EC Erosion Control

Erosion control refers to methods for reducing the volume or velocity of stormwater runoff, which will come into contact with exposed areas of the project site. Erosion control methods involve limiting the exposure of graded areas to offsite runoff through modifications of the construction design plan or scheduling, reducing runoff velocities, providing vegetative cover, installing structural controls, and implementing other onsite management options. If a pre-manufactured product is to be implemented on a site for erosion control, the contractor should always follow the manufacturer's installation and maintenance recommendations as the primary reference for implementation.

VENDOR PRODUCTS

See Appendix F.1 for Erosion Control BMPs.

Disclaimer

Any hyperlinks in the vendor products table will direct you out of the Flood Control District of Maricopa County (FCDMC) domain. FCDMC is providing the following vendor information for possible assistance to any interested parties, but does not necessarily endorse any of the information or products provided by the vendors.

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EC-1 Erosion Control Mats

DEFINITION

Geotextiles, mats, plastic covers, or erosion control blankets designed to stabilize disturbed soil areas and protect soils from erosion by wind or water.

GENERAL INFORMATION

Applicability - Effectiveness
Slope Protection - moderate
Material Stockpiles - moderate

Most effective when used with:

Seeding or other re-vegetation methods described in SPC-6 Revegetation

Alternative BMPs:

Consider using chemical stabilization for large areas or steeper slopes: EC-7 Dust Control

RATINGS

Associated Costs	**H**	**M**	**L**
Implementation	X		
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material			X
Metals			X
Other Construction Waste			X

FIGURES

Photos/Sketches

EC-1 Erosion Control Mats Photos

CAD Drawings

Installation of Netting and Matting

Orientation of Netting and Matting

Purpose

Erosion control matting is used to reduce rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. The matting may be used alone or with a mulch during the establishment of protective vegetative cover on critical slopes.

APPROPRIATE APPLICATIONS

Erosion control matting can be applied to:

- Steep slopes, generally steeper than 1:3 (V:H).
- Slopes with newly vegetated slopes or where the erosion potential is high.
- Slopes and disturbed soils where mulch must be anchored.
- Disturbed areas where plants are slow to develop.
- Channels with flows exceeding 3 to 7 ft/sec.
- Stockpiles.
- Slopes adjacent to water bodies.

LIMITATIONS

Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.

Blankets and mats:

- More expensive than other erosion control measures, due to labor and material costs. This usually limits their application to areas inaccessible to hydraulic equipment, or where other measures are not applicable, such as channels.
- Generally not suitable for excessively rocky sites, or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).

Plastic sheeting:

- Easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- Limit the use of plastic covers to covering stockpiles, or very small graded areas for short periods of time (such as through one imminent storm event), until alternative measures, such as seeding and mulching, may be installed.

PLANNING CONSIDERATIONS

Consider using Revegetation in conjunction with Erosion Control Mats for additional erosion control and stabilization.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Jute Mat - should be a uniform plain weave of undyed and unbleached single jute yarn and weigh about 1.2 pounds per linear yard of cloth. The yarn should be loosely twisted, with an average twist of not less than 1.6 turns per inch, and should not vary in thickness by more than half its normal diameter.

Straw Mat - should be a machine produced mat consisting of about 70 ± 3% agricultural straw and 30 ± 3% coconut fiber. The blanket should be of consistent thickness with the straw and coconut fiber evenly distributed. 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, have a polypropylene netting with an approximate ½" x ½" mesh.

Excelsior Mat - should be wood excelsior, about 48 inches in width, and about 0.8 pounds per square yard. The excelsior material should be covered with a netting to facilitate handling and to increase strength.

Glass Fiber Matting - should be made of bonded textile glass fibers with an average fiber diameter of eight to twelve microns and two to four inch strands of fiber bonded with phenol formaldehyde resin. Mat should be roll type, water permeable, minimum thickness ¼ inch, maximum thickness ½ inch, and have a density greater than three pounds per cubic foot.

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

Staples - used as anchors should be Number 11 gauge wire or heavier, and the length should be six to ten inches, minimum.

Installation

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 1.5 inches in diameter and any foreign material that will prevent contact of the protective mat with the soil surface.

Planting:

Fertilize and seed in accordance with seeding or other type of planting plan. 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 sprigged areas when grass has been planted. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting.

Erosion Stops:

Erosion stops are made of glass fiber strips, excelsior matting strips or tight-folded jute and are useful on steep, highly erodible slopes. They prevent water from flowing below the erosion control matting at the matting joints. Erosion stops can be placed in narrow trenches six to twelve inches deep across the channel, left flush with the soil surface, and must extend the entire cross section of designed flow. Straw wattles (see Organic Filter Barrier) are commonly installed as erosion stops

Laying and Securing Matting:

Before laying the matting, all erosion stops should be installed and the friable seed bed made free of clods, rocks, and roots. Most matting comes with manufacturer's recommendations for installation, which should always be followed. The matting should be unrolled starting at the upper end of the channel, allowing a four-inch overlap of mattings along the center of channel. To secure, bury the top ends of matting in a narrow trench, minimum of six inch depth. Backfill trench and tamp firmly to conform to channel cross section. Secure with a row of staples about four inches down slope from trench with staples twelve inches apart.

Where matting crosses erosion stops, reinforce with a double row of staples, six-inch spacing, staggered pattern on either side of erosion stop. Likewise, overlaps joining the length of matting together and 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 be in accordance with the fabric manufacturer's recommendations or as approved by the Engineer.

The surface upon which the separation fabric will be placed should be compacted and finished according to the manufacturer's recommendations.

Final Check:

- 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.

RECOMMENDED MAINTENANCE AND INSPECTION

- Inspect blankets and mats periodically after installation. Installation should be inspected after significant rainstorms to check for erosion and undermining. If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.

- Repairs may include re-anchoring loosened nettings and replace lost net and staples as required.

- Reapply or replace temporary soil stabilization when protected area becomes exposed or exhibits visible erosion.

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

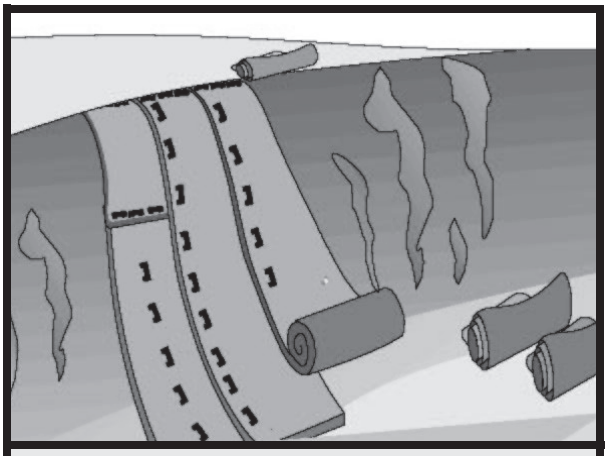
North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA.

City of Austin, Texas, March, 2004, Environmental Criteria Manual.

Arizona Department of Transportation (ADOT), June 1995, Erosion and Pollution Control Manual, Intermodal Transportation Division.

EC-1 Erosion Control Mats Photos



Schematic of applying erosion control matting to a slope.

Courtesy of CALTRANS

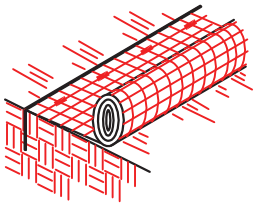
Biodegradable erosion control.

Courtesy of EPA

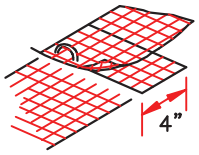
Applying sod to a slope

Courtesy of Douglas County

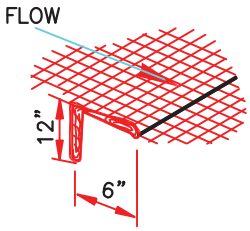
EC-1 Erosion Control Mats Drawing



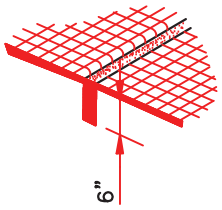
ANCHOR SLOT: BURY THE UP–CHANNEL END OF THE NET IN A 12" DEEP TRENCH. TAMP THE SOIL FIRMLY. STAPLE AT 12" INTERVALS ACROSS THE NET.



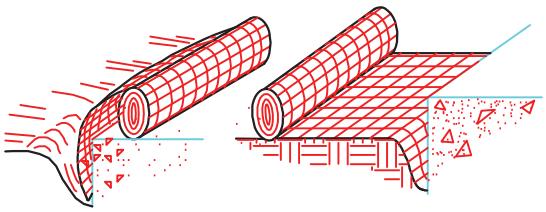
OVERLAP: OVERLAP EDGES OF THE STRIPS AT LEAST 4". STAPLE EVERY 12" DOWN THE CENTER OF THE STRIP.



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



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

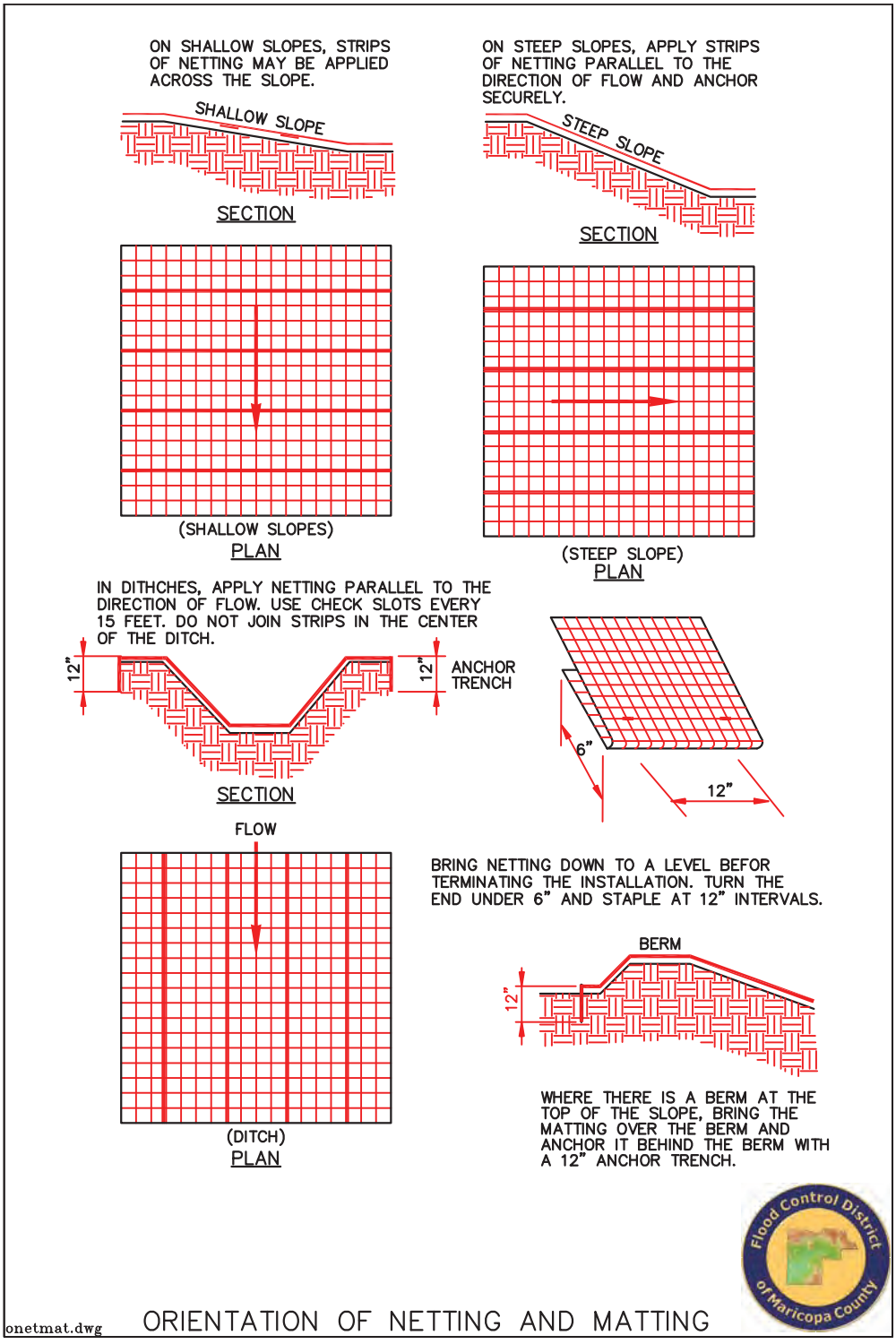


ANCHORING ENDS AT STRUCTURES: PLACE THE END OF THE NET IN A 12" SLOT ON THE UP–CHANNEL SIDE OF THE STRUCTURE. FILL THE TRENCH AND TAMP FIRMLY. ROLL THE NET UP THE CHANNEL. PLACE STAPLES AT 12" INTERVALS ALONG THE ANCHOR END OF THE NET.

netmat.dwg

INSTALLATION OF NETTING AND MATTING

EC-1 Erosion Control Mats Drawing



EC-2 Mulching

DEFINITION

Providing a stabilized surface for seeding and/or prevention of erosion. Mulches include organic materials, straw, wood chips, bark or other wood fibers, decomposed granite, gravels, a variety of netting or mats of organic or non-organic materials, and chemical soil stabilization.

GENERAL INFORMATION

Applicability - Effectiveness
Slope Protection - moderate

Most effective when used with:

EC-1 Erosion Control Mats

Seeding or other re-vegetation methods described in SPC-6 Revegetation

Alternative BMPs:

Consider using chemical stabilization for large areas or steeper slopes: EC-7 Dust Control

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance		X	
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease		X	
Nutrients			X
Sediment	X		
Floatable Material			X
Metals			X
Other Construction Waste			X

FIGURES

Photos/Sketches

EC-2 Mulching Photos

CAD Drawings

None

PURPOSE

The purposes of using mulch are: (1) prevent erosion by protecting the soil surface from raindrop impact and reducing the velocity of overland flow and (2) to foster the growth of vegetation by increasing available moisture and providing insulation against extreme heat and cold.

Mulches can increase the infiltration rate of the soil, reduce soil moisture loss by evaporation, prevent crusting and sealing of the soil surface, modify soil temperatures, and provide a suitable microclimate for seed germination.

APPROPRIATE APPLICATIONS

- Mulching is appropriate for temporary or permanent methods of erosion control. Organic mulches, straw and wood fiber are appropriate in landscaped or revegetated areas as temporary controls. Permanent controls that are appropriate for arid regions include gravels and decomposed granite.
- Apply mulching to the following:
    - Areas that have been permanently seeded,
    - Areas that can not be seeded right away due to the season or other environmental restrictions but still need to be reinforced,
    - Seeded or planted areas where slopes are steeper than 2:1
    - Areas where seedlings require protection from extreme temperatures or moisture loss.

LIMITATIONS

The following limitations of mulching should be considered:

- Mulching may delay seed germination because the cover changes soil surface temperatures.
- Mulches are susceptible to erosion and may be washed away in large storm events.
- Maintenance is necessary to ensure that mulches provide effective erosion control.
- Chemical soil stabilizers are less effective than mulches when used alone.

PLANNING CONSIDERATIONS

Mulches are applied to the soil surface to conserve a desirable soil property or to promote plant growth. A surface mulch is one of the most effective means of controlling runoff on disturbed land. There are several forms and methods of mulching. The choice of materials for mulching

will be based on the type of soil to be protected, site conditions, landscape requirements, and economics. Additionally, consider that:

- Organic mulch materials, such as straw, wood chips, bark, and wood fiber, have been found to be the most effective where re-vegetation will be provided by reseeding.
- Chemical soil stabilizers can enhance the mulching effectiveness by binding organic mulches together or to stabilize flat areas such as roadways.
- A variety of nets and mats developed for erosion control may also be used as mulches, particularly in critical areas such as waterways. They may be used to hold other mulches to the soil surface (see Erosion Control Mats).
- Seeding or other re-vegetation methods should be used in conjuction with mulching as described in Revegetation. Decomposed granite, gravels and bark are also effective as ground cover in landscaped areas.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Design Criteria

Mulching 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 Engineer.

Materials

Compliance with the requirements of Subsection 106.05 of the ADOT Standard Specifications for Road and Bridge Construction is recommended.

Wood fiber mulch - Should consist of a specially prepared wood fiber processed to contain no growth or 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.

Straw mulch - Should conform to the requirements of Subsection 805 - 2.03 of ADOT's Standard Specifications and 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.

Emulsified asphalt - Emulsified asphalt should be type SS-1 or CSS-1 and should conform to the requirements of Subsection 1005-3.04 of the ADOT Standard Specifications.

Binder - Binder should be free flowing, noncorrosive powder produced from natural plant gum marketed under M-Binder, M145 Binder, AZ-TAC or approved equal.

Preparation/Method and Equipment

The equipment and methods used to distribute mulching materials should provide an even and uniform application of mulch and/or other materials at the specified rate. The mulch can be spread by hand or by mulch-blowing equipment.

Applying mulch - Mulch should be immediately affixed by either crimping or tacking as described below; the Engineer should determine which areas are not conducive to anchoring by crimping and direct the contractor to instead anchor the mulch by tacking. Within 24 hours after each area is planted, straw mulch should be uniformly applied at about 2.5 tons per acre for crimped areas and 1.75 tons per acre for tacked areas. See photos of this process

Crimping - Mulch should be anchored into the soil using a tractor disc, spaced no more than nine inches apart. Mulch should be anchored to a depth of at least two inches and should not cover an excessive amount of soil. Crimp the mulch across the slopes, where practical, with one or two passes. Immediately following the crimping operation, tack the mulched area.

Tacking - Mulch can also be anchored by uniformly applying either emulsified asphalt approximately 500 gallons per acre or a slurry consisting of about 150 pounds of binder, 400 pounds of wood fiber mulch, and 700 gallons of water per acre. The specific content of pre-manufactured tacking product may vary, so be sure to follow manufacturer instructions before each application.

RECOMMENDED MAINTENANCE AND INSPECTION

Maintenance requirements will vary greatly based upon the type of mulch used and the type of vegetation to be established. Mulches are not usually 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, such as along steep slopes or areas of higher velocity flows, a geotextile mat or net is recommended instead.

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

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Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

North Carolina State University, (NCSU) North Carolina Nonpoint Source Pollution Control Measures http://h2osparc.wq.ncsu.edu/info/bmps.html

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Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1992, Virginia Erosion and Sedimentation Control Handbook, Thrid Edition.

Smolen, M.D., September 1988, North Carolina Erosion and Sediment Control Planning and Design Manual, North Carolina Sediment Control Commission, et al.

EC-2 Mulching Photos

Mulching protects exposed areas and seeding for revegetation.

Straw mulching along the shoulder of a highway.

Mechanical chipper application of mulching

Courtesy of NCDOT

EC-3 Protection of Trees and Vegetation in Construction Areas

DEFINITION

Preservation of existing vegetation is the identification and protection of desirable vegetation in order to provide erosion and sediment control and protect desirable trees from mechanical damage while the land is being developed.

GENERAL INFORMATION

Applicability - Effectiveness
Perimeter and Access Controls - moderate
Landscaping and Vegetation - high
Channels and Medians - high

Most effective when used with:

SPC-6 Revegetation to enhance the existing vegetation.

Alternative BMPs:

None

RATINGS

Associated Costs	H	M	L
Implementation			X
Maintenance		X	
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease		X	
Nutrients			X
Sediment	X		
Floatable Material			X
Metals			X
Other Construction Waste			X

FIGURES

Photos/Sketches

EC-3 Protection of Trees and Vegetation in Construction Areas Photos

CAD Drawings

Tree Well

PURPOSE

Preserving natural vegetation protects desirable trees, vines, bushes, and grasses from damage during project development. Vegetation provides erosion control, stormwater detention, biofiltration, and aesthetic values to a site during and after construction activities.

