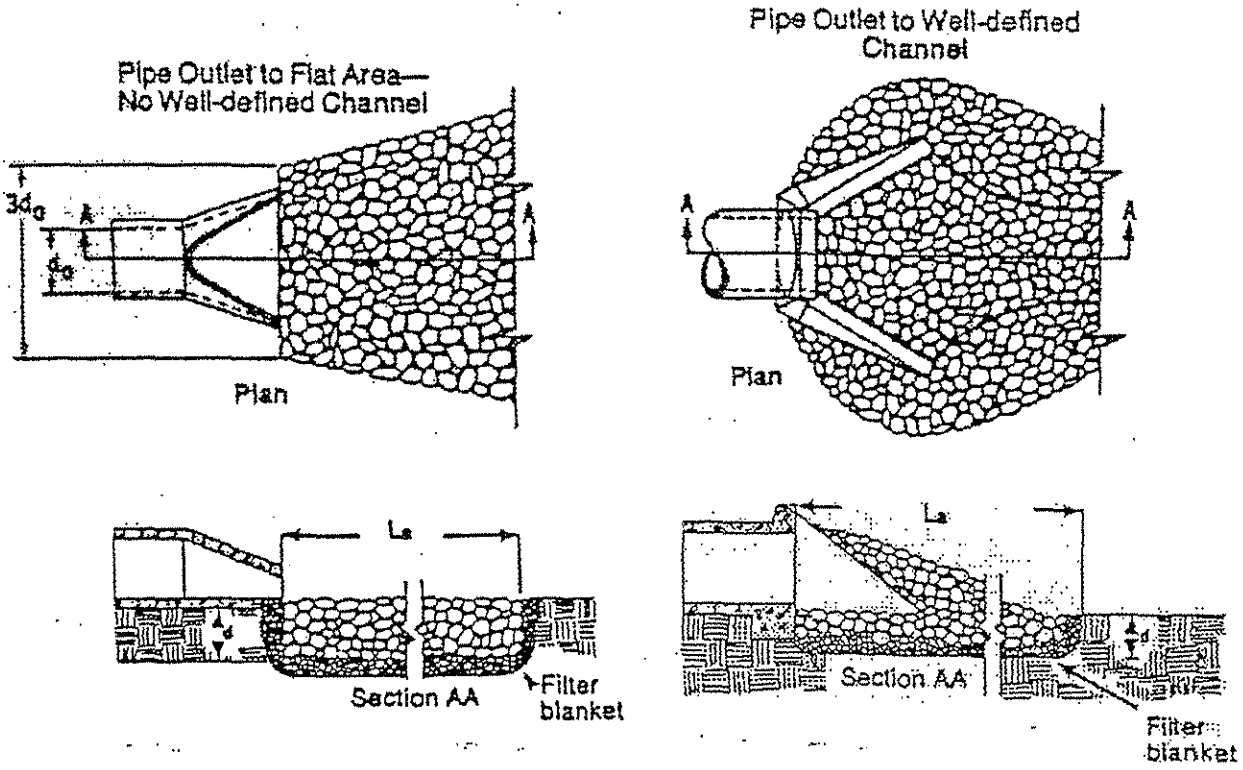


Figure 6.24b Riprap Outlet Protection

Determine the maximum allowable velocity for the receiving stream, and design the riprap apron to reduce flow to this velocity before flow leaves the apron. Calculate the apron length for

velocity control or use the length required to meet stable conditions downstream, whichever is greater.

Ensure that the apron has zero grade. There should be no overfall at the end of the apron; that is, the elevation of the top of the riprap at the downstream end should be the same as the elevation of the bottom of the receiving channel or the adjacent ground if there is no channel.

The apron should be straight throughout its entire length, but if a curve is necessary to align the apron with the receiving stream, locate the curve in the upstream section of riprap.

The riprap shall consists of a well-graded mixture of stone. Larger stone should predominate, with sufficient smaller sizes to fill the voids between the stones.

The minimum thickness of riprap shall be 1.5 times the maximum stone diameter or 6", whichever is thicker.

Select quality stones for riprap from field stone or quarry stone. The stone should be hard, angular, and highly weather-resistant.

Install a filter to prevent soil movement through the openings in the riprap. The filter should consist of a graded gravel layer or a synthetic filter cloth.

Construction Specifications

1. Ensure that the subgrade for the filter and riprap follows the required lines and grades shown in the plan. Compact any fill required in the subgrade to the density of the surrounding undisturbed material. Low areas in the subgrade on undisturbed soil may also be filled by increasing the riprap thickness.

2. The riprap and gravel filter must conform to the specified grading limits shown on the plans.

3. Filter cloth, when used, must meet design requirements and be properly protected from punching or tearing during installation. Repair any damage by removing the riprap and placing another piece of filter cloth over the damaged area. All connecting joints should overlap a minimum of 1 foot. If the damage is extensive, replace the entire filter cloth.

4. Riprap may be placed by equipment, but take care to avoid damaging the filter.

5. The minimum thickness of the riprap should be 1.5 times the maximum stone diameter, or 6".

6. Riprap may be field stone or rough quarry stone. It should be hard, angular, highly weather-resistant and well graded.

7. Construct the apron on zero grade with no overfall at the end. Make the top of the riprap at the downstream end level with the receiving area or slightly below it.

8. Ensure that the apron is properly aligned with the receiving stream and preferably straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.

Maintenance

Inspect outlet structures after heavy rains to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.

Mats, Nets and Blankets

Definition

Mats, Nets and Blankets, collectively Mattings, are made of natural or synthetic material which are used to temporarily or permanently stabilize soil.

Purpose

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

Where Applicable

Mattings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks where moving water at velocities between 3 fps and 6 fps is likely to wash out 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 (i.e., late season construction and/or the arrival of an early rain season).

Planning Consideration

Erosion control matting should be considered when the soils are fine grained and permanently erosive.

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. Mattings strengths and uses vary, therefore, manufacturer's specifications must be followed. Proper installation of mattings is critical in order to obtain firm continuous contact with the soil.

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 to some geotextiles. Matting strengths and uses vary; the manufacturer's specifications should be followed.

Construction Specifications

The following natural or synthetic mattings are 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 wrap ends per width of cloth and 41 wrap ends per linear yard of cloth. The yarn should be of a loosely twisted construction having an average twist of not less than 1.6 turns per inch and shall not vary in thickness by more than its normal diameter.

Straw Mat – should be a machine produced mat consisting of 70% (±3%) agricultural straw and 30% (±3%) coconut fiber. The blanket should be 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 (10) 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, with a 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 matting should be installed according to the manufacturer's recommendations.

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

Planting: Fertilize and seed in accordance with seeding specifications or other types of landscaping plants. 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 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.

Maintenance Inspect mats, nets and blankets monthly and after each rainfall event. Re-anchor loosened matting and replace missing matting and staples as required.

Mulching

Definition

Mulching is used for temporary and permanent stabilization of cleared or freshly seeded areas. Types of mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite, and gravel.

Purpose

Mulching protects the soil from rainfall impact; increases infiltration; conserves moisture around trees, shrubs and seedings; prevents compaction and cracking of soil; and aids plant growth for seedings and plantings by holding the seeds, fertilizers and topsoil in place until growth occurs.

Where Applicable

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

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

Planning Consideration

A surface mulch is the most effective, practical means of controlling runoff and erosion on disturbed land prior to vegetation establishment. Mulch reduces soil moisture loss by evaporation, reduces the impact force of falling rain, prevents crusting and sealing of the soil surface, provides a suitable microclimate for seed germination, and may increase the infiltration rate of soils.

Organic mulches have been found to be the most effective, however, materials which may be sources of unwanted weeds and grasses should be avoided. Decomposition of some wood products can tie up significant amounts of soil nitrogen making it necessary to modify fertilization rates.

Recently developed mats and fabrics are suitable forms of mulch, particularly in critical areas such as waterways and channels. Various forms of netting materials are also available to anchor organic mulches. Chemical soil stabilizers or soil binders may also provide suitable mulch properties, and are particularly effective when combined with other mulching materials.

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.

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.

Construction Specifications

Areas to be mulched should be fairly smooth and free of small rills. The mulch material must completely and evenly cover the ground area. Organic mulch should be a minimum of 2-inches thick.

Where mulch is used to establish vegetation, an adequate fertility level should be maintained. A rule of thumb is 25 pounds of available nitrogen per ton of mulch to meet the extra nitrogen required during decomposition of the mulch material.

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.

A variety of nettings or mats or organic or non-organic materials and chemical sod stabilization are practices that may be used in conjunction with mulching.

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. When used as a tackifier with straw mulch, wood fiber mulches are good for steep slopes and severe climates.

Wood fiber mulch is 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.

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 (25 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.

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 2½ tons of straw mulch per acre should be applied if the mulch is anchored by crimping.
- Tacking: The mulch is bound by using a binder either independently or followed by crimping. If tacked, straw mulch may be applied at a rate of 1-3/4 tons per acre, and tacked with emulsified asphalt at a rate of 500 gallons per acre.

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, waterways or groundwater via discharge runoff.

Mats and Nets: Netting is very effective in holding mulch in place on waterways and slopes before grass establishment. Mats promote seeding growth in the same way as organic mulches and are very effective in establishing grass in channels and waterways.

When installing nets and mats, it is critical to obtain a firm, continuous contact between the material and the soil. Without such contact, nets and mats are useless and erosion will occur under the material.