APPROPRIATE APPLICATIONS

Preservation of natural vegetation is applicable to all construction sites where vegetation exists in the predevelopment condition. Areas where preserving vegetation can be particularly beneficial are floodplains, wetlands, stream banks, steep slopes, and other areas where erosion controls would be difficult to establish, install, or maintain. Only land needed for building activities and vehicle traffic needs to be cleared.

LIMITATIONS

Preservation of vegetation is limited by the extent of existing vegetation in preconstruction conditions. It requires planning to preserve and maintain the existing vegetation. It is also limited by the size of the site relative to the size of structures to be built. High land prices might prohibit preservation of natural areas. Additionally, equipment must have enough room to maneuver; in some cases preserved vegetation might block equipment traffic and may constrict the area available for construction activities. Finally, improper grading of a site might result in changes in environmental conditions that result in vegetation dieoff. Consideration should be given to the hydrology of natural or preserved areas when planning the site.

PLANNING CONSIDERATIONS

There are various methods for protecting existing trees on a site:

- Stake off root system limits (drip line of tree).
- Fence off tree along the drip line.
- Flag or mark trees to remain in place.
- Tree wells and retaining walls (permanent)

To enhance the existing vegetation in construction areas is most effective when installed with Revegetation.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Protect existing trees with tree wells as shown in the CAD drawing.

Rock Mulch

Rock mulch should be in accordance with the applicable requirements of Subsections 803-3.03 of the ADOT Standard Specifications and should meet the following gradation:

Sieve Size (inch)	Percent Passing (%)
3	75-100
2	25-75
1.5	0-25

Wall Construction Rocks

The rock should be clean, durable, free from segregations, seams, cracks and other structural defects or imperfections as approved by the Engineer, and should meet the following gradation:

Sieve Size (inch)	Percent Passing (%)
12	75-100
8	25-75
6	0-25

Mortar should consist of one part portland cement and two parts fine aggregate by volume. Portland cement and water should conform to the applicable requirements of Section 1006 of ADOT specifications. Hydrated lime should conform to the requirements of ASTM C-207, Type N, to the extent of 10% by volume of cement, may be added to the mortar. Hydrated lime should be treated as an additive and not a replacement for cement.

Construction of tree wells should be in accordance with the applicable requirements of Sections 201, 202, 203, and 803 of the ADOT Standard Specifications and/or as directed by the Engineer.

RECOMMENDED MAINTENANCE AND INSPECTION

- During construction, the limits of disturbance should be clearly marked at all times. Irrigation or maintenance of existing vegetation should conform to the requirements in the landscaping plan.
- Damaged vegetation should be repaired or replaced immediately.
- Newly planted vegetation should be planned to enhance the existing vegetation.

POST CONSTRUCTION METHODS

Both newly planted and protected trees and vegetation can be incorporated as part of the final landscaping around the perimeter of a developed site, referred to as buffer zones. For environ-

mentally sensitive areas including streams, natural washes, the recommended minimum width for buffer zones is 100 feet and should include vegetated ground cover and depressions to sufficiently contain stormwater runoff from leaving the development. Studies have shown that buffer zones are often seen as amenities.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

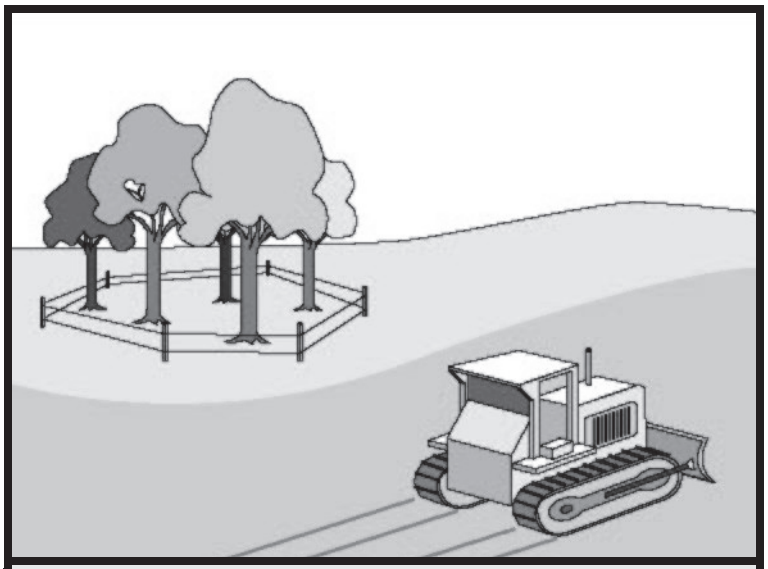
CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1992, Virginia Erosion and Sedimentation Control Handbook, Thrid Edition.

Smolen, M.D., September 1988, North Carolina Erosion and Sediment Control Planning and Design Manual, North Carolina Sediment Control Commission, et al.

EC-3 Protection of Trees and Vegetation in Construction Areas Photos

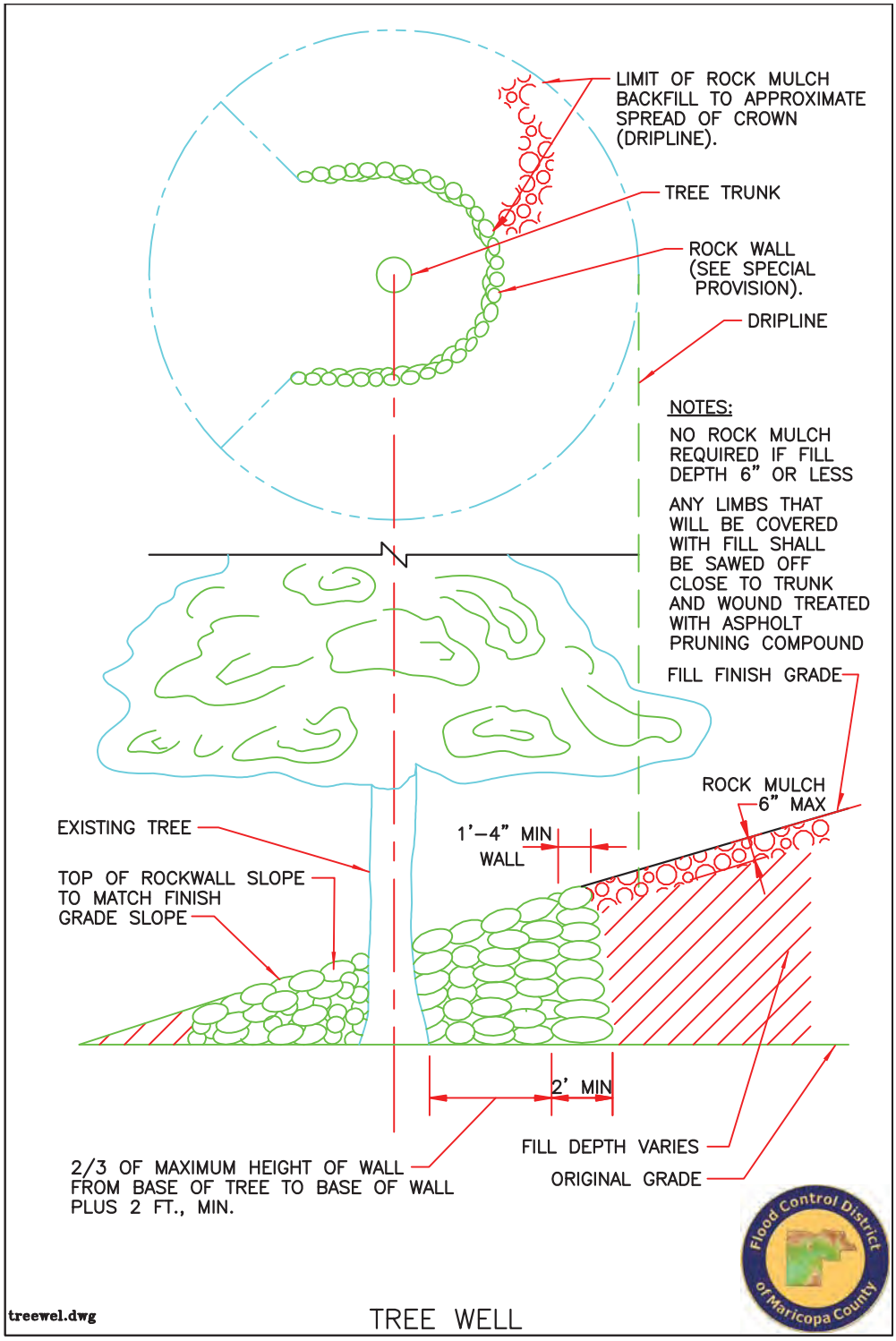


Schematic of vegetation protection.

Courtesy of CALTRANS

Flagging and wooden stakes help to protect existing trees and groundcover.

EC-3 Protection of Trees and Vegetation in Construction Areas Drawing



EC-4 Pipe Slope Drains

DEFINITION

A temporary rigid or flexible pipe that conveys runoff down unstabilized slopes. The drain is anchored on the upstream end with some form of headwall to limit erosion, secure the pipe, and direct water into the pipe inlets.

GENERAL INFORMATION

Applicability - Effectiveness
Slope Protection - high

Most effective when used with:

EC-1 Erosion Control Mats

EC-2 Mulching

EC-9 Diversion Dikes

Alternative BMPs:

For smaller slopes that are not as steep, consider: EC-12 Surface Roughening

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance	X		
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material		X	
Metals			X
Other Construction Waste			X

FIGURES

Photos/Sketches

Pipe Slope Drains Photos

CAD Drawings

Pipe Slope Drains Drawing (rigid)

Pipe Slope Drains Drawing (flexible)

PURPOSE

Pipe slope drains convey concentrated flows of surface runoff and protect preliminary and final graded slopes. Pipe slope drains are used during the establishment of temporary and permanent ground covers on sites with long, unstabilized, steep slope areas that are subject to erosion from overland flow. They minimize erosion down a slope because all flow is confined to an enclosed pipe.

APPROPRIATE APPLICATIONS

Pipe slope drains are applicable to sites with large berms or grade changes, such as road embankments. They are typically used in conjunction with top of slope diversion dikes or swales and may also be used as an emergency spillway for a sediment basin.

LIMITATIONS

- The area drained by a temporary slope drain should not exceed 5 acres.
- Physical obstructions substantially reduce the effectiveness of the drain.
- Pipe slope drains can also fail due to overtopping if the pipe inlet capacity is exceeded and/ or the diversion channel capacity and ridge height is reduced.
- Drains must be located away from construction areas since the drain can easily be damaged by construction traffic.
- Securing the pipe to the slope can be difficult and require significant maintenance during the life of the system.
- If a pipe slope drain conveys a sediment-laden runoff, pipes can become clogged during large rain events.
- Pipe slope drains reduce erosion, but it does not prevent or reduce the amount of sediment in runoff. Additional BMPs should be used in conjunction with pipe slope drains to treat the flow.
- Erosion and scouring may occur at the discharge point.

PLANNING CONSIDERATIONS

Pipe slope drains are easiest to install, maintain, and remove when flexible pipe is used and are most effective when installed with Erosion Control Mats, Mulching, and Diversion Dikes.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Pipe slope drains are effective in eliminating slope erosion because water is not allowed to flow directly on the slope.

- Pipe slope drains minimize erosion down a slope because all flow is confined to an enclosed pipe.
- When flexible pipe is used, slope drains are easy to install and require little maintenance.

Design and Sizing Criteria

The capacity for temporary drains should be sufficient to handle a 10-year, 24-hour peak flow. This may be computed using the Rational Method described in the Flood Control District of Maricopa County's "Hydrology Manual". Higher flows must be safely stored or routed to prevent any offsite concentration of flow.

- Temporary pipe slope drains should not be sized smaller than as shown in the following table:

Minimum Pipe Diameter (inches)	Maximum Upstream Drainage Area (acres)
12	0.5
18	1.5
21	2.5
24	3.5
30	5.0

- The entrance should consist of a standard flared end section for culverts 12-inches and larger with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance should be at least 3 percent. The soil around and under the pipe and entrance section should be thoroughly compacted. The flared inlet section should be securely connected to the slope drain and have watertight connecting bands.
- Slope drain sections should be securely fastened together and have gasketted watertight fittings, and be securely anchored into the soil.
- Interceptor dikes should be used to direct runoff into a slope drain. The height of the dike should be at least 1 foot higher at all points than the top of the inlet pipe.
- The area below the outlet must be stabilized with a riprap apron per the attached construction drawings.
- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.

RECOMMENDED MAINTENANCE AND INSPECTION

- Check inlet and outlet points regularly, especially after heavy storms.

- The inlet should be free of undercutting and no water should pass around the point of entry. Erosion around the pipe drain should be stabilized with erosion control mats, crushed stone, concrete, or other acceptable methods. The headwall should be reinforced with compacted earth or sand bags.

- The outlet point should be free of erosion and installed with appropriate outlet protection.

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention, http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

iSWM, integrated Storm Water Management Design Manual for Construction, December 2003, North Central Texas Council of Governments.

North Carolina State University, (NCSU) North Carolina Nonpoint Source Pollution Control Measures http://h2osparc.wq.ncsu.edu/info/bmps.html

Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA.

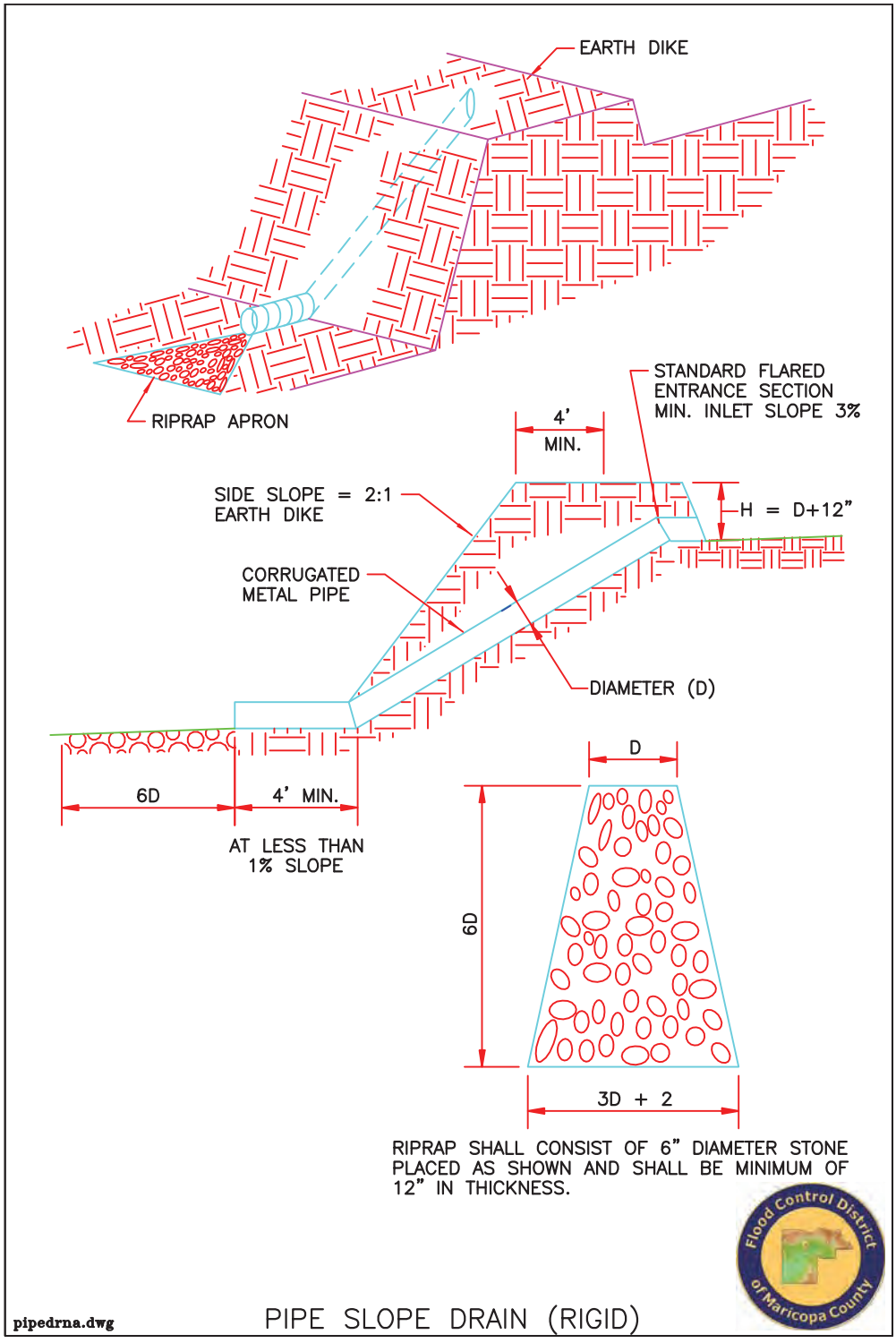
Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15

EC-4 Pipe Slope Drains Photos

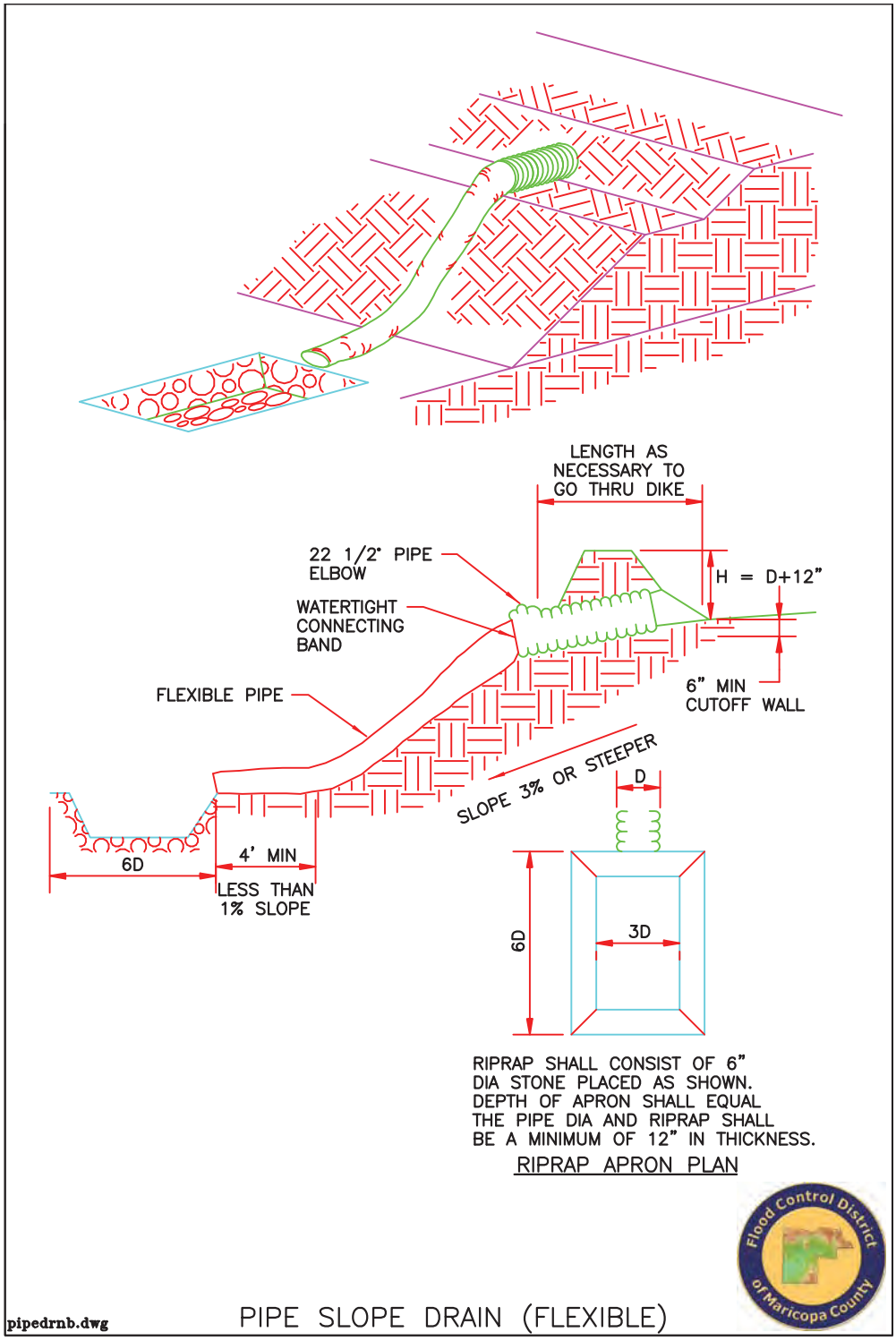
Pipe slope drain with a sediment basin at the bottom

Courtesy of:http://www.cacaponinstitute.org

EC-4 Pipe Slope Drains Drawing (rigid)



EC-4 Pipe Slope Drains Drawing (flexible)



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AEC-5 Stabilized Construction Entrance

DEFINITION

A stabilized pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk or parking area.

GENERAL INFORMATION

Applicability - Effectiveness
Perimeter and Access Controls - high

Most effective when used with:

EC-6 Construction Road Stabilization

EC-7 Dust Control

GH-6 Road Sweeping/Trackout Cleaning

Alternative BMPs:

GH-4 Designated Washdown Areas – wheel wash is especially useful with clay soils.

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance		X	
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material			X
Metals		X	
Other Construction Waste			X

FIGURES

Photos/Sketches

Stabilized Construction Entrance Photos

CAD Drawings

Stabilized Construction Entrance Drawing

PURPOSE

The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights-of-way or streets. Reducing trackout of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

APPROPRIATE APPLICATIONS

A stabilized construction entrance should be used at all points of construction ingress and egress. NPDES permits require that appropriate measures be implemented to prevent trackout of sediments onto paved roadways.

LIMITATIONS

The stabilized construction entrance plan should be reviewed as part of the project traffic control plan.

- Construct on level ground.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.

PLANNING CONSIDERATIONS

Stabilized construction entrances are not very effective in removing sediment from equipment leaving a construction site. Efficiency is greatly increased, though when a washing rack is included as part of a stabilized construction entrance. Build on level ground.

+ Advantages:

- Does remove some sediment from equipment and serves to channel construction traffic in and out of the site.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Stabilized construction entrances alone are not very effective in removing sediment from equipment leaving a construction site. Efficiency is greatly increased, though, when a washing rack is included at the point of egress.

Design and Sizing Considerations

The aggregate for stabilized construction entrance aprons shall be 1 to 3 inches in size, washed, well-graded gravel or crushed rock. The apron dimensions recommended are 30 ft. X 50 ft. And 6 inches deep.

- Entrance must be properly graded to prevent runoff from leaving the construction site.
- When wash areas are provided, washing shall be done on an area stabilized with crushed stone which drains into a properly constructed sediment trap or basin (pond).

RECOMMENDED MAINTENANCE AND INSPECTION

- Inspect monthly and after each rainfall.
- Replace gravel mat when surface voids are no longer visible. Periodic top dressing with additional stone will be required.
- All sediments deposited on paved roadways must be removed within 24 hours.
- Remove gravel and filter fabric upon completion of construction.

Note: If working on a project that is subject to a Maricopa County Dust Control Permit under Rule 310, follow the permit requirements for Stabilized Construction Entrance design and sizing.

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

North Carolina State University, (NCSU) North Carolina Nonpoint Source Pollution Control Measures http://h2osparc.wq.ncsu.edu/info/bmps.html

Center for Watershed Protection, Inc., Stormwater Manager's Resource Center (SMRC). http://www.stormwatercenter.net/

Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA,

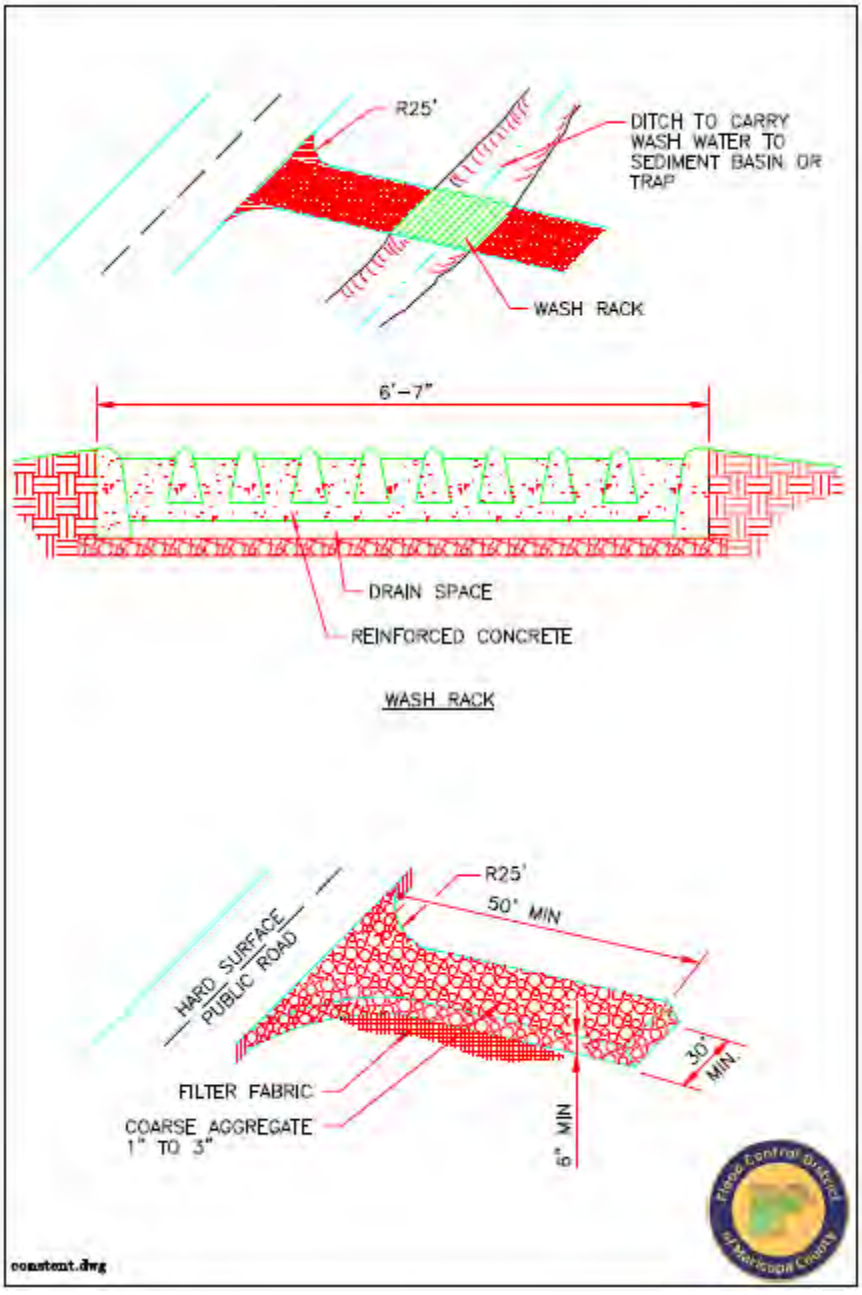
City of Austin, Texas, March, 2004, Environmental Criteria Manual.

AEC-5 Stabilized Construction Entrance Photos

Stabilized entrances should consist of well-graded, washed gravel up to 3 inches in diameter

Stabilized construction entrances reduce trackout to public right-of-ways or streets

AEC-5 Stabilized Construction Entrance Drawing



EC-6 Construction Road Stabilization

DEFINITION

The temporary stabilization of the subgrade, sub-base, and base of access roads, subdivision roads, parking areas, and other onsite vehicle transportation routes for dust and erosion control.

GENERAL INFORMATION

Applicability - Effectiveness
Slope Protection - moderate
Perimeter and Access Controls - high

Most effective when used with:

GH-4 Designated Washdown Areas

EC-5 Stabilized Construction Entrance

EC-7 Dust Control for additional erosion and fugitive dust control.

Alternative BMPs:

For light traffic, dust suppressants in EC-7 Dust Control can be used for topical stabilization

For roadways crossing waterways, use EC-8 Temporary Access Waterway Crossing

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance		X	
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material		X	
Metals		X	
Other Construction Waste			X

FIGURES

Photos/Sketches

EC-6 Construction Road Stabilization Photos

CAD Drawings

None

PURPOSE

Roads graded for construction vehicles are especially susceptible to erosion. The exposed soil surface is continually disturbed resulting in erosion, dust problems, and loss of sediment-laden runoff. During wet weather, the roads may generate significant quantities of sediment that may be transported offsite in surface runoff or on the wheels of construction vehicles. Stabilization helps to increase the compressive strength and durability of access roads. Stablization also helps limit dust and erosion created by vehicular tracking and creates easier and safer driving conditions for construction vehicles and equipment.

APPROPRIATE APPLICATIONS

- Parking areas (both permanent and temporary) for use by construction traffic
- For phased construction projects where roadways are graded for utility installations, but will not be paved immediately.
- Detour roadways.
- When roadway construction occurs in wet weather.

LIMITATIONS

- Measures on temporary roads must be cheap to install and remove
- Aggregate or chemical stabilization to construction roads may need to be applied more than once during a construction period.
- All unpaved construction roads will generate airborne dust. The contractor should control dust in compliance with the requirements of the Maricopa County Air Quality Division, refer to Dust Control for strategies to control dust including the suite of chemical stabilization methods.

PLANNING CONSIDERATIONS

Construction Road Stabilization can be enhanced when implemented with Designated Wash-down Areas, Stabilized Construction Entrance, and Dust Control.

RECOMMENDED STANDARDS AND SPECIFICATIONS

There are various levels of road stabilization methods in costs and effectiveness. They are described in increasing order:

1. Dust palliative on an untreated/unimproved road.

   Chemical dust suppressants, or palliatives, can also act as road stabilization for light traffic and loading conditions. Refer to Commonly Used Dust Suppressants Table for an overview of these chemical treatments.

2. Gravel surface road consisting of either aggregate or imported gravel.

   Gravel or aggregate will provide additional stabilization to the road surface. A 6-inch layer of crushed rock (2 - 4 inch nominal diameter), gravel base, or crushed surface base course should be applied immediately after grading or utility installation has been completed within the right-of-way. A 4-inch course of aggregate base course may be used in lieu of the crushed rock.

3. Treated base and sub-base.

   The compressive strength of road base and sub-base material can be increased through chemical treatment including cement and lime/fly-ash. Lignosulfonates have also been shown to increase the compressive strength of base and sub-base materials. Road surfaces can also be strengthened using one or more layers of bituminous material (chip seal). Refer to Chapter 3 of the ADOT Construction Manual for exact specifications and requirements.

4. Composite road section design.

   Composite road section design provides the highest level of road stabilization. It also requires the highest level of design and implementation cost, time, and labor). A typical composite road section consists of a compacted native sub-grade soil, followed by a stabilized base course, followed with an unbound base, and finally a wearing surface of asphalt concrete or a Portland cement concrete pavement. Refer to Chapter 4 of the ADOT Construction Manual and/or Chapter 10 of the 2004 MCDOT Roadway Design Manual for exact specifications and requirements.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible and the slope should not exceed 15 percent. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway for a normal crown section, or to the downstream side for a super-elevated section. Simple gravel berms without a trench can also be used. Installed drainage inlets should be protected to prevent sediment-laden water entering the drain sewer system (see Storm Drain Inlet Protection BMP).

RECOMMENDED MAINTENANCE AND INSPECTION

Inspect stabilized roads at regular intervals (a minimum of once a month) and on a more frequent basis during rainy seasons. Look for cracks, potholes, and other signs of road surface erosion. Add rock, gravel, or asphalt patches where necessary to prevent any exposed areas to erosion.

POST CONSTRUCTION METHODS

Stabilized roads can be converted to a more permanent form, usually when the base and sub-base has been treated or when a composite road section design has been constructed. Refer to Chapters 3 and 4 of the ADOT Construction Manual and Chapter 10 of the MCDOT Roadway Design Manual.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

NCSU, North Carolina State University, North Carolina Nonpoint Source Pollution Control North Carolina State University, (NCSU) North Carolina Nonpoint Source Pollution Control Measures http://h2osparc.wq.ncsu.edu/info/bmps.html

Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1992, Virginia Erosion and Sedimentation Control Handbook, Thrid Edition.

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

EC-6 Construction Road Stabilization Photos

Comparison of a haul road before and after it has been stabilized.

Courtesy of Dust Pro, Inc.

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EC-7 Dust Control

DEFINITION

A comprehensive plan to limit offsite sediment depression by minimizing or controlling airborne fugitive dust.

GENERAL INFORMATION

Applicability - Effectiveness
Perimeter and Access Controls - high

Most effective when used with:

EC-5 Stabilized Construction Entrance

EC-6 Construction Road Stabilization

GH-6 Road Sweeping/Trackout Cleaning

Alternative BMPs:

For long term dust control, consider SPC-6 Revegetation

RATINGS

Associated Costs	H	M	L
Implementation			X
Maintenance	X		
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment	X		
Floatable Material			X
Metals		X	
Other Construction Waste			X

FIGURES

Photos/Sketches

EC-7 Dust Control Photos

Tables

Commonly Used Dust Suppressants

PURPOSE

Sediments which are transported from construction sites by stormwater runoff, wind, erosion and vehicle trackout are often re-dispersed to the air by subsequent vehicular traffic and high winds. Likewise, these sediments may be transported by the next rainfall into public storm sewer systems. Implementation of control measures to minimize the generation of fugitive dust from construction sites will reduce particulate matter in the air, which has significant health effects to workers and any nearby residents. There are three methods of dust control: (1) Geotextiles, mats, plastic covers, and other mechanical methods (2) dust palliatives (soil binders), and (3) revegetation.

APPROPRIATE APPLICATIONS

Dust control measures should be applied at the following locations and activities:

- Grading Operations (land clearing and earthmoving)
- Drilling and blasting
- Batch drop operations (loader operation)
- Exposed areas, cleared unstabilized area.
- Vehicle traffic on unpaved surfaces
- Sediment tracking on paved surfaces
- Blasting and wrecking ball operations
- Soil and debris storage piles

The contractor is responsible for complying with the Maricopa County Air Quality regulations. Refer to Appendix C for additional information on dust control and air permit compliance in Maricopa County. A summary of the basic requirements are as follows:

- Permits require the use of reasonably available dust control measures.
- Enforce visible opacity emission limits to determine compliance.
- Require dust control plans for construction or land clearing projects.
- Enforcement activities with priority given to citizen complaints.
- Require contractors to maintain records.

LIMITATIONS

Dust suppresants have a range of limitations and precautions. Refer to Commonly Used Dust Suppressants Table for limitations of each type of dust suppressant.

- All dust suppressants are temporary in nature and may need reapplication(s) throughout the life of a project.
- Dust suppressants require a minimum curing time until fully effective, as prescribed by the manufacturer, which may be 24 hours or longer. Reapplication may be necesary after a storm event.
- Dust suppressants will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, the runoff may completely undercut the stabilized soil layer and discharge at a point further down the slope.
- Dust suppressants may not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.
- Some dust suppressants can be environmentally hazardous, especially if the dust suppressant dissolves in water. Dissolved chemicals can migrate with the runoff or percolate further below the ground surface. For additional information, refer to the EPA document, "Potential Environmental Impacts of Dust Suppressants: Avoiding Another Times Beach", referenced at the end of this BMP.
- Some dust suppressants do not perform well with low relative humidity, while others become slippery or leach out of the soil under heavy precipitation.

PLANNING CONSIDERATIONS

Many of the reasonably available control measures for controlling fugitive dust from construction sites can also be implemented as Best Management Practices for stormwater pollution prevention. Those best management practices include:

- Pave, vegetate, or chemically stabilize access points to paved roads.
- Provide covers for trucks transporting materials that contribute dust.
- Provide for wet suppression or chemical stabilization of exposed soils.
- Provide for rapid cleanup of sediments deposited on paved roads.
- Furnish stabilized construction road entrances and vehicle wash down areas.
- Stabilize unpaved haul roads, parking and staging areas.
- Implement dust control measures for material stockpiles.

- Prevent drainage of sediment-laden stormwater onto paved surfaces.
- Stabilize abandoned construction sites using vegetation or chemical stabilization methods.
- Limit the amount of areas disturbed by clearing and earth moving operations by scheduling these activities in phases.

RECOMMENDED STANDARDS AND SPECIFICATIONS

There are many products available as dust suppressants for chemicals available and recommendations for their use are summarized in Commonly Used Dust Suppressants Table.

RECOMMENDED MAINTENANCE AND INSPECTION

Dust control is an ongoing process during site construction. Re-application of dust control measure may be necessary until construction is complete.

POST CONSTRUCTION METHODS

Consider Revegetation or emulsion chip seals for more permanent dust control after the construction project has been completed.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction

U.S. Environmental Protection Agency, Nevada May 30-31, 2002, Potential Environmental Impacts of Dust Suppressants: “Avoiding Another Times Beach” An Expert Panel Summary, Las Vegas.

EC-7 Dust Control Photos

Wind blown dust.

EC-7 Dust Control Table

TABLE 5.2
COMMONLY USED DUST SUPPRESSANTS

Types	Functional Mechanism	Advantages	Limitations
Freshwater	Moisture wets particles, thereby increasing their mass and binding them together.	Usually readily available, low material cost, and easy to apply	Frequent light applications may be necessary during hot dry weather and can be labor intensive. Over application may result in loss of traction, erosion, or points of road failure.
Calcium Chloride	At a relative humidity greater than approximately 30% (77 F), the salts within the soil will pull moisture from the air above and retain it in the soil.	Reduces evaporation rate of surface moisture, lowers the freezing point of water, which reduces frost heave and freeze-thaw cycles, thereby reducing required road maintenance. Calcium Chloride also increases the compacted density of existing road base material. Effectiveness is retained after reblading.	Effectiveness in arid and semi-arid regions may be limited due to low relative humidity. It is very corrosive to aluminum alloys and slightly corrosive to steel. Solubility of calcium chloride results in leaching during heavy precipitation. Releases heat when mixed with water.
Magnesium Chloride	At a relative humidity greater than approximately 30% (77° F), the salts within the soil will pull moisture from the air above and retain it in the soil.	Reduces evaporation rate of surface moisture, lowers the freezing point of water, which reduces frost heave and freeze-thaw cycles, thereby reducing required road maintenance. Magnesium Chloride increases the compacted density of existing road base material more than Calcium Chloride. Effectiveness is retained after reblading.	Effectiveness in arid and semi-arid regions may be limited due to low relative humidity. It is very corrosive to aluminum alloys and slightly corrosive to steel. Solubility of calcium chloride results in leaching during heavy precipitation.
Lignin Derivatives	Act as adhesives by binding soil particles together and curing.	Greatly increases dry strength of soil, not humidity-dependent, imparts some plasticity to road surfaces, and lowers freezing point of road surface and base. Effectiveness is retained after reblading.	High solubility results in leaching during heavy precipitation. It is corrosive to aluminum alloys due to acidity ($CaCO_3$ can neutralize the acidity). Proper aggregate mix is important to performance. Becomes slippery when wet and brittle when dry.
Tree Resin Emulsions (tall oil)	Act as adhesives by binding soil particles together and curing.	Low solubility after curing minimizes leaching and provides degree of surface waterproofing. Imparts some plasticity to road surfaces, has a high bonding strength, and is non-corrosive.	Requires proper weather and time to cure. No residual effectiveness after reblading. Equipment requires prompt cleanup to avoid curing of resin in hoses and pipes.
Synthetic Polymer	Bind soil particles together by forming a polmerizing matrix; a function similar to adhesives.	Applicable to a range of emission sources and function well in sandy soil conditions. Some types allow seeded vegetation to grow through the polymer matrix.	Requires proper weather and time to cure. Water repellant. May be subject to UV (sunlight) degradation. Application equipment requires timely cleaning. Thre is no residual effectiveness after reblading.
Bituments, Tars, and Resins	Asphalt and resinous products are adhesive binding soil particles together. Petroleum oil products coat soil particles, increasing their mass and binding them together.	Water insoluble when dry; provide a degree of surface waterproofing. Good residual effectiveness.	Surface crusting fracturing arid potholing may develop. Long-term application may cause road to become too hard for reblading. Bituments won't lower freezing point and petroleum oil products lack adhesive characteristics.
Cementitious Based Binders	High purity gypsum mixes with water and mulch to form a thin cement-like crust on the soil surface.	Flexible, durable, water permeable, arid resists soil chemicals. Reduces amount of aggregate required during initial construction and has lower maintenance costs than other dust suppressants.	Cementitious based binders are only effective for dust control in non-traffic areas. Instead, consider mixing cementitious based binders with sub-base soils for greater soil strength.