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.

Preservation of Existing Vegetation

Definition

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.

Purpose

Existing vegetation to be preserved on 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.

Where Applicable

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

Planning Consideration

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.

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

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.

Construction Specifications

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.

- Clearly mark, flag or fence vegetation or areas where vegetation should be preserved.
- Prepare landscaping plans which include as much of the existing vegetation as possible and state proper care of this vegetation before, during and after construction.
- Define with berms, fencing, signs, etc., a protective 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 should 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.

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.

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.

Protection of Stockpiles

Definition	Carefully planned placement and protection of stockpiles minimizes the potential for wind and rain erosion, and reduces the potential for fugitive dust problems.
Purpose	Stockpiles are for the temporary storage of material only.
Where Applicable	Stockpiles of gravel or topsoil within roadway areas. Stockpiles of excavated material to be moved to off-site locations. Stockpiles of imported materials prior to installation. Stockpiles for surcharging soil to stabilize or consolidate an area.
Planning Consideration	Provisions should be made for the permanent movement of stockpiled materials. Failure to contain stockpiled material may cause erosion or flood damage to downstream properties, or fugitive dust problems to downwind properties.
Construction Specifications	Provide adequate setback from waterways and adjoining properties. Provide earth dikes or other diversion to keep runoff away from stockpiles. Provide silt fences at the toe of the stockpile to mitigate runoff during rain events. Cover, grass or provide other stabilization measures over the stockpile. Provide silt basins where required.
Maintenance	Inspect the stockpile and surrounding areas periodically and after every significant rainfall event. Repair protective measures as necessary.

Construction Road Stabilization

Definition

The stabilization of temporary construction access routes, on-site vehicle transportation routes, and construction parking areas.

Purpose

To control erosion on temporary construction routes and parking areas.

Where Applicable

All traffic routes and parking areas for temporary use by construction traffic.

Planning Considerations

Improperly planned and maintained construction roads can become a continual erosion problem. Excess runoff from roads causes erosion in adjacent areas, and an un-stabilized road may become a dust problem. Construction vehicle traffic routes are especially susceptible to erosion because they become compacted and collect and convey runoff water along their surfaces. Rills, gullies, and troublesome muddy areas form unless the road is stabilized.

During wet weather, un-stabilized dirt roads may become so muddy they are virtually unusable, generating sediment and causing work interruption. Proper grading and stabilization of construction routes often saves money for the contractor by improving the overall efficiency of the construction operation while reducing the erosion problem.

Situate construction roads to reduce erosion potential, following the natural contour of the terrain. Avoid steep slopes, wet or rocky areas, and highly erosive soils.

Controlling surface runoff from the road surface and adjoining areas is a key erosion control consideration. Generally locate construction roads in areas where seasonally high water tables are deeper than 18 inches, otherwise subsurface drainage may be necessary. Avoid stream crossings and drainageways if possible.

When practical, install permanent paved roads and parking areas and use them for construction traffic early during the construction operation to minimize site disruption.

Design Criteria

A maximum road grade of 10% to 12% is recommended, although grades up to 15% are possible for short distances.

Road widths of 14 feet minimum for one-way traffic and 20 feet minimum for two-way traffic are recommended.

Side slope of road embankment should be 2:1 or flatter.

Construction Specifications

1. Clear roadbed and parking areas of objectionable material.

2. Ensure that road construction follows the natural contours of the terrain, if possible.

3. Locate parking areas on naturally flat areas if they are available. Keep grades sufficient for drainage but generally not more than 2 to 3%.

4. Provide surface drainage, and divert excess runoff to stable areas.

5. Keep cuts and fills at 2:1 or flatter for safety and stability and to facilitate establishment of vegetation and maintenance.

6. Spread a 6-inch course of crushed stone evenly over the full width of the road or parking area and smooth to avoid depressions.

7. Where seepage areas or seasonally wet areas must be crossed, install subsurface drains or geotextile fabric cloth before placing the crushed stone.

8. Vegetate all roadside ditches, cuts, fills, and other disturbed areas or otherwise appropriately stabilize as soon as grading is complete.

9. Provide appropriate sediment control measures to prevent off-site sedimentation.

Maintenance

Inspect construction roads and parking areas periodically for condition of surface. Add new gravel as needed. Check road ditches and other seeded areas for erosion and sedimentation weekly and after each rainfall event. Maintain all vegetation in a healthy, vigorous condition. Sediment-producing areas should be treated immediately.

Temporary Excavated Drop Inlet Protection

Definition

An excavated area in the approach to a storm drain inlet.

Purpose

To trap sediment at the approach to the storm drainage system. This practice allows the use of permanent storm water collection and conveyance systems at an early stage of site development.

Where Applicable

Where storm drain drop inlets are to be made operational before permanent stabilization of the disturbed drainage area. This method of inlet protection is applicable where relatively heavy flows are expected and overflow capability is needed (Figure 6.50a). Frequent maintenance is required and temporary flooding in the excavated area will occur. This practice can be used with other temporary inlet protection devices such as Practice 6.51, *Fabric Drop Inlet Protection* and Practice 6.52, *Block and Gravel Inlet Protection.*

Design Criteria

Provide a minimum depth of 1 foot and a maximum depth of 2 feet below the top of the inlet.

Maintain side slopes around the excavation no steeper than 2:1.

Keep the minimum volume of excavated area around the drop inlet at approximately 35 cu. yds. per acre of disturbed drainage area.

Shape the basin to fit site conditions, with the longest dimension oriented toward the longest inflow area to provide maximum trap efficiency.

Provide weep holes for draining the temporary pool to improve trapping efficiency for small rainfall events and to avoid problems from standing water after heavy rains.

Construction Specifications

1. Clear the area of all debris that might hinder excavation and disposal of spoil.

2. Grade the approach to the inlet uniformly to direct surface runoff.

3. Protect weep holes by grading gravel or using filter fabric.

4. When the contributing drainage area has been permanently stabilized, seal weep holes, fill the basin with stable soil to finish grade elevations, compact properly, and stabilize.

Maintenance Inspect, clean, and properly maintain the excavated basin after every storm event until the contributing drainage area has been permanently stabilized. To provide satisfactory basin efficiency, remove sediment when the volume of the basin as been reduced by one-half. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize it appropriately.

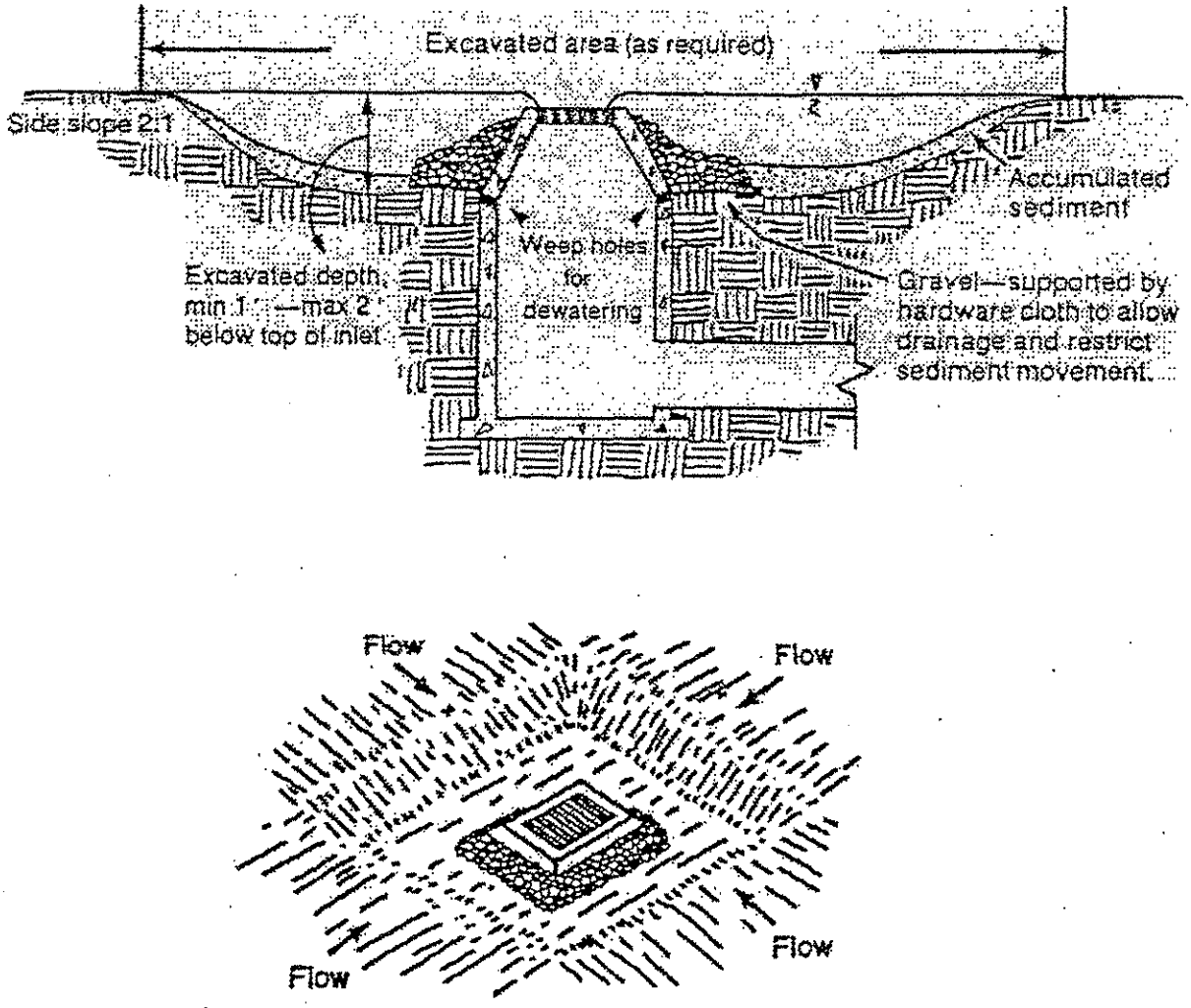


Figure 6.50a Excavated drop inlet protection

Concrete Waste Management

Definition

Management of excess concrete disposal and concrete wash waste.

Purpose

To prevent or reduce the discharge of pollutants to storm water systems and drainageways from concrete waste by conducting washout off-site, performing on-site washout in designated areas, and training employees and subcontractors.

Where Applicable

For on-site washout:

- Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Construct a temporary pit or bermed area large enough to contain liquid and solid waste;
- Washout wastes into the temporary pit where the concrete can set, be broken up, and then disposed of properly.

Planning Consideration

Suitable locations for off-site washout of concrete wastes may not always be available. Designated and properly prepared onsite locations prevent illegal disposal.

Construction Specifications

Perform washout of concrete trucks off site or in designated onsite areas only. Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.

When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water to a contained bermed or level area.

Train employees and subcontractors in proper concrete waste management.

Maintenance

Inspect subcontractors to ensure that concrete wastes are being properly managed.

If using a temporary pit, dispose of hardened concrete on a regular basis.

Do not hose out dumpsters on the construction site. Leave dumpster cleaning to trash hauling contractor. If a container does spill, clean up immediately.

Maintenance Collect site trash daily.

Inspect construction waste and recycle areas regularly for signs of contamination. Arrange for regular recyclable and waste collection.

Vehicle Fuel and Maintenance Management

Definition — Offsite or onsite fueling and maintenance of construction equipment and vehicles.

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

Where Applicable — Utilize off-site facilities whenever practical, or perform work in designated onsite areas only.

Fueling Consideration — Utilize off-site fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at your site.

If fueling equipment and vehicles onsite is required, fuel vehicles and equipment outdoors and in areas where fuel will not spill or leak onto paved surfaces or into drainageways. Discourage "topping-off" of fuel tanks.

Always use secondary containment, such as a drain pan or drop cloth, when fueling to catch spills/leaks. Place a stockpile of spill cleanup materials where it will be readily accessible in the event of a spill. Use absorbent materials promptly and dispose of properly.

Carry out all Federal and State requirements regarding stationary above ground storage tanks. Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas.

Train employees and subcontractors in proper fueling and cleanup procedures.

Segregate and recycle wastes, such as greases, used oil or oil filters, anti-freeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids.

Maintenance Considerations — Keep vehicles and equipment clean, don't allow excessive build-up of oil and grease. Regularly inspect on-site vehicles and equipment for leaks, and repair immediately. Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids.

Use off-site repair shops as much as possible. If maintenance must occur on-site, use designated areas, located away from drainage courses, to prevent the runon of storm water and the runoff of spills.

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

Waste Reduction Parts are often cleaned using solvents. Many of these parts cleaners are harmful and must be disposed of as a hazardous waste. If possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials.

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

Oil filters disposed of in trash cans or dumpsters can leak oil and contaminate storm water. Drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.

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

Store cracked batteries in a non-leaking secondary container. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Do not bury used tires.

Temporary Fabric Drop Inlet Protection

Definition A temporary fabric barrier placed around a drop inlet.

Purpose To help prevent sediment from entering storm drains during construction operations allowing the early use of the permanent storm drain system.

Where Applicable Where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. This method of inlet protection is effective where the inlet drains a small area. The immediate land area around the inlet should be relatively flat and located so accumulated sediment can be easily removed.

Design Criteria The maximum height of fabric above the crest of the drop inlet shall not exceed 1.5 feet. This height allows a shallow temporary desilting pool to form behind the fabric but limits the pressure against the fabric if overtopping occurs. The selected height of the top of the barrier should allow overflow into the drop inlet and not let overflow bypass the inlet to unprotected lower areas.

Use minimum 3 foot long stakes and space them a maximum of 3 feet apart. Securely drive them into the ground close to the drop inlet so that overflow will fall directly into the structure and not on unprotected soil.

Construct a frame around the stakes to attach the fabric. Ensure both fabric and supporting stakes are sufficiently strong to hold a 1.5 foot head of water without failure (Figure 6.51a).

Improve performance and sediment storage volume by excavating the area around the drop inlet (Practice 6.50, *Excavated Drop Inlet Protection*).

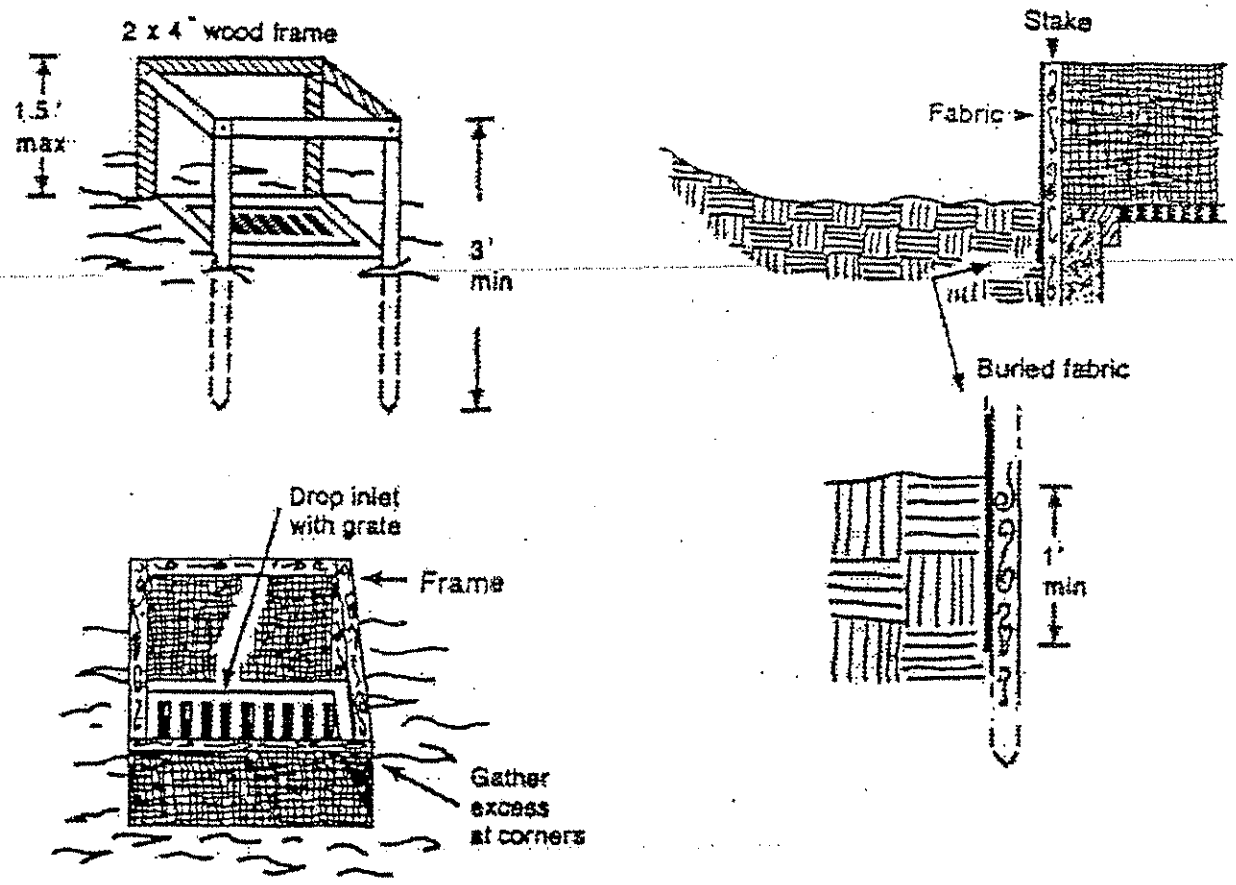


Figure 6.51a Fabric and supporting frame for inlet protection

Construction Specifications

1. Use a pervious sheet of nylon, polyester, or ethylene yarn-extra strength (50 lb./1 inch minimum) that contains ultraviolet ray inhibitors and stabilizers. Fabric should be sufficiently porous to provide adequate drainage of the temporary sediment pool. Burlap may be used for short-term applications, however, it must be replaced every 60 days.

2. Cut fabric from a continuous roll to eliminate joints.

3. Use 2 x 4-inch wooden stakes or equivalent metal stakes.

4. Space stakes evenly around the perimeter of the inlet a maximum of 3 ft. apart, and securely drive them into the ground.

5. Frame a crest with 2 x 4-inch lumber at a maximum of 1.5 feet above the drop inlet for stability.

6. Place the bottom 12 inches of the fabric in a trench and backfill the trench with at least 4 inches of crushed stone or 12 inches of compacted soil.