EC-7 Dust Control Table

TABLE 5.2
COMMONLY USED DUST SUPPRESSANTS (CONT.)

Types	Ideal Soil Characteristics	Relative Cost Comparison (average life expectancy)	Environmental Considerations
Freshwater	None	Low initial cost, high long-term maintenance cost (0 months)	Minimal environmental hazard. If applied excessively, may result in erosion and sediment runoff . Supply may be limited in some areas and, depending on the source, may require a water right permit.
Calcium Chloride	Plasticityindex>8 10-20 percent fines passing the No. 200 sieve (by weight)	Low initial cost, medium long-term maintenance cost (1-6 months)	Repeated applications and long term use may harm adjacent vegetation (See the manufacturer's product information).
Magnesium Chloride	Plasticityindex>8 10-20 percent fines passing the No. 200 sieve (by weight)	Low initial cost, medium long-term maintenance cost (1-6 months)	Repeated applications and long term use may harm adjacent and nearby vegetation (See the manufacturer's product information).
Lignin Derivatives	Plasticityindex>8 10-30 percent fines passing the No. 200 sieve (by weight)	Medium initial cost, low long-term maintenance cost (3-12 months)	Lignin products have high BOD (biological oxygen demand) in aquatic systems. Spills or runoff into surface or groundwaters may create low dissolved oxygen conditions resulting in fish kills or increases in ground water concentrations of iron, sulfur compounds arid other pollutants. (See the product MSDS for specific information).
Tree Resin Emulsions (tall oil)	Plasticityindex<3 10-20 percent fines passing the No. 200 sieve (by weight)	Medium initial cost, low long-term maintenance cost (1-6 months)	(See the manufacturer's product information)
Synthetic Polymer	Plasticityindex<3 5-20 percent fines passing the No. 200 sieve (by weight)	High initial cost, low long-term maintenance cost (1-3 months)	(See the manufacturer's product information)
Bituments, Tars, and Resins	Plasticityindex<3 <20 percent fines passing the No. 200 sieve (by weight)	High initial cost, high long-term maintenance cost (1-3 months)	Use of used oils prohibited. Some petroleum based products may contain carcinogenic polycyclic aromatic hydrocarbons (PAHs). (See the manufacturer's product information)
Cementitious Based Binders	Depending on the type of cementitious based binder, will work with both high and low plasticity index soils.	Low initial cost, medium long-term maintenance cost (3-6 months)	None

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EC-8 Temporary Access Waterway Crossing

DEFINITION

A temporary access stream crossing is a structure placed across a waterway to provide access for construction purposes for a period of less than one year.

GENERAL INFORMATION

Applicability - Effectiveness
Inlet Drain Protection - high
Debris Management, Cleanup, and Washout - high

Most effective when used with:

None

Alternative BMPs:

None

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease		X	
Nutrients			X
Sediment			X
Floatable Material			X
Metals			X
Other Construction Waste		X	

FIGURES

Photos/Sketches

EC-8 Temporary Access Waterway Crossing Photos

CAD Drawings

Temporary Access Culvert

Temporary Access Ford

PURPOSE

The purpose of the temporary access waterway crossing is to provide a safe, pollution free access across a stream. Temporary access waterway crossings are necessary to prevent construction equipment from damaging the stream and tracking sediment and other pollutants into the waterway.

APPROPRIATE APPLICATIONS

Temporary stream crossings are installed at sites:

- Where appropriate permits have been secured (404 Permits and/or 401 Certification).
- Where construction equipment or vehicles need to frequently cross a waterway.
- When alternate access routes that do not cross streams impose significant constraints to the project
- Construction activities will not last longer than one year.

There are two main temporary access waterway crossings that are generally constructed:

- Temporary access culverts - are effective in controlling erosion, easily constructed, and allow for heavy equipment loading.
- Temporary access fords - offer very little sediment and erosion control and are only effective in ephemeral stream channels. Temporary fords are the least expensive waterway crossing, allow for maximum load limits, and require minimal maintenance.

LIMITATIONS

- Temporary access culverts - often require maintenance and can cause erosion if stream flow is restricted. Culverts usually disturb the waterway during installation and removal.
- Temporary access fords - offer little erosion control.
    - May require section 401 and 404 certification of the Clean Water Act prior to installing a temporary access ford.
    - Special care must be taken for all these practices when crossing an environmentally sensitive stream. Oils or other potentially hazardous materials should not be used for surface treatments.

PLANNING CONSIDERATIONS

- Most streams within Maricopa County will be flowing only after moderate to heavy rainfalls. For minor washes, no crossing may be necessary. For larger streams, the contrac-

tor should consider the time of year, construction schedule and construction requirements. For crossing intermittently flowing streams, a shallow access ford or culvert is recommended. Temporary culverts must be sized and installed per the requirements of the Flood Control District of Maricopa County or local municipal stormwater agency.

- Construction in dry streams should be at or near the natural invert of the streambed to prevent flooding upstream of the crossing. Construction in waterways may be subject to additional permit requirements. Contact the Flood Control District of Maricopa County or local municipal stormwater agency for information.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Temporary culverts should be sized and installed per the requirements of the Flood Control District of Maricopa County and the ADOT Construction Manual, Sections 501 and 502.

RECOMMENDED MAINTENANCE AND INSPECTION

- Periodically remove debris behind fords, in culverts, and under bridges.
- Replace protective aggregate from culvert inlets and outlets that were eroded and lost during a storm.
- Remove a temporary crossing promptly when it is no longer needed.
- Check for structural weakening of the temporary crossing, such as cracks, and undermining of foundations and abutments.
- Inspect, at a minimum, weekly and after each significant rainfall. The inspection should include:
    - Checking for blockage in the channel, debris buildup in culverts or fords, and under bridges or trapped debris.
    - Checking for erosion of abutments, channel scour, riprap displacement, or piping in the soil.

POST CONSTRUCTION METHODS

Fords are only temporary waterway crossings and the stream must be returned to the original natural state as it was prior to construction. Temporary access culverts may remain permanent, per the requirements of the Flood Control District of Maricopa County and the ADOT Construction Manual, Sections 501 and 502.

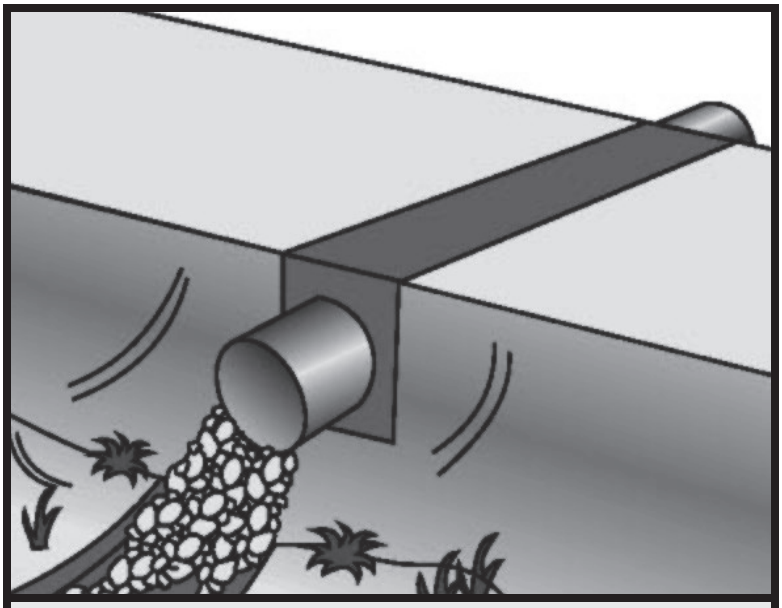
REFERENCES

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Carolina Department of Transportation, August 2003, Best Management Practices for Construction and Maintenance Activities, Chapter 5.0 “Operation Best Management Practices”, http://www.doh.dot.state.nc.us/operations/BMP_manual/

EC-8 Temporary Access Waterway Crossing Photos



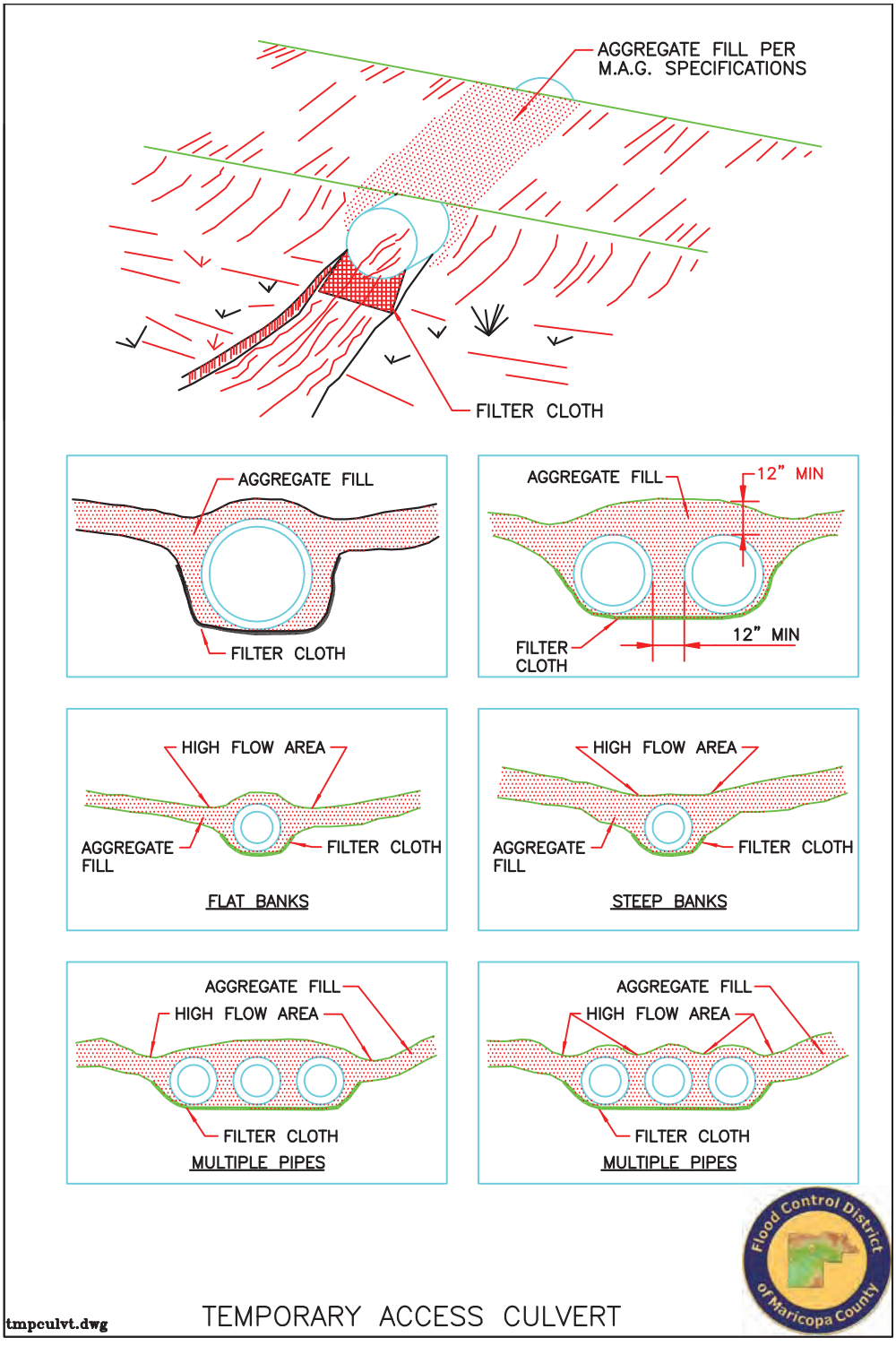
Schematic of a temporary access culvert.

Courtesy of CALTRANS

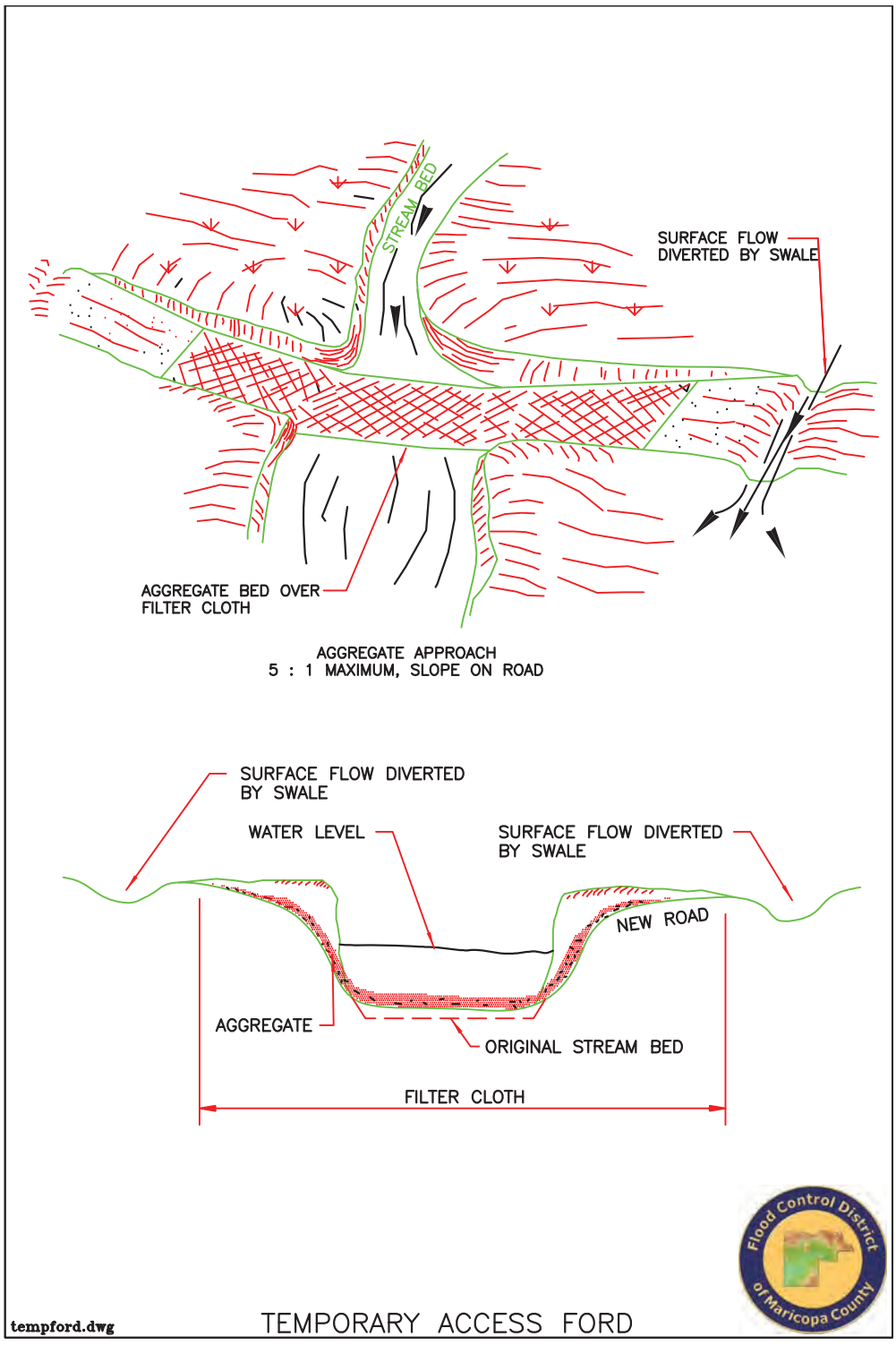
Temporary access culvert.

Courtesy of NCDOT

EC-8 Temporary Access Waterway Crossing Drawing



EC-8 Temporary Access Waterway Crossing Drawing



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EC-9 Diversion Dikes

DEFINITION

A ridge of compacted soil (recommended with a vegetated lining) that is often located at the top or base of a sloping disturbed area, and redirects runoff to a less sensitive outfall or area.

GENERAL INFORMATION

Applicability - Effectiveness
Slope Protection - high
Excavated areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high

Most effective when used with:

EC-1 Erosion Control Mats to help reduce erosion along the dike.

EC-4 Pipe Slope Drains to provide additional control if flow cannot be completely routed around the disturbed area.

Alternative BMPs:

For a less expensive, temporary control, consider SPC-2 Sand Bag Barrier

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material		X	
Metals			X
Other Construction Waste			X

FIGURES

Photos/Sketches

EC-9 Diversion Dikes Photos

CAD Drawings

Diversion Dikes

PURPOSE

Depending on the location and topography, diversion dikes can achieve two different goals:

- Located on the upslope of a site, they can prevent surface sheet flow runoff from entering a disturbed construction site.
- Located on the downslope of a site, they can divert sediment-laden runoff created onsite to sediment trapping devices, preventing soil loss from the disturbed area.

APPROPRIATE APPLICATIONS

Diversion dikes may be used to:

- Intercept and divert runoff to avoid sheet flow over sloped surfaces.
- Divert and direct runoff towards a stabilized watercourse, drainage pipe or channel.
- Intercept runoff from paved surfaces.

Diversion dikes may be installed:

- Below steep grades where runoff begins to concentrate.
- Along roadways and facility improvements subject to flood drainage.
- At the top of slopes to divert runon from adjacent or undisturbed slopes.
- At bottom and mid-slope locations to intercept sheet flow and convey concentrated flows.

LIMITATIONS

- Limit to upstream drainage areas of 10 acres or less and for slopes less than 5 percent. For larger areas more permanent structures should be built.
- All structures should be in compliance with hydraulic design standards set by the local municipality or Flood Control District of Maricopa County.
- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately which increases maintenance and installation costs.
- Diverted stormwater flow may cause flood damage to adjacent areas.
- Diversion dikes are not suitable as sediment trapping devices.

- The concentrated runoff in a channel or ditch has increased erosion potential. To alleviate this erosion capability, diversion dikes must be used in conjunction with sediment trapping devices, soil stabilization, and sediment controls.

PLANNING CONSIDERATIONS

Several considerations must be made before installing diversion dikes. Diversion dikes can either be installed temporarily or as a permanent structure:

Temporary diversion dikes are generally made up of earth material. Earth dikes are advantageous because they can handle flows from large drainage areas, are relatively inexpensive and easy to install, use onsite materials, and once stabilized, earth dikes require little maintenance. However, earth dikes, alone, do not control erosion or remove sediment from runoff. Rather, they direct runoff to erosion control devices such as Temporary Sediment Basins or Temporary Sediment Traps, or away from an erodible surface. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations.