7. Fasten fabric securely to the stakes and frame. Joints must be overlapped to the next stake.

8. The top of the frame and fabric must be well below the ground elevation down slope from the drop inlet to keep runoff from bypassing the inlet. It may be necessary to build a temporary dike on the down slope side of the structure to prevent bypass flow. Material from within the sediment pool may be used for diking.

Maintenance

Inspect the fabric barrier weekly and after each rainfall event and make repairs as needed.

Remove sediment from the pool area as necessary to provide adequate storage volume for the next rain. Do not damage or undercut the fabric during sediment removal.

When the contributing drainage area has been adequately stabilized, remove all materials and any unstable sediment and dispose of them properly. Bring the disturbed area to the desired finish grade, and appropriately stabilize all bare areas around the inlet.

Temporary Block and Gravel Inlet Protection

Definition A sediment control barrier formed around a storm drain inlet with standard concrete block and gravel.

Purpose To help prevent sediment from entering storm drains before stabilizing the contributing area allowing the early use of the storm drain system.

Where Applicable Where storm drain inlets are made operational before permanent stabilization of the disturbed drainage area. This method of inlet protection applies to both drop inlets and curb inlets where heavy flows are expected and an overflow capacity is necessary to prevent excessive ponding around the structure. Shallow temporary flooding after rainfall should be expected.

This practice must not be used near the edge of fill material and must not divert water away from the storm drain.

Design Criteria Allow access for frequent removal and adequate disposal of accumulated sediment.

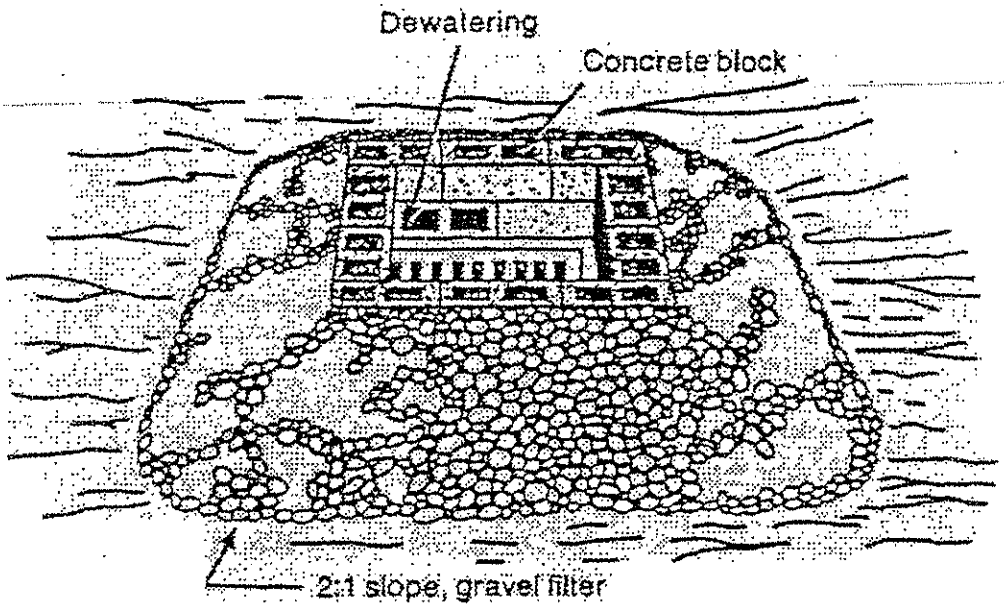
Keep the height of the barrier at least 12 inches and no greater than 24 inches. Limit the height to prevent excessive ponding and bypass flow. Do not use mortar.

Bury the first course of blocks at least 2 inches below the crest opening of the storm drain for lateral support. Support subsequent courses laterally if needed by placing a 2 x 4-inch wood stud through the block openings. Lay a few blocks on their side in the bottom row for dewatering the pool (figure 6.52a).

Place gravel just below the top of the blocks on slopes of 2:1 or flatter. Place hardware cloth, comparable wire mesh with ½-inch openings, or porous filter fabric over all block openings to hold gravel in place.

An alternative design is to construct the entire structure of gravel and stone eliminating the concrete blocks. A structure made entirely of stone is commonly called a "gravel doughnut." In this case, keep the stone slope toward the inlet at 3:1 or flatter to help prevent stone from being washed into the drop inlet (Figure 6.52b). A minimum 1-foot wide level area set 4 inches below the drop inlet crest will add further protection against the entrance of material. Stone on the slope toward the inlet should be 3 inches or larger for stability, and 1 inch or smaller on the slope away from

the inlet to control flow rate. Wire mesh may be placed over the drain grating for debris protection but must be inspected frequently to avoid blockage by trash.



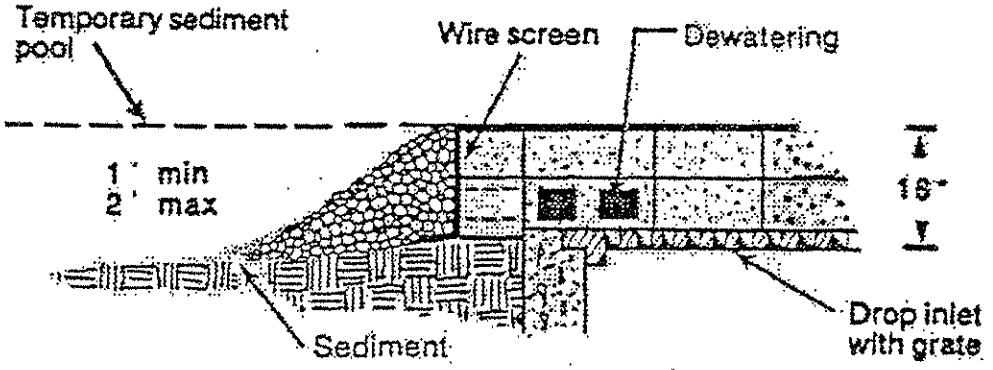


Figure 6.52a Block and Gravel Inlet Protection

The top elevation of the structure must be at least 6 inches lower than the ground elevation down slope from the inlet. It is important that all storm flows pass over the structure and into the storm drain and not past the structure. Temporary berms below the structure may be necessary to prevent bypass flow. Material may be excavated from inside the sediment pool for this purpose.

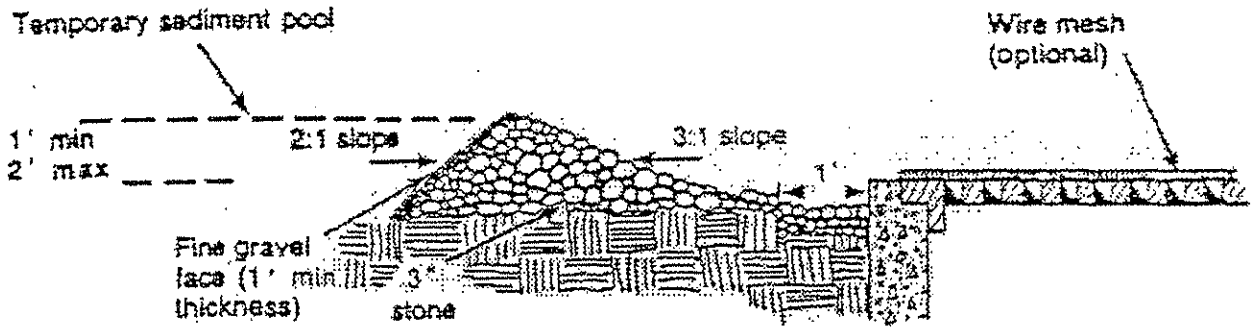


Figure 6.52b Gravel Donut Protection

Construction Specifications

1. Lay one block on each side of the structure on its side in the bottom row to allow pool drainage. The foundation should be excavated at least 2 inches below the crest of the storm drain. Place the bottom row of blocks against the edge of the storm drain for lateral support and to avoid washouts when overflow occurs. If needed, give lateral support to subsequent rows by placing 2 x 4-inch wood studs through block openings.

2. Carefully fit hardware cloth, comparable wire mesh with ½-inch openings or filter fabric over all block openings to hold gravel in place.

3. Use clean gravel, ½-inch to ¾-inch in diameter, placed 2 inches below the top of the block on a 2:1 slope or flatter and smooth it to an even grade.

4. If only stone and gravel are used, keep the slope toward the inlet no steeper than 3:1. Leave a minimum 1-ft. wide level stone area between the structure and around the inlet to prevent gravel from entering inlet. On the slope toward the inlet, use stone 3 inches in diameter or larger. On the slope away from the inlet use ½-inch to ¾-inch gravel at a minimum thickness of 1 ft.

Maintenance

Inspect the barrier weekly and after each rainfall event, and make repairs as needed.

Remove sediment as necessary to provide adequate storage volume and filtration for subsequent rains.

When the contributing drainage area has been adequately stabilized, remove all materials and any unstable soil, and either salvage or dispose of it properly. Bring the disturbed area to proper finish grade and appropriately stabilize all bare areas around the inlet.

Sod Drop Inlet Protection

Definition An early application of an established permanent grass sod filter area around a storm drain drop inlet.

Purpose To limit sediment from entering storm drainage systems as a permanent protection measure.

Where Applicable Where the drainage area of the drop inlet has been permanently seeded and mulched, and the immediate surrounding area is to remain in dense vegetation.

Design Criteria Place sod to form a turf mat completely covering the soil surface for a minimum distance of 4 feet from each side of the drop inlet where runoff will enter.

Maintain the slope of the sodded area no greater than 4:1.

Construction Specifications

1. Bring the area to be sodded to finish grade with top soil.
2. Lay all sod strips perpendicular to the direction of flow.
3. Keep the width of the sod at least 4 ft. in the direction of flows.
4. Stagger sod strips so that adjacent strip ends are not aligned.

Maintenance Water sod often to encourage and establish growth.

Maintain grass height at least 2 inches.

Apply fertilizer as necessary to maintain the desired growth and sod density.

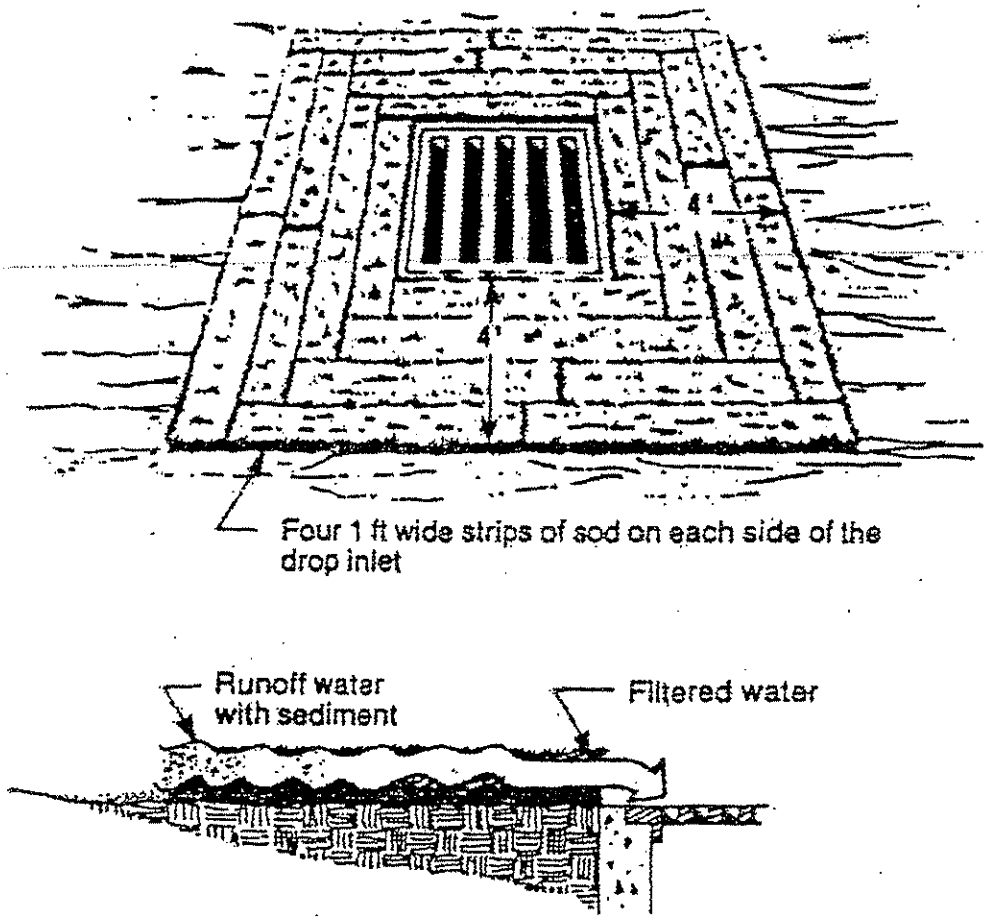


Figure 6.53a Sod Drop Inlet Protection

Temporary Sediment Trap

Definition

A small, temporary ponding basin formed by an embankment or excavation to capture sediment.

Purpose

To detain sediment-laden runoff and trap the sediment to protect receiving streams, lakes, drainage systems, or adjacent properties.

Where Applicable

At the outlets of diversions, channels, slope drains, or other runoff conveyances that discharge sediment-laden water.

Where access can be maintained for sediment removal and proper disposal.

At the approach to storm water inlets as part of an inlet protection system.

Structure life limited to 2 years.

Planning Considerations

Select locations for sediment traps during site evaluation. Note natural drainage divides and select trap sites so that runoff from potential sediment-producing areas can be easily diverted into the traps.

Make traps readily accessible for periodic sediment removal and other necessary maintenance. Plan locations for sediment disposal as part of trap site selection. Clearly designate all disposal areas on the plans.

In preparing plans for sediment traps, it is important to consider provisions to protect the embankment from failure from storm runoff that exceeds the design capacity. Consider non-erosive emergency bypass areas, particularly if there could be severe consequences from failure. If a bypass is not possible and failure would have severe consequences, consider alternative sites.

Sediment trapping is achieved primarily by settling within a pool formed by an embankment. The sediment pool may also be formed by excavation, or by a combination of excavation and embankment. Sediment-trapping efficiency is a function of surface area and inflow rate (Practice 6.61, *Sediment Basin*). Therefore, it is prudent to maximize the surface area in the design. Installations that provide pools with large length to width ratios reduce short circuiting and allow more of the pool surface area for settling. This optimizes efficiency.

Because well-planned sediment traps are key measures to preventing off-site sedimentation, they should be installed in the first stages of project development.

Design Criteria

Ensure drainage area for a sedimentation trap does not exceed 5 acres.

Storage capacity-Keep the minimum volume of the sediment trap at 1800 cu. ft./acre based on disturbed area draining into the basin. Measure volume below the crest elevation of the outlet. The volume of a natural sediment trap may be satisfactorily approximated by the equation:

$$\text{volume (cu. ft.)} = 0.4 \times \text{surface area (sq. ft.)} \times \text{maximum pool depth (ft.)}$$

Trap cleanout-Remove sediment from the trap and restore the capacity to original trap dimensions when sediment has accumulated to one-half the design depth.

Trap efficiency-Keep the surface area at peak flow as large as possible. Research by Barfield and Clar (1985) indicates that use of the following equation will give trap efficiency of 75% for most Coastal Plain and Piedmont soils:

$$\text{Surface area at design flow (acres)} = (0.01)\ \text{peak inflow rate (cfs)}$$

Embankment-Ensure that embankments for temporary sediment traps do not exceed 5 ft. in height measured at the centerline from the original ground surface to the top of the embankment. Additional freeboard may be added to the embankment height to allow flow through a designated bypass location. Construct embankments with a minimum top width of 5 ft. and side slopes of 2:1 or flatter. Machine compact embankments.

Excavation-Where sediment pools are formed or enlarged by excavation, keep side slopes at 2:1 or flatter for safety.

Outlet section-Construct the sediment trap outlet using a stone of embankment located at the low point in the basin. The stone section serves two purposes: (1) the top section serves as a nonerosive spillway outlet for flood flows, and (2) the bottom section provides a means of dewatering the basin between runoff events.

Stone size-Construct the outlet using well-graded stones with a size of 9 inches and a maximum stone size of 14 inches. A 1-ft.

thick layer of ½ - ¾-inch aggregate should be placed on the inside face to reduce drainage flow rate.

Side slopes-Keep the side slopes of the spillway section at 2:1 or flatter. To protect the embankment, keep the sides of the spillway at least 21 inches thick.

Depth-Keep the crest of the spillway outlet a minimum of 1.5 ft. below the settled top of the embankment.

Protection from piping-Place filter cloth on the foundation below the riprap to prevent piping. An alternative would be to excavate a keyway trench across the riprap foundation and up the sides of the height of the dam.

Weir length and depth-Keep the spillway weir at least 4 ft. long and sized to pass the peak discharge of the 10-yr. storm (Figure 6.60a). A maximum flow depth of 1 ft., a minimum freeboard of 0.5 ft., and a maximum side slopes of 2:1 are recommended.

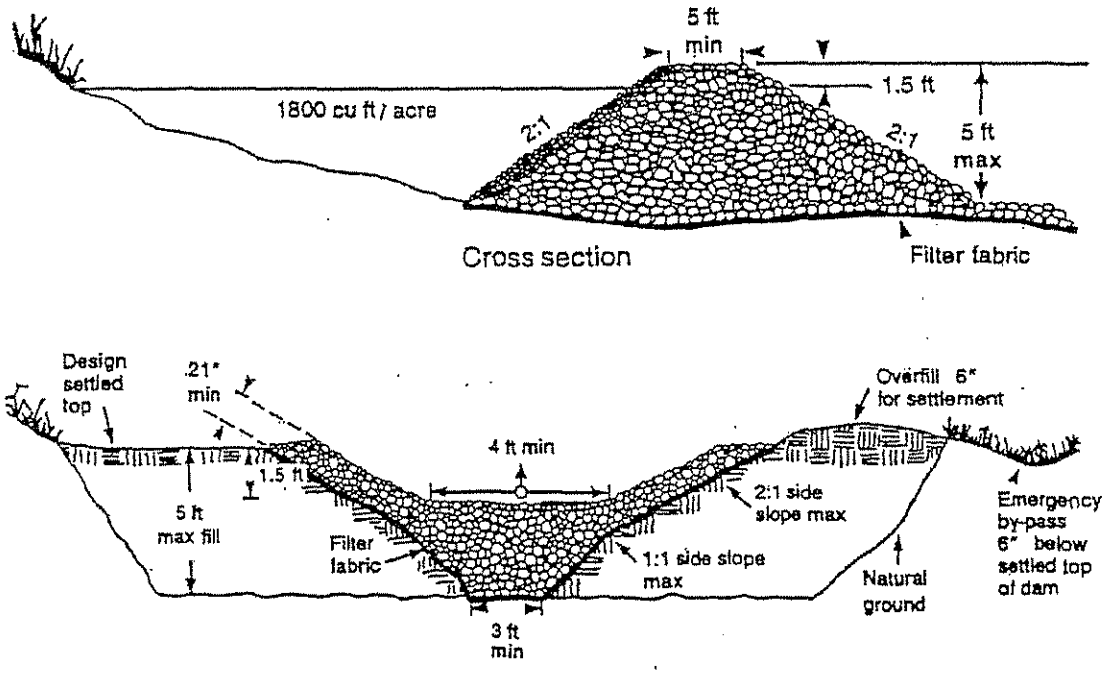


Figure 6.60a Temporary sediment trap

Construction Specifications

1. Clear, grub, and strip the area under the embankment of all vegetation and root mat. Remove all surface soil containing high amounts of organic matter and stockpile or dispose of it properly. Haul all objectionable material to the designated disposal area.