For large flows, earth dikes can begin to erode and further contribute to the sediment loading in the runoff. Stone, recycled concrete, rip-rap, or filter cloth can be used to temporarily stabilize a diversion dike (see Recommended Standards and specifications below).

Consider using Erosion Control Mats and Pipe Slope Drains in conjunction with a Sand Bag Barrier for additional erosion control and stabilization.

RECOMMENDED STANDARDS AND SPECIFICATIONS

- All dikes should be compacted by earth-moving equipment.
- All dikes should have positive drainage to an outlet.
- Top width may be wider and side slopes may be flatter if desired to facilitate crossing by construction traffic.
- Runoff should be conveyed to a sediment trapping device such as a sediment trap or sediment basin when either the dike channel or the drainage area above the dike are not adequately stabilized.
- Temporary stabilization, when necessary, should be as scheduled below:
    - Stone or recycled concrete equivalent, should be applied in a layer at least 8 inches in thickness and be pressed into the soil with construction equipment.
    - Rip-rap should be applied in a layer at least two times the D50 and pressed into the soil.
    - Approved equivalents can be substituted for any of the above materials.

- Filter cloth and erosion control mats may be used for dikes in use for long periods.

RECOMMENDED MAINTENANCE AND INSPECTION

- Inspect temporary measures prior to the rainy season, after rainfall events, and regularly during the rainy season.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.

POST CONSTRUCTION METHODS

By providing a vegetated cover to the diversion dike, the dike can become a permanent structure.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

North Carolina Department of Transportation, August 2003, Best Management Practices for Construction and Maintenance Activities, Chapter 5.0 “Operation Best Management Practices”, http://www.doh.dot.state.nc.us/operations/BMP_manual/

Center for Watershed Protection, Inc., Stormwater Manager’s Resource Center (SMRC). http://www.stormwatercenter.net/

Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA.

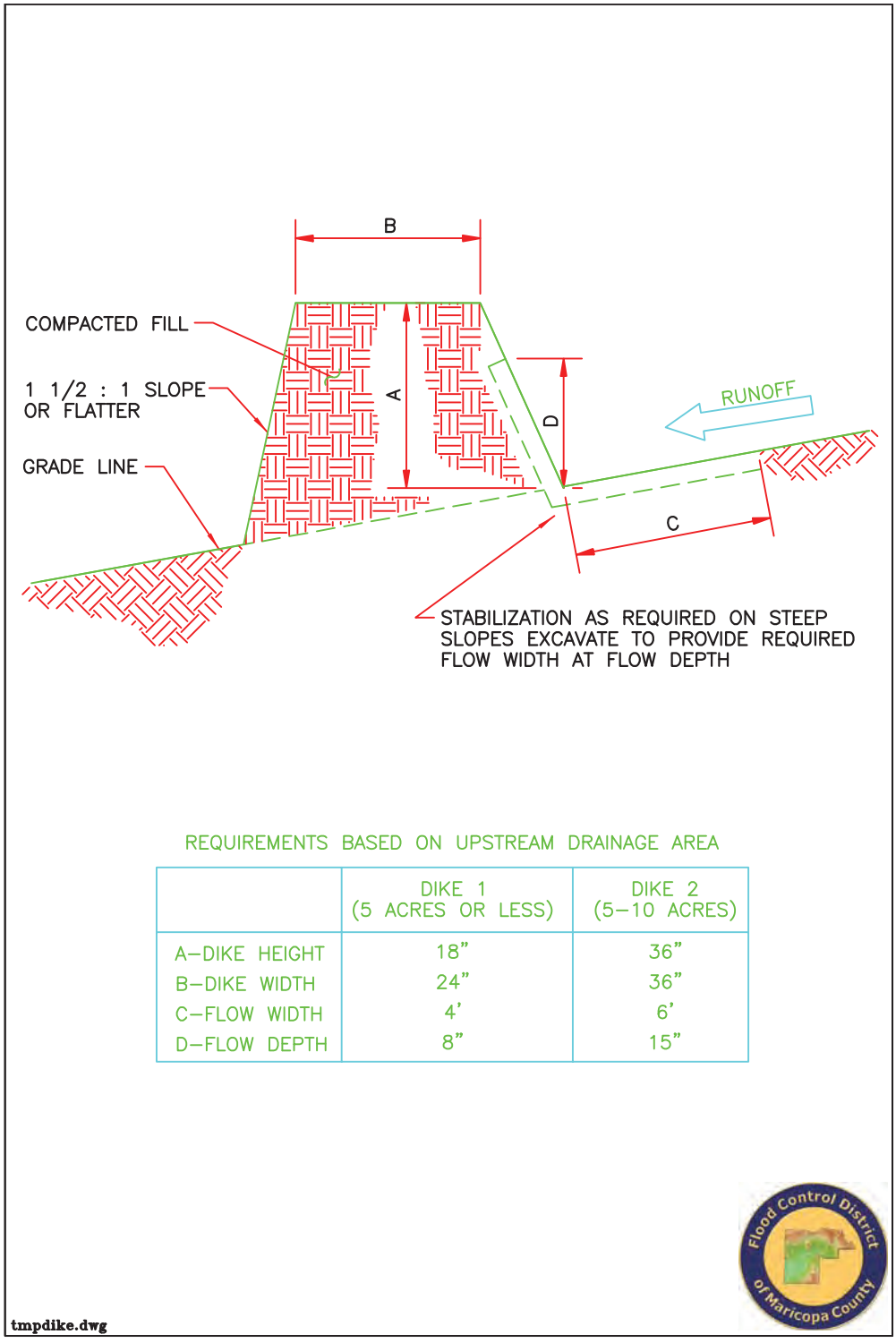
EC-9 Diversion Dikes Photos

A temporary diversion dike can be stabilized with straw mulching.

Courtesy of Douglas County

Permanent diversion dikes can be constructed of grouted riprap and vegetated.

EC-9 Diversion Dikes Drawing



REQUIREMENTS BASED ON UPSTREAM DRAINAGE AREA

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

tmpdike.dwg

EC-10 Drainage Swales

DEFINITION

A drainage way with a lining of grass, stone, asphalt, concrete, or other material. Permanent channels must be designed and constructed in accordance with appropriate local design standards.

GENERAL INFORMATION

Applicability - Effectiveness

Slope Protection - high
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high
Channels and Medians - high

Most effective when used with:

EC-11 Outlet Protection, Velocity Dissipation Devices

EC-1 Erosion Control Mats

SPC-4 Check Dams

All of the above provide erosion control for higher flows.

Alternative BMPs:

EC-9 Diversion Dikes

RATINGS

Associated Costs	**H**	**M**	**L**
Implementation	X		
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment	X		
Floatable Material			X
Metals		X	
Other Construction Waste		X	

FIGURES

Photos/Sketches

Drainage Swales Photos

CAD Drawings

Drainage Swales Drawing

PURPOSE

Drainage swales are used as perimeter controls or slope protection to convey runoff without causing erosion by intercepting runoff from above unprotected slopes or at the perimeter and directing the runoff to a sediment trapping device or stabilized outlet. Depending on the design of the drainage swale, different objectives can be achieved. A meandering or winding swale with vegetation helps to reduce flow velocities and reduce suspended sediments. A straight, lined swale provides the maximum conveyance of drainage flows.

APPROPRIATE APPLICATIONS

Drainage swales and lined ditches may be used to:

- Convey surface runoff down sloping land.
- Intercept and divert runoff to avoid sheet flow over sloped surfaces.
- Divert and direct runoff towards a stabilized watercourse, drainage pipe or treatment facility.
- Intercept runoff from paved surfaces.

Drainage swales and lined ditches may be used:

- Below steep grades where runoff begins to concentrate.
- Along roadways and facility improvements subject to flood drainage.
- At the top of slopes to divert runon from adjacent or undisturbed slopes.
- At bottom and mid-slope locations to intercept sheet flow and convey concentrated flows.

LIMITATIONS

- Temporary drainage swales or any diversion of runoff should not adversely impact upstream or downstream properties and must conform to local floodplain management regulations.
- Constructing the proper swale to handle the desired runoff flows often requires engineering design work which can be costly.
- Swales can be expensive to construct if a liner is required.
- Interceptor swales must be stabilized quickly upon excavation in order not to contribute further to the sediment loading.

PLANNING CONSIDERATIONS

Consider using Outlet Protection, Velocity Dissipation Devices, Erosion Control Mats, and Check Dams in conjunction with Drainage Swales to provide erosion control for higher flow rates.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Once the proper geometry and lining is used in a drainage swale, large volumes of flows can be effectively conveyed and/or treated with little maintenance. Velocity dissipation devices should be installed at the beginning or end of the swale to prevent erosion or scour.

Design and Sizing Criteria

The Hydraulics Manual of the Flood Control District of Maricopa County will be used for all appropriate design criteria. In addition:

1. All temporary swales should have uninterrupted grade to an outlet.
2. Diverted runoff from a disturbed area should be conveyed to a sediment trapping device.
3. Diverted runoff from an undisturbed area should outlet directly into an undisturbed stabilized area at non-erosive velocity.
4. All trees, brush, stumps, and obstructions, may need to be removed and disposed of so as not to interfere with the proper functioning of the swale, but can remain for sediment filtration.
5. The swale should be excavated or shaped to line, grade, and cross section as required to meet the criteria specified herein and be free of bank projections or other irregularities which will impede normal flow.
6. Fills should be compacted by earth moving equipment.
7. All earth removed and not needed on construction should be placed so that it will not interfere with the functioning of the swale.
8. For flow velocities up to 4 feet per second, use vegetation. For flow velocities less than 4 feet per second, apply a vegetated cover to the channel. For velocities greater than 4 feet per second, consult the table below.

Flow Stabilization

Type of Treatment	Channel Grade%	Average Diameter of Rock Drainage Area <5 acres	5-10 acres
1	0.5 - 1.0	4” Rock	4” Rock
2	1.1 - 2.0	6” Rock	6” Rock
3	2.1 - 3.0	8” Rock	Rip-Rap 6-12”
4	3.1 - 5.0	8-12” Rip-Rap	Engineered

Note: Refer to the drainage swale CAD drawing file for specified dimensions.

RECOMMENDED MAINTENANCE AND INSPECTION

- Inspect temporary measures prior to the rainy season, after rainfall events, and regularly during the rainy season.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment, and repair linings and embankments as needed.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

POST CONSTRUCTION METHODS

By providing a vegetated cover to the diversion swale, the swale can become a permanent structure.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II.

http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

Center for Watershed Protection, Inc., Stormwater Manager's Resource Center (SMRC). http://www.stormwatercenter.net/

Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA.

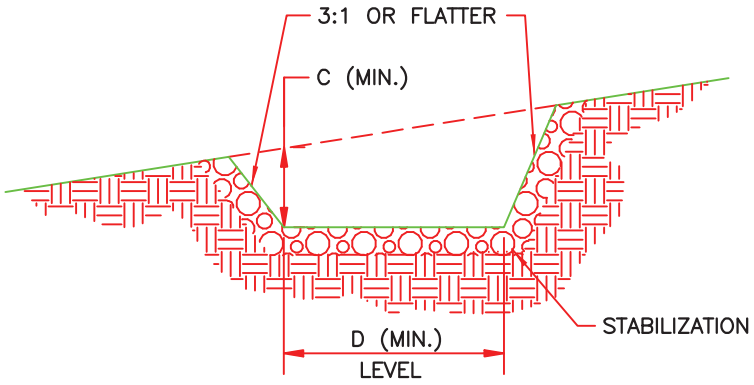
Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

EC-10 Drainage Swales Photos

When possible, leave existing vegetation in the drainage swale for added velocity reduction.

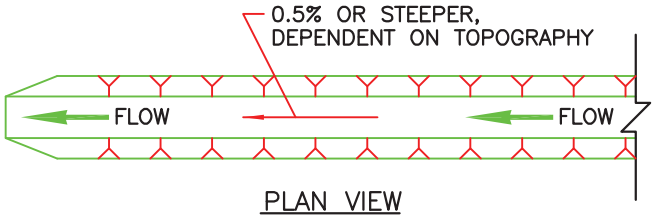
Permanent drainage swales are often vegetated.

EC-10 Drainage Swales Drawing



	SWALE A	SWALE B
C	1'	1'
D	4'	6'

CROSS SECTION VIEW



PLAN VIEW

tmpswale.dwg

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AEC-11 Outlet Protection, Velocity Dissipation Devices

DEFINITION

A section of rock protection placed at the outlet end of culverts, conduits or channels. Grouted riprap and concrete rubble are also used for pipe outlet stabilization.

GENERAL INFORMATION
Applicability - Effectiveness Perimeter and Access Controls - high
Most effective when used with: None
Alternative BMPs: None

RATINGS			
Associated Costs	**H**	**M**	**L**
Implementation	X		
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment	X		
Floatable Material			X
Metals			X
Other Construction Waste			X

FIGURES

Photos/Sketches

EC-11 Outlet Protection, Velocity Dissipation Devices Photos

CAD Drawings

Pipe Outlet Conditions

PURPOSE

The purpose of the rock outlet protection is to reduce the velocity, and energy of water, such that the flow will not erode the receiving downstream reach.

APPROPRIATE APPLICATIONS

This practice applies where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the next downstream reach.

Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters; it also serves to trap sediment and reduce flow velocities. Rock size should be increased for high velocity flows.

LIMITATIONS

Rock outlet protection may need continual maintenance because large storms often wash away the stone and leave the area susceptible to erosion. Grouted or wire-tied rock riprap can minimize maintenance requirements.

PLANNING CONSIDERATIONS

Rock outlet protection is effective when the rock is sized and placed properly. When this is accomplished, rock outlets do much to limit erosion at pipe outlets. If runoff is sediment-laden, a sediment trap below the pipe outlet is recommended.

Permanent rock riprap protection should be designed and sized by the engineer as part of the culvert, conduit or channel design.

RECOMMENDED STANDARDS AND SPECIFICATIONS

General recommendations for rock size and length of outlet protection mat are shown in the CAD drawing figure.

General recommendations for rock size and length of outlet protection mat shown in the rock outlet protection figure. Best results are obtained when sound, durable, angular rock is used.

RECOMMENDED MAINTENANCE AND INSPECTION

Inspect monthly and after each rainfall. Replace rocks as needed.

POST CONSTRUCTION METHODS

Rock outlet protection and other velocity dissipation devices can remain after the construction project for long term erosion protection. However, the design engineer should consult with the local municipality or the Flood Control District of Maricopa County for specific requirements of permanent outlet protection.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

North Carolina State University, (NCSU) North Carolina Nonpoint Source Pollution Control Measures http://h2osparc.wq.ncsu.edu/info/bmps.html

City of Austin, Texas, March, 2004, Environmental Criteria Manual.

Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1992, Virginia Erosion and Sedimentation Control Handbook, Thrid Edition.

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

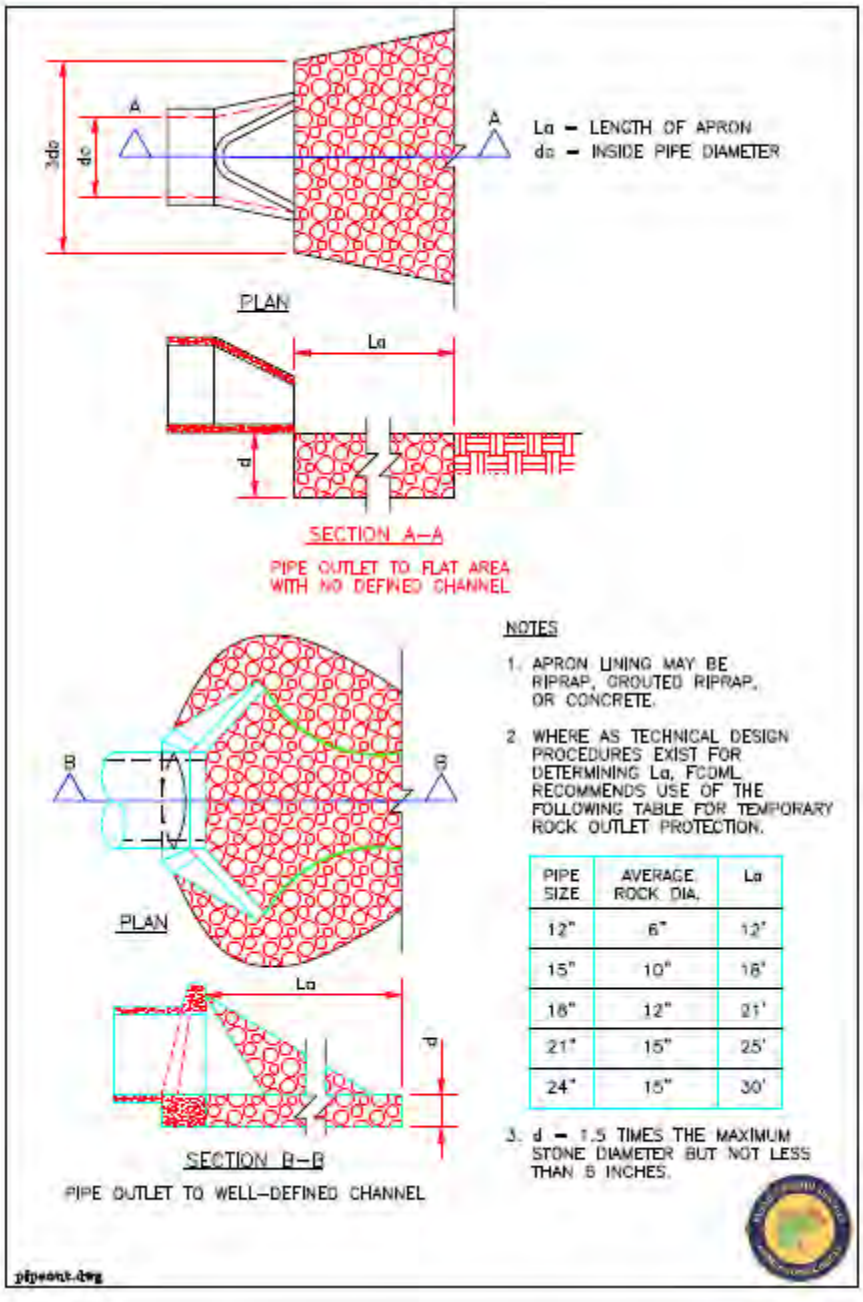
AEC-11 Outlet Protection, Velocity Dissipation Devices Photos

Schematic of culvert outlet protection.

Courtesy of CALTRANS

Drainage outlet protection to the shoulder of a highway.

AEC-11 Outlet Protection, Velocity Dissipation Devices Drawing



PIPE SIZE	AVERAGE ROCK DIA.	La
12"	6"	12'
15"	10"	16'
18"	12"	21'
21"	15"	25'
24"	15"	30'

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EC-12 Surface Roughening

DEFINITION

A temporary erosion control practice often used in conjunction with grading. Soil roughening involves increasing the relief of a bare soil surface with horizontal grooves, stair-stepping (running parallel to the contour of the land), or tracking using construction equipment. Slopes that are not fine graded and that are left in a roughened condition can also reduce erosion.

GENERAL INFORMATION

Applicability - Effectiveness
Slope Protection - moderate

Most effective when used with:

EC-2 Mulching to establish vegetation

EC-9 Diversion Dikes to divert flow away from the slope

Alternative BMPs:

For inaccessible slopes/areas, use EC-1 Erosion Control Mats

For slopes or loose soils, use EC-4 Pipe Slope Drains

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment	X		
Floatable Material			X
Metals			X
Other Construction Waste			X

FIGURES

Photos/Sketches

EC-12 Surface Roughening Photos

CAD Drawings

Stair-Stepping Cut Slopes and Grooving Slopes

PURPOSE

Soil roughening reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares the soil for seeding and planting by giving seed an opportunity to take hold and grow.