2. Ensure that fill material for the embankment is free of roots, woody vegetation, organic matter, and other objectionable material. Place the fill in lifts not to exceed 9 inches and machine compact it. Over fill the embankment 6 inches to allow for settlement.

3. Construct the outlet section in the embankment. Protect the connection between the riprap and the soil from piping by using filter fabric or a keyway cutoff trench between the riprap structure and the soil.

- Place the filter fabric between the riprap and soil. Extend the fabric across the spillway foundation and sides to the top of the dam; or

- Excavate a keyway trench along the centerline of the spillway foundation extending up the sides to the height of the dam. The trench should be at least 2 ft. deep and 2 ft. wide with 1:1 side slopes.

4. Clear the pond area below the elevation of the crest of the spillway to facilitate sediment cleanout.

5. All cut and fill slopes should be 2:1 or flatter.

6. Ensure that the stone (drainage) section of the embankment has a minimum bottom width of 3 ft. and maximum side slopes of 1:1 that extend to the bottom of the spillway section.

7. Construct the minimum finished stone spillway bottom width, as shown on the plans, with 2:1 side slopes extending to the top of the over filled embankment. Keep the thickness of the sides of the spillway outlet structure at a minimum of 21 inches. The weir must be level and constructed to grade to assure design capacity.

8. Material used in the stone section should be a well-graded mixture of stone with a size of 9 inches and a maximum stone size of 14 inches. The stone may be machine placed and the smaller stones worked into the voids of the larger stones. The stone should be hard, angular, and highly weather-resistant.

9. Ensure that the stone spillway outlet section extends downstream past the toe of the embankment until stable conditions are reached and outlet velocity is acceptable for the receiving stream. Keep the edges of the stone outlet section flush with the surrounding ground and shape the center to confine the outflow stream.

10. Direct emergency bypass to natural, stable areas. Locate bypass outlets so that flow will not damage the embankment.

11. Stabilize the embankment and all disturbed areas above the sediment pool and downstream from the trap immediately after construction.

12. Show the distance from the top of the spillway to the sediment cleanout level (one-half the design depth) on the plans and mark it in the field.

Maintenance

Inspect temporary sediment traps weekly and after each period of significant rainfall. Remove sediment and restore the trap to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment that is removed in the designated disposal area and replace the contaminated part of the gravel facing.

Check the structure for damage from erosion or piping. Periodically check the depth of the spillway to ensure it is a minimum of 1.5 ft. below the low point of the embankment. Immediately fill any settlement of the embankment to slightly above the design grade. Any riprap displaced from the spillway must be replaced immediately.

After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly.

Sediment Basin

Definition An excavation or embankment located to capture sediment.

Purpose To retain sediment on the construction site and prevent sedimentation in off-site streams, lakes, drainageways, or oceans.

Where Applicable This practice applies only to the design and installation of sediment basins where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use of public roads or utilities. Regardless of hazard classification, limit basin structures to a height of 10 feet.

Sediment basins are needed where erosion control measures are not adequate to prevent off-site sedimentation. Specific criteria for installation of a sediment basin are as follows:

- Keep the drainage area less than 10 acres.
- Ensure that the basin location provides a convenient concentration point for sediment-laden flows from the area served.
- Ensure that the basin location allows access for sediment removal and proper disposal under all weather conditions.
- Do not locate sediment basins in perennial streams.

Planning Considerations Select key locations for sediment basins during initial site evaluations. Install basins before any site grading takes place within the drainage area.

Select basin sites to capture sediment from all areas that are not treated adequately by other sediment traps. Always consider access for maintenance cleaning and disposal of the trapped sediment. Locations where a pond can be formed by constructing a low dam across a natural swale are generally preferred to sites that require excavation. If practical, divert sediment-free runoff away from the basin.

Sediment trapping efficiency is primarily a function of sediment particle size and the ratio of basin surface area to inflow rate. Therefore, design the basin to have a large surface area for its volume.

Sediment basins with an expected life greater than 3 years should be designed as permanent structures. In these cases, the structure should be designed by a qualified licensed professional engineer experienced in the design of dams. Permanent ponds and artificial lakes are beyond the scope of this practice standard.

Design Criteria

Limit drainage areas to 10 acres.

Limit embankment heights to 10 ft.

Select basin locations that:

- provide capacity for storage of sediment from as much of the planned disturbed area as practical;
- exclude runoff from undisturbed areas, where practical;
- provide access for sediment removal throughout the life of the project;
- limits interference with construction activities.

Studies indicate that the following relationship between surface area and peak inflow rate gives a trapping efficiency greater than 75% for most sediment:

$$A = 0.01q$$

Where A is basin surface area in acres and q is peak inflow rate in cfs. Area is measured at the crest of the principal spillway.

Ensure that the flow length to basin width ratio is greater than 2:1 to improve trapping efficiency. This basin shape may be attained by the site selection, excavation or installing baffles. Length is measured at the elevation of the principal spillway.

Remove sediment from the basin when approximately one-half of the storage volume has been filled.

The spillway system must carry the peak runoff from the 10-yr. storm with a minimum 1 ft. freeboard in the emergency spillway.

Show the sediment clearout distance when the basin is 50% full. This elevation should be marked in the field on a permanent stake set in the basin.

Keep the minimum barrel size at 8 inches for corrugated metal pipe or 6 inches for smooth wall pipe to facilitate installation and reduce potential for failure from blockage. Ensure that the pipe is

capable of withstanding the maximum external loading without yielding, buckling or cracking. To improve the efficiency of the principal spillway system, make the cross-sectional area of the riser at least 1.5 times that of the barrel.

Many new techniques are available for dewatering sediment basins. A single hole placed just above the sediment cleanout level will dewater the basin slowly and should not interfere with trap efficiency. Perforating the riser with multiple is also acceptable, however, perforated risers that dewater the basin rapidly may interfere with sediment trapping.

The basin may also be dewatered by perforating the lower half of the riser with ½-inch holes with a spacing of approximately 3 inches in each outside valley. Cover the perforated section with 2 ft. of ½ - ¾-inch gravel.

It is important that a suitable trash guard be installed to prevent the dewatering holes from becoming clogged.

- Install a trash guard on the top of the riser to prevent trash and other debris from clogging the conduit. A combination anti-vortex device and trash guard improves the efficiency of the principal spillway and protects against trash intake.

- Secure the riser by an anchor with buoyant weight greater than 1.1 times the water displaced by the riser to protect against flotation.

Construct the entire flow area of the emergency spillway in undisturbed soil (not fill). Make the cross section trapezoidal with side slopes of 3:1 or flatter. Make the control section of the spillway straight and at least 20 ft. long. The inlet portion of the spillway may be curved to improve alignment, but ensure that the outlet section is straight due to supercritical flow in this portion.

The minimum design capacity of the emergency spillway must be the peak rate of runoff from the 10-yr. storm, less any reduction due to flow in the principal spillway. In no case should freeboard of the emergency spillway be less than 1 ft. above the design depth of flow.

Ensure that the velocity of flow discharged from the basin is nonerosive for the existing conditions. When velocities exceed that allowable for the receiving areas, provide outlet protection.

- Excavate a cutoff trench at the centerline of the embankment. Ensure that the trench is in undisturbed soil and extends through the length of the embankment to the

elevation of the riser crest at each end. A minimum of 2 ft. depth is recommended.

Ensure that the minimum difference between the design water elevation in the emergency spillway and the top of the settled embankment is 1 ft.