APPROPRIATE APPLICATIONS

Soil roughening is appropriate for slopes up to 3:1 or higher than 5 vertical feet, on piles of excavated soil, and in areas with highly erodible soils. This technique is especially appropriate for soils that are frequently mowed or disturbed because roughening is relatively easy to accomplish. To slow erosion, roughening should be done as soon as possible after the vegetation has been removed from the slope. Roughening can be used with both seeding and planting and temporary mulching to stabilize an area. For steeper slopes and slopes that will be left roughened for longer periods of time, a combination of surface roughening and vegetation is appropriate. Alternatively consider terracing along steep slopes. Roughening should be performed immediately after grading activities have ceased (temporarily or permanently) in an area.

LIMITATIONS

- Soil roughening is not appropriate for rocky slopes.
- Soil compaction might occur when roughening with tracked machinery.
- Soil roughening is of limited effectiveness in anything more than a gentle or shallow depth rain.
- If roughening is washed away in a heavy storm, the surface will have to be re-roughened and re-seeded or revegetated.

PLANNING CONSIDERATIONS

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but they encourage water infiltration, speed the establishment of vegetation, and decreased runoff velocity.

Rough, loose soil surfaces give lime, fertilizer, and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-

step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.
2. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established. Stairs should be wide enough to work with standard earth moving equipment.
3. Areas which will be mowed should have slopes less than 3:1 and may have small furrows left by discing, harrowing, raking, or seed-planting machinery operated on the contour.
4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased.

For longer slopes or where heavy equipment cannot operate, consider using Erosion Control Mats, and Pipe Slope Drains. Surface roughening is most effective when used with Mulching to establish vegetation or Diversion Dikes to divert flow away from the slope.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Graded areas with slopes greater than 3:1 but less than 2:1 should be roughened before seeding. This can be accomplished in a variety of ways, including "track walking," or driving a crawler tractor up and down the slope, in leaving a pattern of cleat imprints parallel to slope contours.

Graded areas steeper than 2:1 should be stair-stepped with benches as shown in the CAD drawing. The stair-stepping will help vegetation become established and also trap soil eroded from the slopes above. As slopes become steeper, benches can be widened to terraces.

RECOMMENDED MAINTENANCE AND INSPECTION

Areas need to be inspected after storms, since roughening might need to be repeated. Regular inspection of roughened slopes will indicate where additional erosion and sediment control measures are needed. If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, they should be filled, graded again, and reseeded immediately. Proper dust control methods should be used.

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

North Carolina State University, (NCSU) North Carolina Nonpoint Source Pollution Control Measures. Measures. http://h2osparc.wq.ncsu.edu/info/bmps.html

North Carolina Department of Transportation, August 2003, Best Management Practices for Construction and Maintenance Activities, Chapter 5.0 “Operation Best Management Practices”, http://www.doh.dot.state.nc.us/operations/BMP_manual/

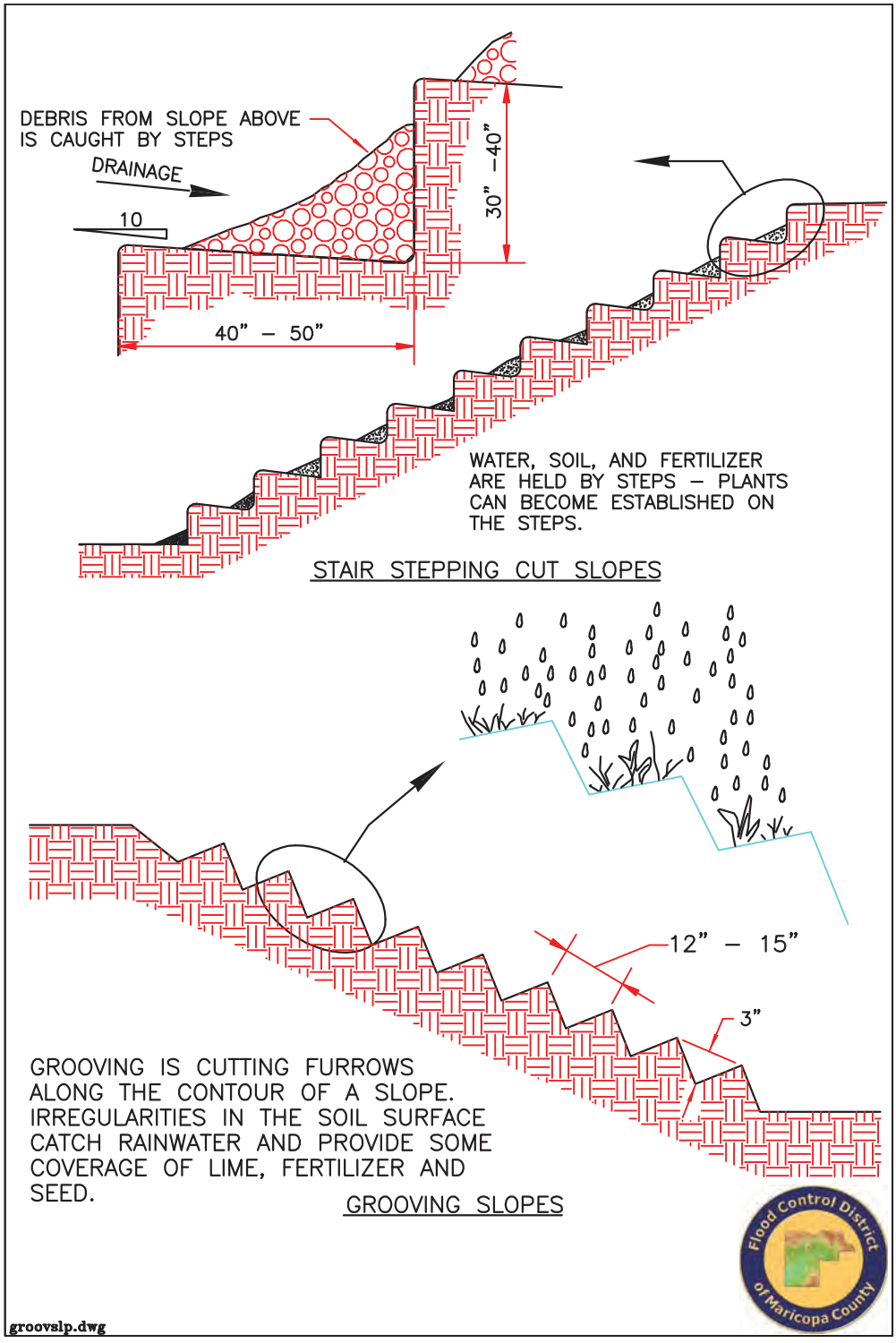
Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

EC-12 Surface Roughening Photos

Creating a roughened soil surface can reduce runoff velocities and increase infiltration.

Courtesy of Douglas County

EC-12 Surface Roughening Drawing



SPC Sediment and Pollutant Control

Sediment and pollutant control includes methods for separating and containing suspended sediment and other construction related pollutants from the stormwater before the water leaves the project site and enters a strom drain inlet or a receiving natural water body. These methods involve constructing organic, sand, and rock barriers to filter sediment-laden runoff, protecting storm drain inlets, and constructing settling ponds. If a pre-manufactured product is to be implemented on a site for sediment or pollutant control, the contractor should always follow the manufacturer's installation and maintenance recommendations as the primary reference for implementation.

VENDOR PRODUCTS

See VENDOR LIST for Sediment and Pollutant Control BMPs.

Disclaimer

Any hyperlinks in the vendor products table will direct you out of the Flood Control District of Maricopa County (FCDMC) domain. FCDMC is providing the following vendor information for possible assistance to any interested parties, but does not necessarily endorse any of the information or products provided by the vendors.

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ASPC-1 Organic Filter Barrier

DEFINITION

A temporary barrier of straw bales or similar material used to intercept sediment laden runoff from small drainage areas of disturbed soil. Purpose the purpose of a straw bale dike is to reduce runoff velocity and cause position of the transported sediment load.

GENERAL INFORMATION

Applicability - Effectiveness

Slope Protection - moderate
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high

Most effective when used with:

SPC-8 Temporary Sediment Basins

SPC-9 Temporary Sediment Traps

Alternative BMPs:

For higher flows or paved surfaces, consider rock socks detailed under SPC-2 Sand Bag Barrier.

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance	X		
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment			X
Floatable Material	X		
Metals			X
Other Construction Waste		X	

FIGURES

Photos/Sketches

SPC-1 Organic Filter Barrier Photos

CAD Drawings

Organic Filter Barrier

PURPOSE

Organic filter barriers reduce runoff velocity and cause deposition of the transported sediment load. They are well suited to sites with small disturbed drainage areas that are not subjected to concentrated flows and that will ultimately be seeded, sodded, or landscaped.

APPROPRIATE APPLICATIONS

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

LIMITATIONS

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

PLANNING CONSIDERATIONS

When installed and maintained properly, straw bale dikes remove approximately 67% of the sediment transported in construction site runoff. This optimum efficiency can only be achieved through careful maintenance with special attention to replacing rotted or broken bales. Barrier should be constructed on a level contour to prevent concentration of flow against a small portion of the barrier.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Design & Sizing Criteria

1. Bales shall be placed on the contour and in a row with ends tightly abutting the adjacent bales.

2. Maximize pending by locating barrier away from the toe-of-slopes. This also provides access for maintenance.

3. Each bale shall be embedded in the soil a minimum of four inches and placed so the bindings are horizontal. Bindings placed on soil will soon disintegrate and cause the barrier to fail.

4. Bales shall be securely anchored in place by either two stakes or re-bars driven through the bale. The first stake in each bale shall be driven toward the previously laid bale at an angle to force the bales together. Stakes shall be driven flush with the bale.

5. Bales shall be removed when they have served their usefulness so as not to block or impede storm flow or drainage.

Specifications

See Organic Filter Barrier Drawing for the required dimensions of organic filter barriers as described below.

- Size: Each organic filter barrier should be a minimum of 14" wide, 18" high, 36" long and should have a minimum weight of about 50 lbs. Alternatively, organic filter barriers can be trapezoidal or triangular in shape. Organic filter barriers can either be comprosed entirely of straw (i.e. straw bale), or constructed of a mixture of 50% compost and 50% wood mulch (untreated woodchips less than 5 inches in length, 95% passing a 2 inch screen, and less than 30% passing a 1 inch screen.)

- Bindings: Barrier should be bound by steel wire, nylon or polypropylene string placed horizontally. Jute and cotton binding should not be used. Baling wire should be a minimum diameter of 0.06 inches. Nylon or polypropylene string should be approximately 0.08 inches in diameter with a breaking strength of no less than 80 lb-force.

- Stakes: Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Steel bar reinforcement should be equal to a number four designation or greater. End protection should be provided for any exposed bar reinforcement.

RECOMMENDED MAINTENANCE AND INSPECTION

Inspect monthly and after each rain event. Remove and properly dispose of detained sediments when silt depth reaches 6".

POST CONSTRUCTION METHODS

There are no post construction uses for organic filter barriers, but filter barriers can be dismantled and used as mulching for erosion control purposes when a filter barrier is no longer needed.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

Fifield, J.S., 2002, Field Manual on Sediment and Erosion Control, Forester Press, Santa Barbara CA.

Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA.

ASPC-1 Organic Filter Barrier Photos

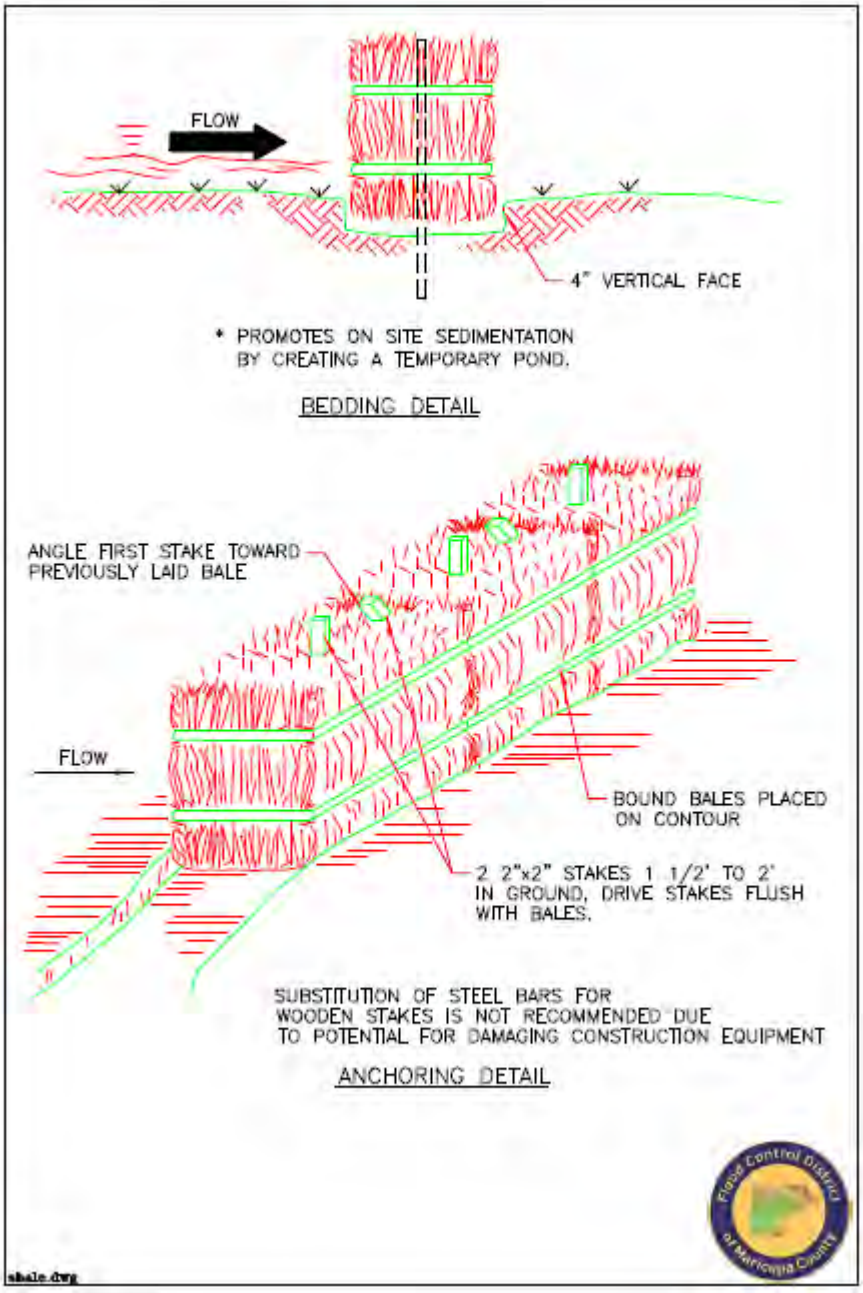
Properly staked organic filter barrier.

Storm wattle (wrapped).

Courtesy of Kristar

Use of an organic filter barrier in the highway median.

ASPC-1 Organic Filter Barrier Drawing



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SPC-2 Sand Bag Barrier

DEFINITION

A temporary berm constructed of stacked sandbags, along the perimeter of a site, installed across a channel, or along the right of way in a disturbed area. The sandbags may be filled with pea-sized gravel to enhance filtration.

GENERAL INFORMATION

Applicability - Effectiveness

Slope Protection - moderate
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high

Most effective when used with:

An Erosion Control (EC) BMP

Alternative BMPs:

If the berm is to be permanent, consider using SPC-4 Check Dams

If used for storm drain inlet protection, consider other methods under SPC-7 Storm Drain Inlet Protection

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance	X		
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material	X		
Metals		X	
Other Construction Waste		X	

FIGURES

Photos/Sketches

SPC-2 Sand Bag Barrier Photos

CAD Drawings

Sand Bag Barrier

PURPOSE

A sandbag barrier is designed to intercept and slow the flow of sediment-laden runoff. Sandbag barriers allow sediment to settle from runoff before water leaves the construction site.

APPROPRIATE APPLICATIONS

Sandbag berms may be used during construction activities when the contributing areas is less than 5 acres. Sandbag berms may also be used to create temporary sediment traps, retention basins and in place of straw bales or silt fences. They are also useful for storm drain protection because they do not need to be anchored down to the paved surfaces. Two main applicable areas include:

Perimeter control

- These areas include the entire construction site boundary, around stockpiles, along streams and channels, across channels to serve as a barrier for utility trenches, parallel to a roadway to keep sediment off paved areas, and along the perimeter of vehicle and equipment fueling and maintenance areas or chemical storage areas.

- Furthermore, sand bag barriers are useful when site conditions or construction sequencing require adjustments or relocation of the barrier to meet changing field conditions and needs during construction, and to temporarily close or continue broken, damaged or incomplete curbs.

Temporary diversion structure

- Sand bag barriers can be used as a temporary diversion structure below the toe of exposed and erodible slopes and down slope of exposed soil areas. They can also be used as a temporary sediment/desilting basin.

LIMITATIONS

- Limit the drainage area upstream of the barrier to 10 acres or less.

- Degraded sandbags may rupture when removed, spilling sand.

- Sandbag barrier installation can be labor intensive.

- Sandbag barriers have limited durability for long-term projects.

- When used to detain concentrated flows, maintenance requirements of sandbags increases.

PLANNING CONSIDERATIONS

Sandbag barriers are appropriate to use when construction of check dams in a channel is unnecessary. They can provide the same function as a check dam without disturbing the stream or vegetation. The sandbag barrier can also retain sediment prior to construction of final detention basins. For lower flows and paved surfaces, consider using rock socks (described below in Recommended Standards and Specifications). Small rock socks are easier to handle and cause less traffic probems than sand bags.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Materials

- Sandbags: The bag should be made of woven polypropylene, polyethylene or polyamide fabric, minimum unit weight 4 ounces per square yard, mullen burst strength exceeding 300 psi in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. **Use of burlap is not acceptable.** Bag dimensions are nominal, and may vary based on locally available materials. Sand-filled bags should generally are 24-30 inches long, 16-18 inches wide, 6-8 inches thick, and weigh approximately 90-125 pounds. The choice of fill material depends on the objectives that are desired from the sand bag barriers. If fine grained sand is used as fill material, the sand bag barrier will provide a barrier and act as a diversion dike. If coarser grained materials are used (i.e. pea-sized gravel), the barrier will allow flow to pass through and act more as a sediment filter.

- Rock socks: An alternative to sand bags, are rock socks, which are more elongated that sand bags and contain pea-size rock. A rock sock should be made of a loosely woven material, such as burlap, when used for filtration. A tighter weave, such as a geotextile, is better for diversion. Note that burlap rock socks are not as sturdy as geotextile ones, but can be recycled on site since they quickly biodegrade.

Installation

- When used as a linear sediment control:
    - Install along a level contour.
    - Turn ends of sandbag row up slope to prevent flow around the ends.
    - Generally, sandbag barriers should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.
    - Sandbag barriers should be set back at least 3 feet from the toe of a slope where practical.

RECOMMENDED MAINTENANCE AND INSPECTION

- Inspect sandbag barriers before and after each rainfall event, and weekly throughout the rainy season.
- Reshape or replace sandbags as needed.
- Inspect sandbag barriers for sediment accumulations and remove sediments when accumulation reaches one-third the barrier height.
- Remove sandbags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

POST CONSTRUCTION METHODS

None.

REFERENCES

City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention, January 1993, Tacoma Public Works Environmental Services. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

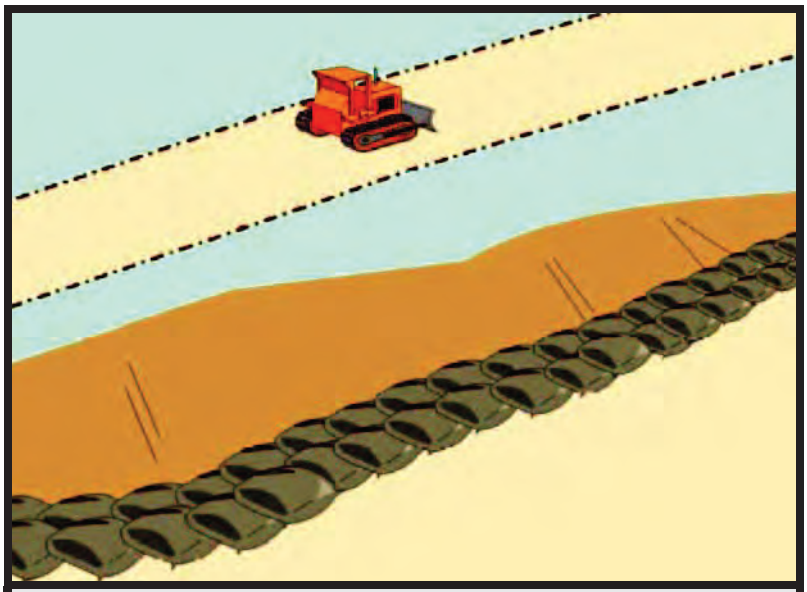
CALTRANS, State of California Department of Transportation, Construction Site Best Management Practices (BMPs) Manual, March 2003. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

Environmental Protection Agency, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II, December 1999. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

SMRC, Stormwater Manager's Resource Center, Center for Watershed Protection, Inc. http://www.stormwatercenter.net/

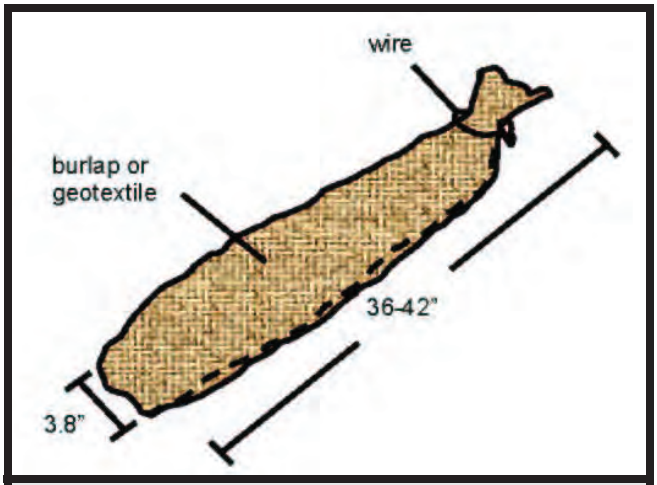
Fifield, J.S., Field Manual on Sediment and Erosion Control, 2002, Forester Press, Santa Barbara CA.

SPC-2 Sand Bag Barrier Photos



Schematic of sand bag barriers.

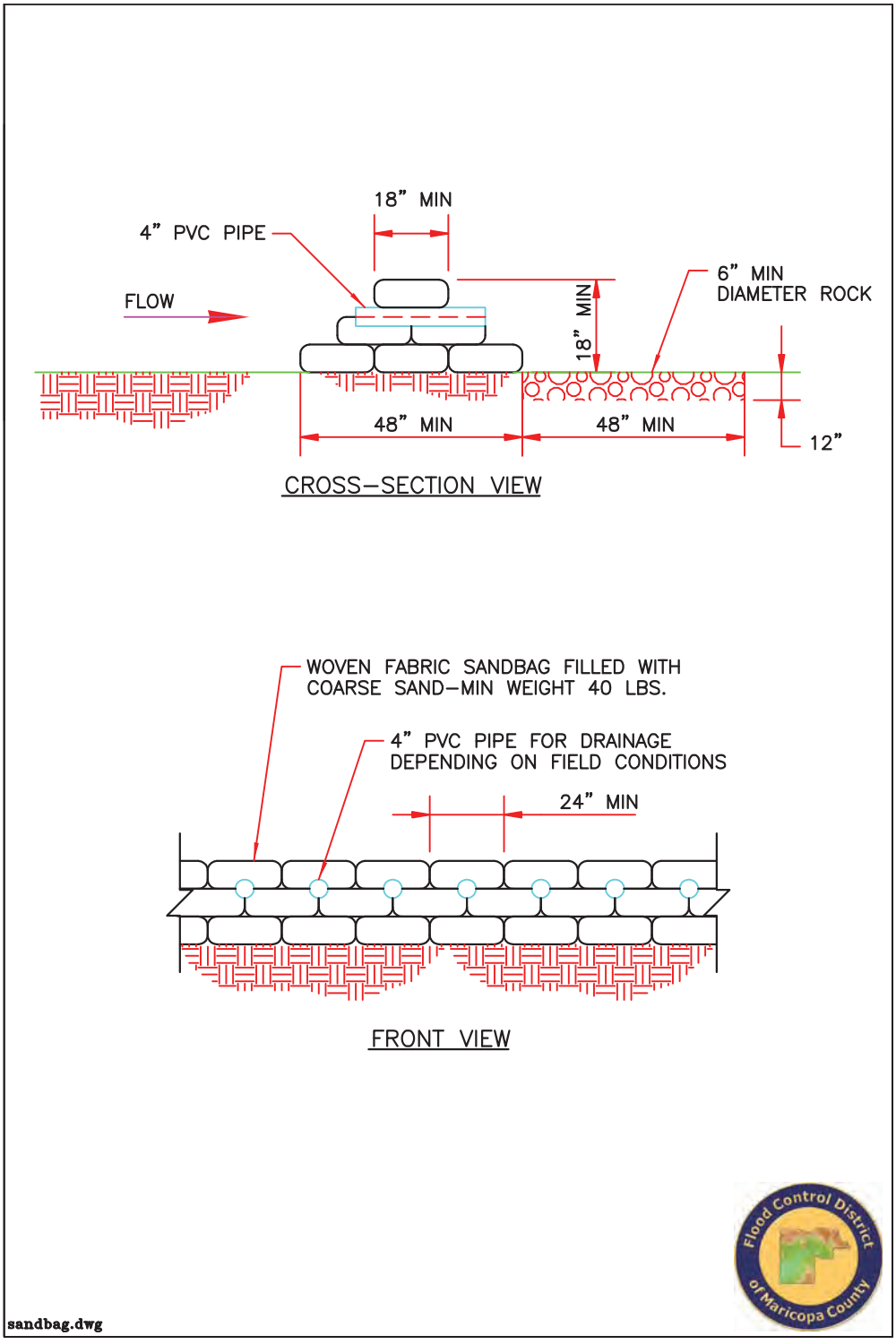
Courtesy of CALTRANS



Schematic of rock socks, often more versatile than sand bags.

Courtesy of Island County

SPC-2 Sand Bag Barrier Drawing



SPC-3 Gravel Filter Berms

DEFINITION

A temporary berm constructed of open graded rock or bags of gravel installed at the toe of a slope, or the perimeter of a developing or disturbed area.

GENERAL INFORMATION

Applicability - Effectiveness
Slope Protection - moderate
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high

Most effective when used with:

An Erosion Control (EC) BMP

Alternative BMPs:

If the berm is to be permanent, consider using SPC-4 Check Dams.

If used for storm drain inlet protection, consider other methods under SPC-7 Storm Drain Inlet Protection.

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance	X		
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material	X		
Metals		X	
Other Construction Waste		X	

FIGURES

Photos/Sketches

Gravel Filter Berms Photos

CAD Drawings

Gravel Filter Berms Drawing

PURPOSE

Gravel filter berms are designed to intercept and detain sediment-laden water from an unprotected area, detain the sediment, and release the water in sheet flow.

APPROPRIATE APPLICATIONS

Where a temporary measure is needed to retain sediments such as:

- Near the toe of slopes.
- At construction site perimeters.
- May be used as check dams across one or more lanes of construction traffic temporary roads, or unsurfaced rights of way subject to construction traffic.

LIMITATIONS

- Limit the drainage area upstream of the barrier to 5 acres and to gently sloping areas.
- Not recommended to be built on landscaped areas due to the difficulty of clean up
- Gravel filter berms are only temporary and must be routinely maintained due to clogging from mud and soil on vehicle tires.

PLANNING CONSIDERATIONS

- Construct along a level contour for intercepting sheet flow.
- Provide an undisturbed or stabilized outlet suitable for sheet flow.
- Allow ample room for sediment removal equipment between the berm and toe-of-slope.
- Installation in stream beds requires large rock, staking of woven wire sheathing (gabions), and daily inspection.
- For a more vegetated control, consider Organic Filter Barriers. In order to lessen the chance of displaced material, consider Sand Bag Barriers, or Silt Fences. Gravel filter berms are more effective when combined with an erosion control BMP.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Open Graded Rock

Open graded rock berms should be built on a level contour, designed for a maximum flow rate of 0.13 cubic feet per second (cfs) per square foot of berm. Use 3/4 to 3 inch diameter rock for sheet flow and 3 to 5 inch diameter rock for concentrated flow. For non-traffic areas, open

graded rock berms should be constructed a minimum of 18 inches high and 24 inches wide, with side slopes of 2:1 or flatter. Woven wire sheathing (poultry netting) is recommended in areas of concentrated flow to keep rocks in place. The wire should be galvanized 20 gauge with 1 inch diameter hexagonal mesh. Provide multiple berms in series:

- Every 300 feet on slopes less than 5 percent
- Every 200 feet on slopes of 5-10 percent.
- Every 100 feet on slopes greater than 10 percent.

If the open graded rock berm is constructed in a traffic area, the berm should be a maximum of 12 inches high.

Gravel Bag Berms

- Gravel bags should be made of woven polypropylene, polyethylene, or polyamide fabric. Bags should have a minimum unit weight of four ounces per square yard, mullen burst strength exceeding 300 pounds per square inch (psi) in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in accordance with ASTM D4355. Bag dimensions are nominal and may vary based on locally available bags and fill material. Generally, gravel bags are 24-30 inches long, 16-18 inches wide, 6-8 inches thick, and weigh approximately 90-125 pounds. Alternative bag sizes should be submitted to the site supervisor or engineer for approval prior to installing at the site. The choice of fill material depends on the objectives that are desired from the gravel bag berm. If finer grained material is used (i.e. pea-sized gravel), the berm acts more as a sediment filter and allows a lower flow than if coarser grained gravel is used (i.e. 3/4 to 3 inch diameter gravel).
- When used as a linear control for sediment removal:
    - Install along a level contour.
    - Turn the ends of the gravel bag berm up slope to prevent flow around the ends.
    - Generally, gravel bag barriers should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.
- When used for concentrated flows:
    - Stack gravel bags to required height using a pyramid approach.
    - Upper rows of gravel bags should overlap joints in lower rows.
- Construct gravel bag barriers with a set-back of at least 3 ft from the toe of a slope, or as far back as possible if the three foot set back is not physically possible.

RECOMMENDED MAINTENANCE AND INSPECTION

- Remove retained sediments when depth reaches 1/3 of berm height or 1 foot, whichever occurs first.
- Inspect monthly and after each rainfall. Reshape berm as needed, replace lost or dislodged rock.
- Remove gravel filter berm at the end of construction

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

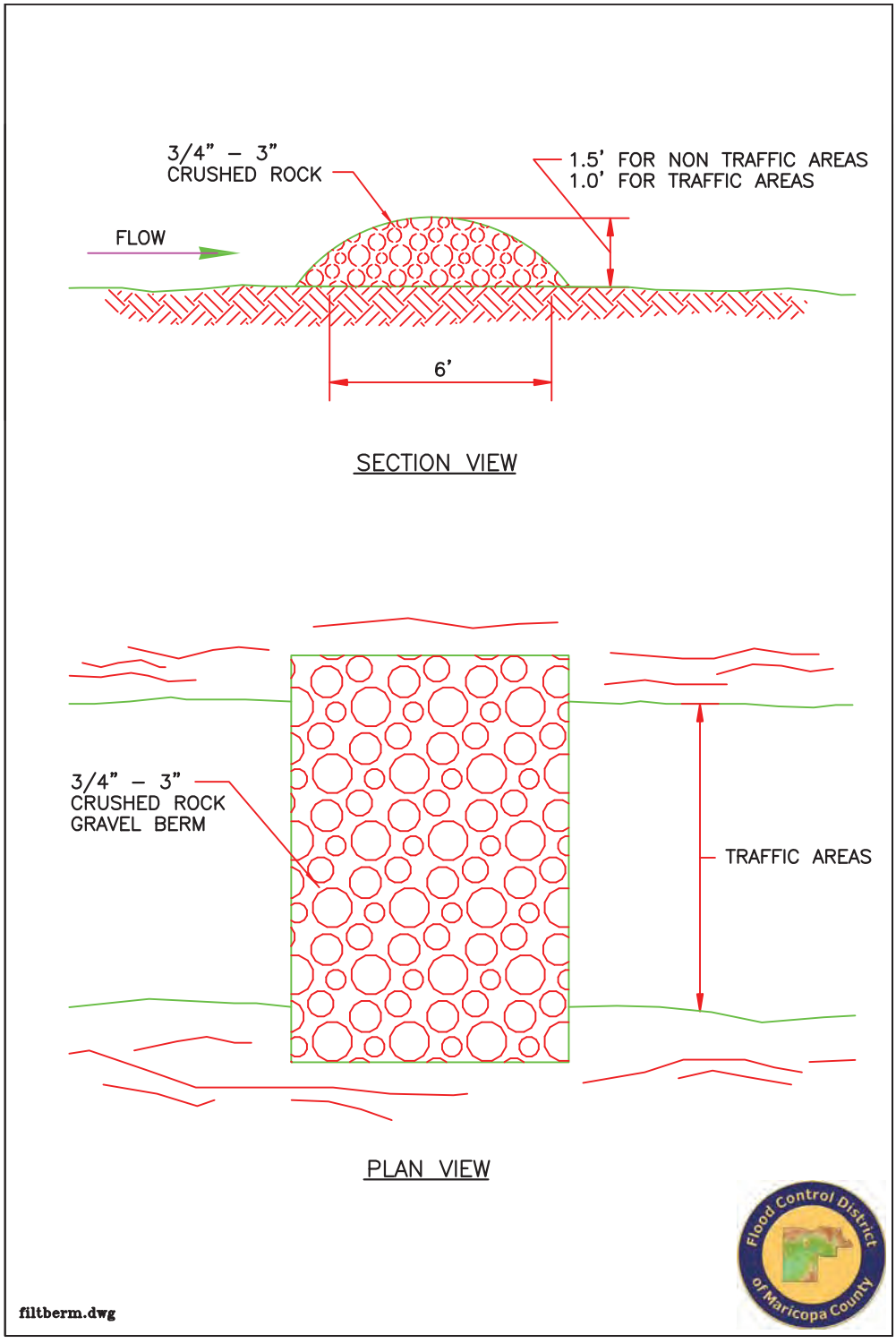
City of Austin, Texas, March, 2004, Environmental Criteria Manual.

SPC-3 Gravel Filter Berms Photos

Gravel filter berms filter sediment-laden water for relatively high flows.

Courtesy of Douglas County

SPC-3 Gravel Filter Berms Drawing



SPC-4 Check Dams

DEFINITION

Small barriers consisting of rock, sand bag, or earth berms placed across a drainage swale or ditch. Typically, they are used in conjunction with other channel protection techniques such as vegetation lining and turf reinforcement mats.

GENERAL INFORMATION

Applicability - Effectiveness

Slope Protection - moderate
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high
Channels and Medians - high

Most effective when used with:

An Erosion Control (EC) BMP

Alternative BMPs:

For a more temporary dam, consider SPC-2 Sand Bag Barrier

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance	X		
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material		X	
Metals			X
Other Construction Waste		X	

FIGURES

Photos/Sketches

SPC-4 Check Dams Photos

CAD Drawings

Check Dams Specifications

PURPOSE

Check dams reduce the velocity of small concentrated flows, provide a barrier for sediment, and help disperse concentrated flows, thereby reducing potential erosion.

APPROPRIATE APPLICATIONS

Check dams are appropriate where a temporary measure is needed to retain sediments such as:

- Near the toe of slopes.
- At construction site perimeters.
- May be used as check dams across one or more lanes of construction traffic temporary roads, or unsurfaced rights of way subject to construction traffic.

LIMITATIONS

- Check dams should not be used in live, flowing streams. They should not be used as a stand-alone substitute for other sediment trapping devices. Do not install check dams in channels, which have already been lined or vegetated. Leaves can clog check dams, thereby reducing their filtering and velocity dissipating functions.
- Check dams only perform their function of reducing velocities of concentrated flows and energy if they have been sized and constructed correctly and are maintained properly.

PLANNING CONSIDERATIONS

- Construct along a level contour for intercepting sheet flow.
- Provide an undisturbed or stabilized outlet suitable for sheet flow.
- Allow ample room for sediment removal equipment between the berm and toe-of-slope.
- Installation in stream beds requires large rock, staking of woven wire sheathing, and daily inspection.

RECOMMENDED STANDARDS AND SPECIFICATIONS

- Check dams should be installed as soon as construction will allow and be used in conjunction with other sediment reduction techniques prior to releasing the flow offsite.
- Check dams should be placed at a distance and height to allow small pools to form between each one. Typically, dam height should be between 18 and 36 inches. Dams should be spaced such that the top of the downstream dam is the same elevation as the toe of the upstream dam. Place check dams along the same contour line, perpendicular to the flow of water.

- Major flows (greater than 2 year design storm) must pass the check dam without causing excessive upstream flooding.

- Use geotextile filter fabric under check dams exceeding 18 inches in height.

Three main types of check dams:

1. Rock Check Dam - usually the simplest and least expensive option.

    - Stone should be well graded with a size range from 1.5 to 3.5 inches in diameter, depending on expected flows

    - Rock check dams should be triangular in cross section with side slopes of 1:1 or flatter on the upstream side and 2:1 or flatter on the downstream side.

2. Sand Bag Check Dam - are lighter and more manageable than rock dams.

    - Sand bag check dams should have a maximum flow through rate of 0.1 cubic feet per second (cfs) per square foot of surface with a minimum top width of 16 inches and bottom width of 48 inches. Bags should be filled with clean coarse sand, pea gravel, or filter stone.

    - Bag should be 24-30 inches long, 16-18 inches wide, 6-8 inches thick, and approximately 40 pounds in weight.

    - Bag material should be polypropylene, polyethylene, polyamide, or cotton burlap woven fabric, minimum unit weight of four ounces per square yard, Mullen burst strength exceeding 300 pounds per square inch (psi) as determined by ASTM D3786.

    - PVC pipes may be installed through the sand bag dam near the top to allow for controlled flow through the dam. Pipe should be schedule 40 or heavier, having a nominal internal diameter of 4 inches.

3. Geotextile-Encased Check Dam (or Triangular Silt Dike) - may provide the most effective filtration of sediment laden water.

    - Consist of a triangular urethane foam sewn into a woven geosynthetic fabric. Dimensions include 10-14 inches high in the center, with a 20-28 inch base. A 2 foot apron extends beyond both sides of the triangle along its standard section of 7 feet. A sleeve at one end of one section can be overlapped and stapled with an adjacent section.

    - Install with ends curved up to prevent water from flowing around the ends.

    - The fabric flaps and check dam units are attached to the ground with wire staples. Wire staples should be No. 11 gauge wire and should be 8 to 12 inches long.

- The leading edge must be secured with rocks, sandbags, or a small key slot and staples.

RECOMMENDED MAINTENANCE AND INSPECTION

- Check dams should be inspected after each storm event to ensure continued effectiveness. During inspection, large debris, trash, and leaves should be removed. The center of a check dam should always be slightly lower than its edges. If erosion or heavy flows cause the edges of a dam to fall to a height equal to or below the height of the center, repairs should be made immediately.