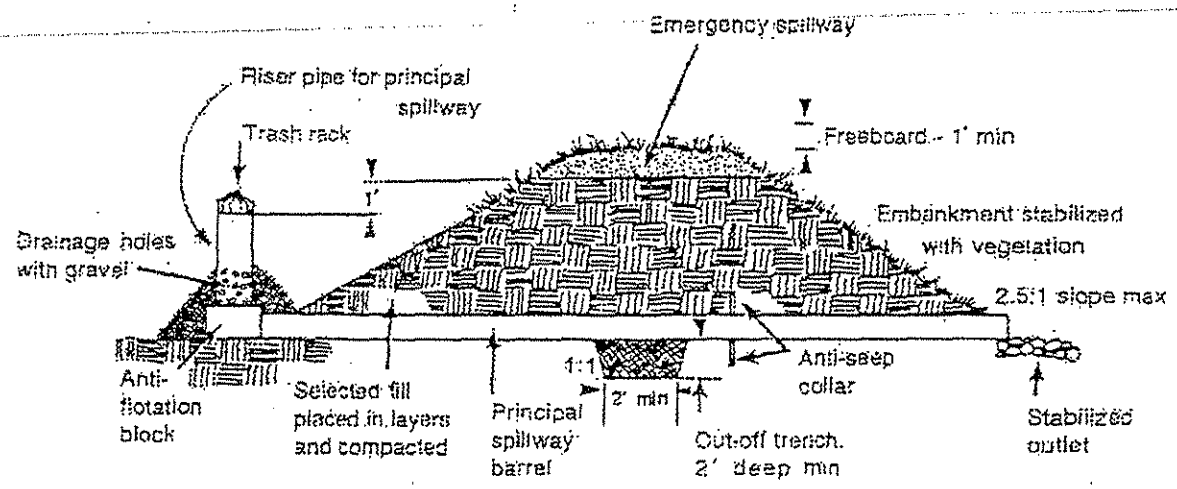


Figure 6.61a Section through embankment and basin controls

Construction Specifications

1. Site preparations - Clear, grub and strip topsoil from areas under the embankment to remove trees, vegetation, roots and other objectionable material. Delay clearing the pool area until the dam is complete and then remove brush, trees and other objectionable materials to facilitate sediment cleanout. Stockpile all topsoil or soil containing organic matter for use on the outer shell of the embankment to facilitate vegetative establishment. Place temporary sediment control measures below the basin as needed.

2. Cut-off trench-Excavate a cut-off trench along the centerline of the earth fill embankment. Cut the trench to stable soil material, but in no case make it less than 2 ft. deep. The cut-off trench must extend into both abutments to at least the elevation of the riser crest. Make the minimum bottom width wide enough to permit operation of excavation and compaction equipment but in no case less than 2 ft. Make side slopes of the trench no steeper than 1:1. Compaction requirements are the same as those for the embankment. Keep the trench dry during backfilling and compaction operations.

3. Embankment-Take fill material from the approved areas shown on the plans. It should be clean mineral soil, free of roots, woody vegetation, rocks and other objectionable material. Scarify areas on which fill is to be placed before placing fill. Place fill

material in 6 to 8-inch continuous layers over the entire length of the fill area and then compact it.

4. Conduit spillway-Securely attach the riser to the barrel or barrel stub to make a watertight structural connection. Secure all connections between barrel sections by approved watertight assemblies. Place the barrel and riser on a firm, smooth foundation of impervious soil. Do not use pervious material such as sand, gravel, or crushed stone as backfill around the pipe or anti-seep collars. Place the fill material around the pipe spillway in 4-inch layers and compact it under and around the pipe to at least the same density as the adjacent embankment. Care must be taken not to raise the pipe from firm contact with its foundation when compacting under the pipe haunches.

5. Emergency spillway - Install the emergency spillway in undisturbed soil. The achievement of planned elevations, grade, design width, and entrance and exit channel slopes are critical to the successful operation of the emergency spillway.

6. Inlets - Discharge water into the basin in a manner to prevent erosion. Use diversions with outlet protection to divert sediment-laden water to the upper end of the pool area to improve basin trap efficiency.

7. Erosion control - Construct the structure so that the disturbed area is minimized. Divert surface water away from the bare areas. Complete the embankment before the area is cleared. Stabilize the emergency spillway embankment and all other disturbed areas above the crest of the principal spillway immediately after construction.

8. Safety - Sediment basins may attract children and can be dangerous. Avoid steep side slopes, and fence and mark basins with warning signs if trespassing is likely. Follow all state and local requirements.

Maintenance

Check sediment basins weekly and after each rainfall event. Remove sediment and restore the basin to its original dimensions when sediment accumulates to one-half the design depth.

Check the embankment, spillways, and outlet for erosion damage, and inspect the embankment for piping and settlement. Make all necessary repairs immediately. Remove all trash and other debris from the riser and pool area.

Sediment Fence (Silt Fence)

Definition

A temporary sediment barrier consisting of filter fabric buried at the bottom, stretched, and supported by posts.

Purpose

To retain sediment from small disturbed areas by reducing the velocity of sheet flows to allow sediment deposition.

Where Applicable

Below small disturbed areas where runoff can be stored behind the sediment fence without damaging the fence or the submerged area behind the fence.

Do not install sediment fences across streams, ditches, or waterways.

Planning Considerations

A sediment fence is a permeable barrier that should be planned as a system to retain sediment on the construction site. The fence retains sediment primarily by retarding flow and promoting deposition. Generally the fence becomes clogged with fine particles over time which reduces flow rate. This causes a pond to develop more quickly behind the fence. The designer should anticipate ponding and provide sufficient storage areas and overflow outlets to prevent flows from overtopping the fence. Since sediment fences are not designed to withstand high heads, locate them so that only shallow pools can form. Tie the ends of a sediment fence into the landscape to prevent flow around the end of the fence before the pool reaches design level. Provide stabilized outlets to protect the fence system and release storm flows that exceed the design storm.

Deposition occurs as the storage pool forms behind the fence. The designer can direct flows to specified deposition areas through appropriate positioning of the fence or by providing an excavated area behind the fence. Plan deposition areas at accessible points to promote routine maintenance. Show deposition areas in the erosion control plan. A sediment fence acts as a diversion if placed slightly off the contour. This may be used by the designer to control shallow, uniform flows from small disturbed areas and to deliver sediment-laden water to deposition areas.

Sediment fences serve no function along ridges or near drainage divides where there is little movement of water. Confining or diverting runoff unnecessarily with a sediment fence may create erosion and sedimentation problems that would not otherwise occur.

Design Criteria

Design the fence for stability during a 10-year recurrence storm event. Ensure that the depth of impounded water does not exceed 1.5 ft. at any point along the fence.

The velocity of the flow along the fence or at the outlet should be non-erosive. Provide a riprap splash pad or other outlet protection device for any point where flow may overtop the sediment fence, such as natural depressions or swales. Ensure that the maximum height of the fence at a protected, reinforced outlet, does not exceed 1 ft. and that support post spacing does not exceed 4 ft.

The design life of a synthetic sediment fence should be 6 months. Burlap is only acceptable for periods up to 60 days.

Construction Specifications

1. Use a synthetic filter fabric or a pervious sheet of polypropylene, nylon, polyester, or polyethylene yarn, certified by the manufacturer or supplier for use in this application.

Synthetic filter fabric should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected useable construction life.

2. Ensure that posts for sediment fences are either 4-inch diameter pine, 2-inch diameter oak, or 1.33 lbs./linear ft. steel with a minimum length of 4 ft. Make sure that steel posts have projections to facilitate fastening the fabric.

3. Construct the sediment barrier of standard strength or extra strength synthetic filter fabrics.

For reinforcement of standard strength filter fabric, use wire fence with a minimum 14 gauge and a maximum mesh spacing of 6 inches. Fasten the mesh securely to the up-slope side of the posts using heavy duty wire staples at least 1 inch long, or tie wires. Extend the wire mesh support to the bottom of the trench. Space support posts a maximum of 8 feet apart and drive securely into the ground a minimum of 18 inches.

Extra strength filter fabric with 6-foot post spacing does not require wire mesh support fence. Staple or wire the filter fabric directly to posts.

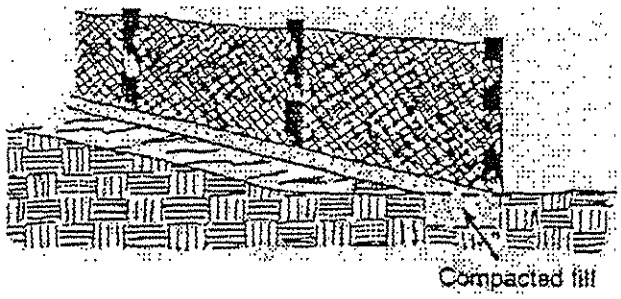
4. The height of the sediment fence shall not exceed 18 inches above the ground surface.

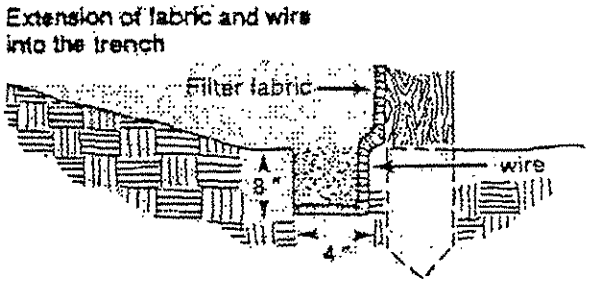
5. Construct the filter fabric from a continuous roll cut to the length of the barrier to avoid joints. When joints are necessary,

securely fasten the filter cloth only at a support post with overlap to the next post.

6. Excavate a trench approximately 4 inches wide and 8 inches deep along the proposed line of posts and up-slope from the barrier (Figure 6.62a). Backfill the trench with compacted soil or gravel placed over the filter fabric.

7. Do not attach filter fabric to existing trees.





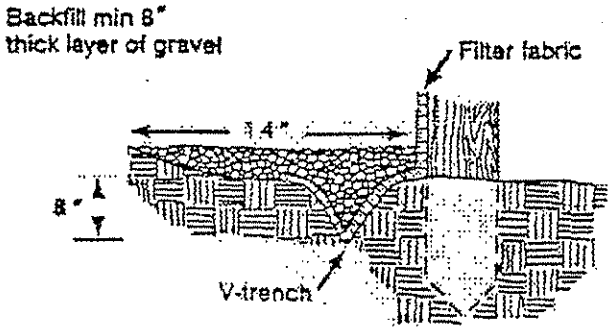


Figure 6.62a Sediment Fence Installation

Maintenance

Inspect sediment fences at least once a week and after each rainfall event. Make any required repairs immediately.

Should the fabric of a sediment fence collapse, tear, decompose or become ineffective, replace it promptly. Replace burlap every 60 days.

Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Avoid undermining the fence during cleaning.

Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized.

Dust Control

Definition — A measure to reduce airborne dust.

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

Where Applicable — 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 silt 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.

Planning Consideration — Installation costs for water and chemical dust suppression are low, however, long term costs may be quite high since these measures are effective for only a few hours to a few days. Overwatering, however, may also cause erosion.

Schedule construction activities to minimize exposed area, and quickly stabilizing exposed soils using permanent vegetation or improvements will help limit the water or chemical suppression period.

The impact of airborne dust can also be minimized by anticipating the direction of prevailing winds, and directing construction traffic to stabilized roadways within the project site.

Comply with the State DOH requirements for dust control.

Maintenance — Dust control measures require frequent, often daily, attention.

Good Neighbor Barrier (Dust Screen)

Definition — A temporary barrier consisting of filter fabric stretched, and supported by posts.

Purpose — To intercept and retain airborne sediment from disturbed areas by creating a wind barrier to allow sediment deposition. Good neighbor barriers also provide a temporary visual barrier screening construction activities from neighboring properties.

Where Applicable — Around the perimeter of construction sites and/or downwind of disturbed areas where airborne sediment can be detained or intercepted by the fence.

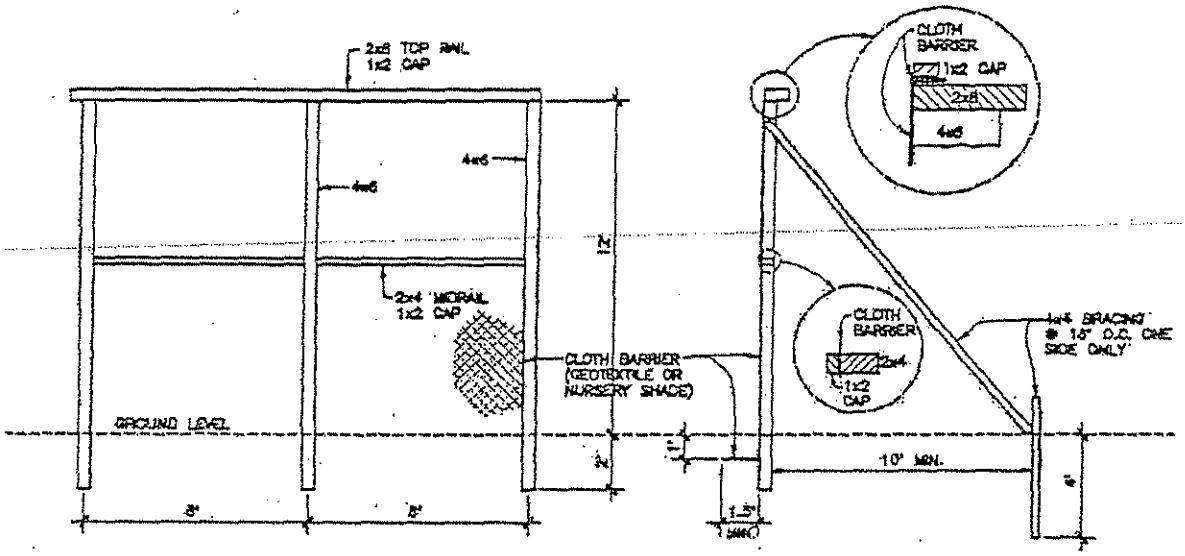
Planning Considerations — A good neighbor barrier or dust screen is a permeable barrier that should be planned as a system to retain airborne sediment on the construction site. The screen retains airborne sediment primarily by intercepting airflow and promoting deposition. Deposition occurs as the airborne sediment strikes the barrier and falls along the fence.

Good neighbor barriers also provide a visual barrier screening construction activities from neighboring properties and roadways.

Design Criteria — Design the barrier to reduce the transport of airborne sediment off the construction site, and to provide a visual barrier for neighboring properties.

Construction Specifications — Construct the barrier as shown in Figure 6.71a Good Neighbor Barrier, providing additional reinforcement as necessary in windy areas.

Construct the filter fabric from a continuous roll cut to the height and length of the barrier to avoid joints. When joints are necessary, provide only vertical joints by securely fastening the filter cloth at a support post. Horizontal joints should be avoided.



GOOD NEIGHBOR BARRIER (TYPICAL SECTION)
NOT TO SCALE

.gure 6.71a Good Neighbor Barrier

Maintenance

Inspect the barrier at least once a week. Make any required repairs immediately.

Should the fabric collapse, tear, decompose or become ineffective, replace it promptly.

Remove sediment deposits as necessary to provide adequate storage. Avoid undermining the fence during cleaning.

Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the project site has been properly stabilized.

Check Dam

Definition Small temporary dams constructed across a drainageway.

Purpose To reduce erosion in a drainage channel by restricting the velocity of flow in the channel.

Where Applicable This practice may be used as a temporary or emergency measure to limit erosion by reducing flow in small open channels. Limit drainage areas to 2 acres or less. Do not use check dams in live streams.

Check dams may be used to:

- reduce flow in small temporary channels that are degrading and where permanent stabilization is impractical;
- reduce flow in small eroding channels where construction delays or weather conditions prevent timely installation of non-erosive liners.

Planning Considerations Check dams are an expedient way to reduce gullying in the bottom of channels that will be filled or stabilized at a later date. It is usually better to line the channel or divert the flow to stabilize the channel than to install check dams, however, under circumstances where this is not feasible, check dams may be helpful.

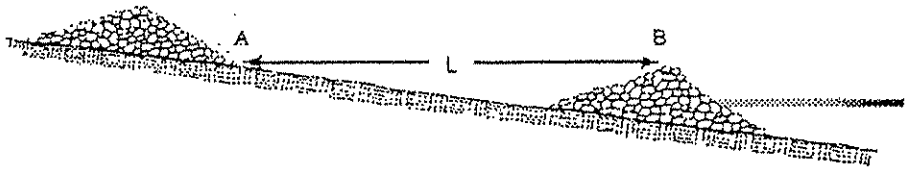
Check dams installed in grass-lined channels may kill the vegetative lining if submergence too long after rains and/or silting is excessive. All stone and riprap must be removed if mowing is planned as part of vegetative maintenance.

Consider the alternative of protecting the channel bottom with materials such as riprap, concrete or other protective linings in combination with grass before selecting check dams.

Design Criteria The following criteria should be used when designing a check dam:

- Ensure that the drainage area above the check dam does not exceed 2 acres.

- Keep the maximum height at 2 ft. at the center of the dam.
- Keep the center of the check dam at least 9 inches lower than the outer edges at natural ground elevation.
- Keep the side slopes of the dam at 2:1 or flatter.
- Ensure that the maximum spacing between dams places the toe of the upstream dam at the same elevation as the top of the downstream dam (Figure 6.83a).
- Stabilize overflow areas along the channel to resist erosion caused by check dams.
- Key the check dam into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.



L = The distance such that points A and B are of equal elevation

Figure 6.83a Check dam spacing

Construction Specifications

1. Place check dam to the lines and dimensions shown in the plan.
2. Keep the check dam center section at least 9 inches below natural ground level where the dam abuts the channel banks.
3. Set spacing between dams to assure that the elevation at the top of the lower dam is the same as the toe elevation of the upper dam.
4. Protect the channel downstream areas from the lowest check dam.

Maintenance

Inspect check dams and channels for damage weekly and after each rainfall event.

Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam. Correct all damage immediately. If significant erosion occurs between dams, install protective riprap liner in that portion of the channel.

Remove sediment accumulated behind the dams as needed to prevent damage to channel vegetation, allow the channel to drain through the material, and prevent large flows from carrying sediment over the dam. Add stones to dams as needed to maintain design height and cross section.

Solid Waste Management

Definition	Management of solid waste materials for recycling, disposal or reuse.
Purpose	Prevent or reduce discharge of pollutants to the land, groundwater, storm water systems and landfill from construction and demolition (C&D) projects by providing designated waste collection areas, separate containers for recycle waste materials, timing collection of waste and recyclable materials with each stage of the construction or demolition project, and properly training subcontractors and employees.
Where Applicable	All construction and demolition projects.
Planning Consideration	Solid waste is one of the major pollutants resulting from any construction or demolition project. There are no limitations to the use of this best management practice.
Construction Specifications	Select and designate solid waste collection areas on the site. Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas. Locate containers in a covered area and/or within a secondary containment. Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it's windy. Inform trash hauling contractors that you will accept only water-tight dumpsters for on-site use. Inspect dumpsters for leaks and repair any dumpster that is not water tight. Plan for additional containers and more frequent pickup during the demolition phase of construction. Collect site trash daily, especially during rainy and windy conditions. Erosion and sediment control devices tend to collect litter. Remove this solid waste promptly. Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris. Salvage or recycle any useful material.