- Accumulated sediment should be removed from the upstream side of a check dam when the sediment has reached a height of approximately one-half the original height of the dam (measured at the center). In addition, all accumulated sediment should also be removed prior to removing a check dam.

- Removal of a check dam should be completed only after the contributing drainage area has been completely stabilized. Permanent vegetation and mulching should replace areas from where the check dam has been removed.

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

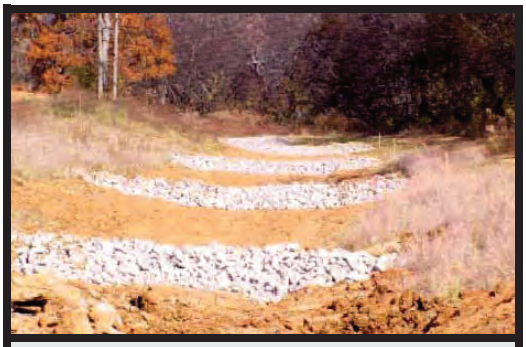
Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA.

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

SPC-4 Check Dams Photos

Check dams can be constructed of crushed rock material from the construction project.

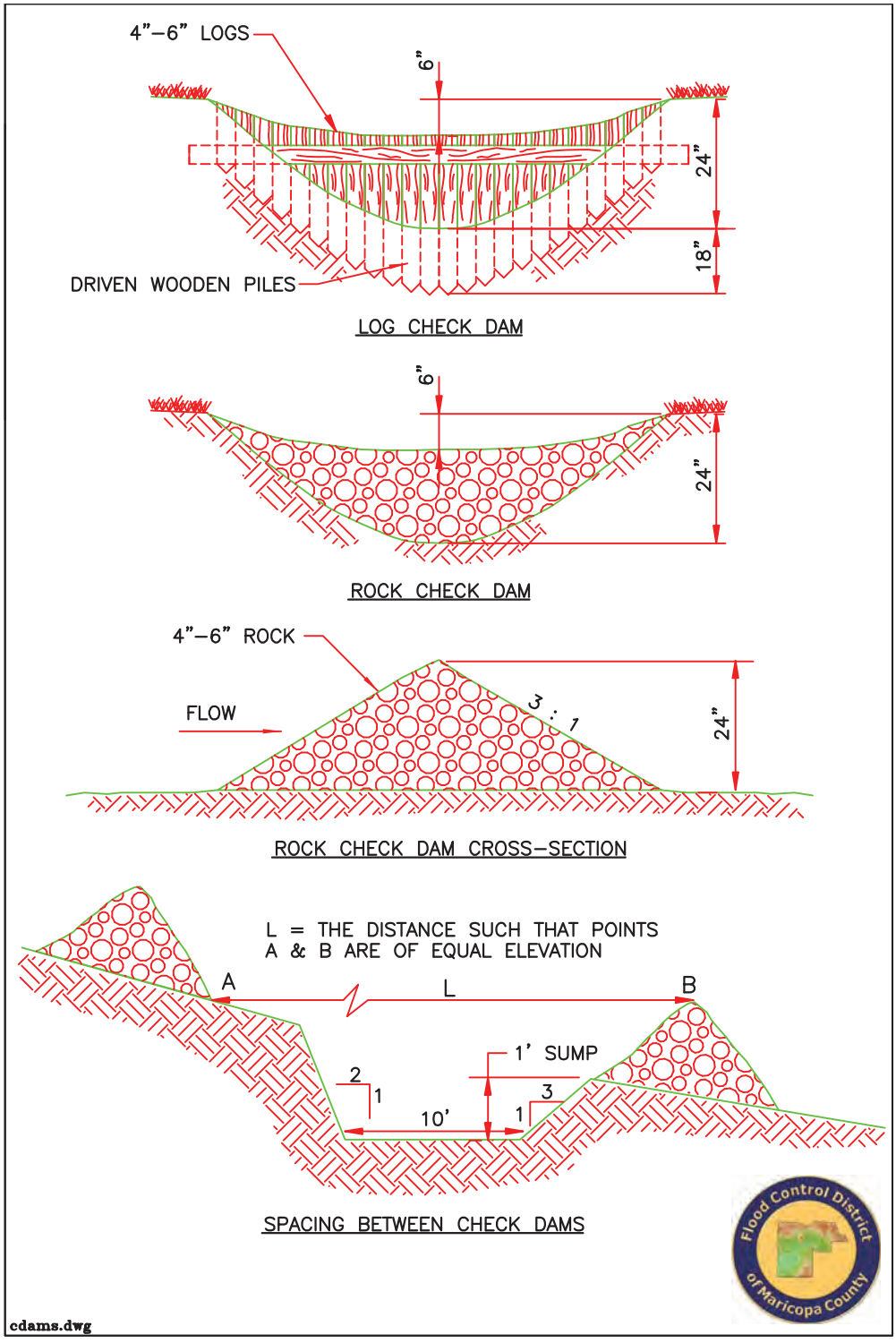
Courtesy of Newfoundland



Check dams are most effective when placed in series.

Courtesy of NCDOT

SPC-4 Check Dams Drawing



ASPC-5 Silt Fence

DEFINITION

A geotextile fabric stretched between either wooden or metal posts with the lower edge of the fabric securely embedded in the soil. The fence is typically located downstream of disturbed areas to intercept sheet flow runoff.

GENERAL INFORMATION

Applicability - Effectiveness
Slope Protection - moderate
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high

Most effective when used with:

An Erosion Control (EC) BMP

Alternative BMPs:

EC-9 Diversion Dikes

SPC-1 Organic Filter Barrier

SPC-2 Sand Bag Barrier

SPC-3 Gravel Filter Berms

SPC-6 Revegetation

SPC-7 Storm Drain Inlet Protection

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance	X		
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material	X		
Metals			X
Other Construction Waste		X	

FIGURES

Photos/Sketches

Silt Fence Photos

CAD Drawings

Silt Fence Drawing

PURPOSE

There are two main purposes for silt fences:

- To intercept and detain small amounts of sediment from disturbed areas during construction operations in order to prevent sediment from leaving the site.
- To decrease the velocity of sheet flows and low-to-moderate level channel flows.

APPROPRIATE APPLICATIONS

Silt fences, as the name implies, are more effective with sandy or silty soil types. For very fine grained soils, such as clays, a soils engineer should confirm the suitability of a silt fence for that area.

Silt fences are generally applicable to construction sites with relatively small drainage areas. Silt fences are not intended for use in detaining concentrated flows. They are appropriate where runoff is a low-level shallow flow, not exceeding 0.5 cubic foot per second (cfs). The drainage area for silt fences generally should not exceed 0.25 acre per 100 feet (ft) of fence length. Slope length above the fence should not exceed 100 ft.

Silt fences may be used:

- Below disturbed areas where runoff may occur in the form of sheet and rill erosion; wherever runoff has the potential to impact downstream resources.
- Parallel to minor swales or ditch lines for up to one acre of contributing drainage areas.
- For both site development areas and linear roadway type projects.

LIMITATIONS

- Silt fences are less effective in areas with predominately clay soil types.
- Silt fences will create a temporary sedimentation pond on the upstream side of the fence, which may cause temporary flooding.
- Silt fences are not practical for large flows. Drainage areas should be restricted to less than one acre and a flow rate less than 0.5 cfs. Do not allow water depth to exceed 1.5 ft at any point in front of the silt fence.
- Silt fences may not filter runoff effectively if the pore size of the fabric is incorrectly selected. Improperly installed fences are subject to failure from undercutting, overtopping, or collapsing.

PLANNING CONSIDERATIONS

If the site contains a high content of clays, consult a soils engineer before installing a silt fence. The Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than straw bales can. Silt fences are preferable to straw barriers in many cases. However, while the failure rate of silt fences is lower than that of straw barriers, there are many instances locally in which silt fences have been improperly installed. The installation methods outlined here can improve performance.

- Anchor the site fence fabric below the ground surface sufficiently to prevent flow from undercutting the fence.
- Construct along a level contour.
- Silt fences should remain in place until the disturbed area is permanently stabilized.
- Provide sufficient room for sediment removal equipment between the silt fence and toes of slopes or other obstructions.
- The ends of the filter fence should be turned uphill to prevent stormwater from flowing around the fence.
- Provide an undisturbed or stabilized outlet suitable for sheet flow.
- Do not construct in live streams or intermittently flowing channels.

As alternatives to silt fences, consider using the following: Diversion Dikes, Organic Filter Barrier, Gravel Filter Berms, Sand Bag Barrier, Revegetation, or Storm Drain Inlet Protection.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Materials

Selection of fabric tensile strength and bursting strength characteristics shall be supported with wire mesh in and as recommended by the fabric manufacturer. Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable life at a temperature range of 0° f. to 120° f.

Installation

Filter fences are to be constructed on a level contour to maximize the available ponding area and prevent concentration of flow against the fence.

A. Posts shall be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 30 inches.

B. A trench shall be excavated approximately 8 inches wide and 12 inches deep along the line of posts and upslope from the barrier.

C. When standard strength filter fabric is used, a wire mesh support fence shall be fastened securely to the upslope side of the posts using heavy- duty wire staples at least 1 inch long, tie wires or hog rings. The wire shall extend into the trench a minimum of 4 inches.

D. The standard strength filter fabric shall be stapled or wired to the fence, and 20 inches of the fabric shall extend into the trench. When extra-strength filter fabric and closer post spacing are used, the wire mesh support fence may be eliminated and the filter fabric stapled or wired directly to the posts.

E. The use of joints should be avoided when joints are necessary, filter cloth shall be spliced together only at a support post, with a minimum 6 inch overlap and both. Ends securely fastened to the post.

F. The trench shall be backfilled with 3/4-inch minimum diameter washed gravel or compacted-native material.

RECOMMENDED MAINTENANCE AND INSPECTION

Maintenance requirements inspect monthly during dry periods and immediately after each rainfall. Repair as necessary. Sediment must be removed when it reaches approximately one third the height of the fence, especially if heavy rains are expected. Filter fences should not be removed until the upslope area has been permanently stabilized

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

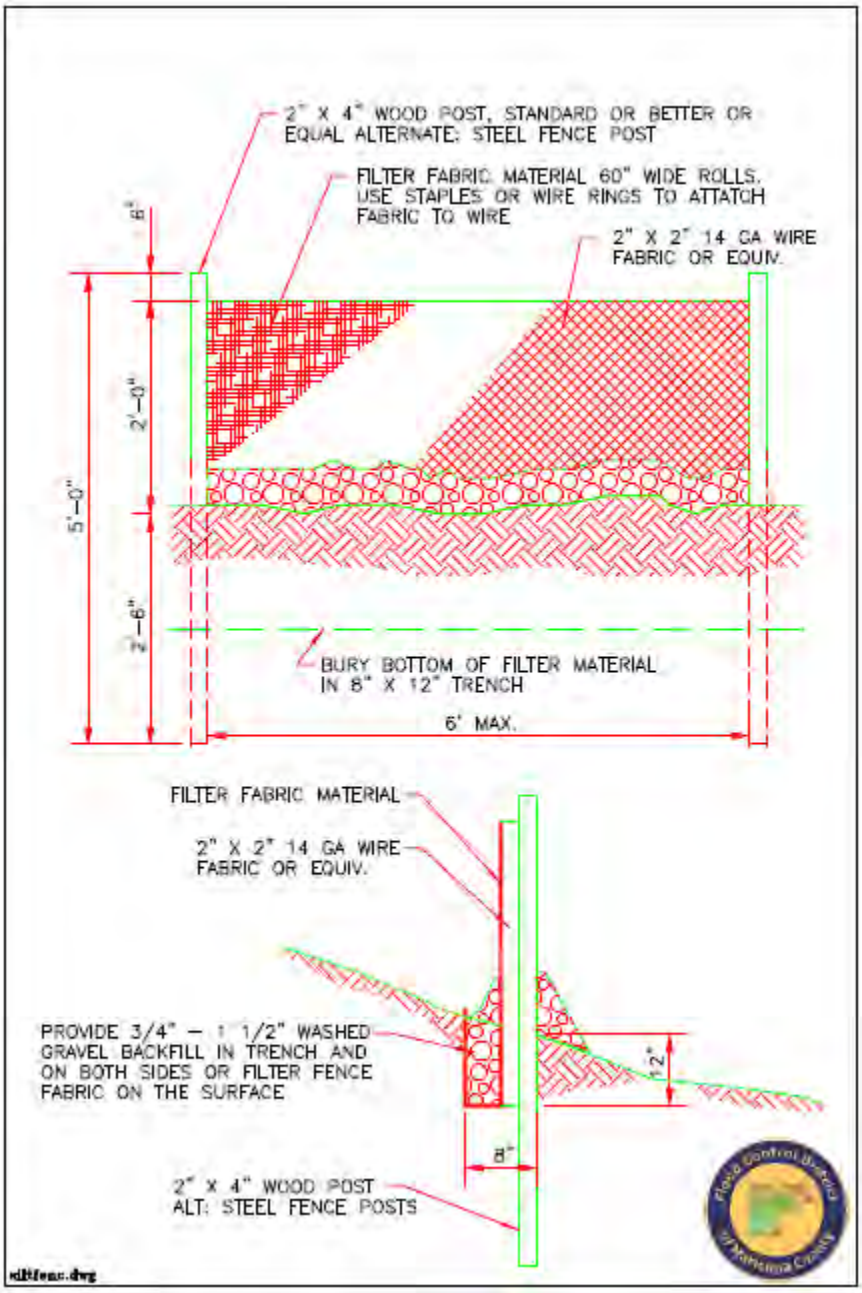
North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

North Carolina Department of Transportation, August 2003, Best Management Practices for Construction and Maintenance Activities, Chapter 5.0 "Operation Best Management

ASPC-5 Silt Fence Photos

Silt fences can span the entire length of a construction site when installed properly.

ASPC-5 Silt Fence Drawing



SPC-6 Revegetation

DEFINITION

Revegetation consists of an area of trees, shrubs, vines, and ground covers that create a buffer or a groundcover between a disturbed construction area and neighboring areas, particularly natural water bodies.

GENERAL INFORMATION

Applicability - Effectiveness

Slope Protection - high
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high
Channels and Medians - high
Landscaping and Vegetation - high

Most effective when used with:

An Erosion Control (EC) BMP

Alternative BMPs:

EC-8 Temporary Access Waterway Crossing
SPC-1 Organic Filter Barrier
SPC-2 Sand Bag Barrier
SPC-3 Gravel Filter Berms
SPC-4 Check Dams
SPC-5 Silt Fence
SPC-7 Storm Drain Inlet Protection

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance	X		
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients		X	
Sediment		X	
Floatable Material			X
Metals		X	
Other Construction Waste			X

FIGURES

Photos/Sketches

SPC-6 Revegetation Photos

CAD Drawings

None

PURPOSE

Revegetating buffers can provide superior, low maintenance, long-term erosion protection, and can often result in a more stable and aesthetically pleasing development. Vegetation stabilizes the soil and help prevent erosion, decrease stormwater runoff, moderate temperature, provide buffers and screens, filter pollutants from the air, supply oxygen, and provide habitat for wildlife.

APPROPRIATE APPLICATIONS

Revegetation can be applied in any area that is able to support vegetation, but it is most effective and beneficial on floodplains, near wetlands, along streambanks, and on steep, unstable slopes. Vegetation is also effective in separating land use areas that are not compatible and in protecting wetlands or waterbodies by displacing activities that might be potential sources of nonpoint source pollution. Trees, shrubs, vines, ground covers, and seeding should be applied:

- On steep or rocky slopes
- Along drainage swales and drainage dikes
- Around sediment basins to provide nutrient removal
- Where soil conservation is necessary (i.e. roughened slopes)
- Where attractive landscaping cover is desirable
- Where onsite dust control is necessary
- To establish a wildlife habitat

LIMITATIONS

Construction activities can easily injure or kill trees and shrubs unless adequate protective measures are taken. Direct contact by equipment is the most obvious problem, but damage can also occur by root stress due to filling, excavating, or compacting too close to trees. See Protection of Trees and Vegetation in Construction Areas for ways to protect vegetation on the construction site.

PLANNING CONSIDERATIONS

- Plants and ground cover can be used on cut-and-fill slopes adjacent to paved areas of shopping centers, schools, industrial parks, or other non-residential projects. They will also help to control foot traffic.
- Trees, shrubs, vines, or ground covers may be planted in residential areas, along rights-of-way, or easements to reduce maintenance and improve appearance.

- The Arizona Department of Water Resources has an approved plant list for Maricopa County of low water use plants, refer to the Drought Tolerant/Low Water Use Plant List on the ADWR website (www.water.az.gov/adwr/content/conservation/LowWaterPlantLists/). Native vegetation is compatible with surrounding desert habitat. Consult a local nursery for recommended plant species and growing tips.

The following steps will help insure good plant growth:

- Dig the holes 1/3 larger than the plant root ball.
- Use good topsoil or soil mixture with a lot of organics.
- Fill hole 1/3 to 1/2 full, shake plants to settle soil among roots, then water.
- Leave saucer-shaped depression around the plant to hold water.
- Water thoroughly and regularly.
- Space plants according to plant type and coverage desired.

Trees:

Some desirable characteristics to consider in selecting existing trees to be protected include: tree vigor, tree species, tree age, tree size and shape, and use as a wildlife food source and habitat. Trees to be saved should be clearly marked so that no construction activity will take place within the drip line of the tree.

At the same time as existing trees are being selected for salvage and protection on site, new plantings should be considered. The site where they will be planted should be evaluated. Consider the prior use of the land: adverse soil conditions such as poor drainage or acidity; exposure to wind; temperature extremes; location of utilities, paved areas, and security lighting and traffic problems.

Transplanting Trees:

- Time of Year - Late fall through winter (November to February) is the preferred time for planting trees.
- Tree preparation - Proper digging of a tree includes the conservation of as much of the root system as possible. Soil adhering to the roots should be damp when the tree is dug, and kept moist until planting. The soil ball should be 12 inches in diameter for each inch of diameter of the trunk.
- Site preparation - Refer to landscape plans and specifications for site and soil preparation.
- Supporting the tree - Newly planted trees need artificial support to prevent excessive swaying.

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

Shrubs:

- Follow the general procedure for tree planting when planting shrubs.

Vines and Ground Cover:

- Site preparation - Ground covers are plants that naturally grow very close together, causing severe competition for space nutrients and water. Soil for ground covers should be well prepared.

- The entire area should be spaded, disced, or roto-tilled to a depth of six to eight inches. Two to three inches of organic material, such as good topsoil or peat, should be spread over the entire area.

Seeding:

- Climate, soils, and topography are major factors that dictate the suitability of the types of vegetation to seed. The soil on a disturbed site might require nutrient or mineral amendments to provide sufficient nutrients for seed germination and growth. The surface soil should be loose enough for water infiltration and root penetration. Soil pH should be between 6.0 and 6.5 and can be increased with liming if soils are too acidic. Seeds can be protected with mulch to retain moisture, regulate soil temperatures, and prevent soil loss during seedling establishment. Consult a local nursery for growing conditions for particular species of plants.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Materials

There are many different species of plants from which to choose, but care must be taken in their selections. It is essential to select planting materials suited to both the intended use and specific site characteristics. Vegetative plans must include close-growing plants or an adequate mulch with all plantings of trees, shrubs, vines, and ground covers.

There are many species of plants that may be used for erosion purposes. The plants discussed in this practice are those which are known to be adapted to Maricopa County, and commonly available from commercial nurseries. Information can be obtained from local nurserymen, landscape architects, and extension agents. An approved low water use plant list from the Arizona Department of Water Resources is found on the ADWR website (www.water.az.gov/adwr/content/conservation/LowWaterPlantLists/).

RECOMMENDED MAINTENANCE AND INSPECTION

Specific maintenance requirements may be listed on landscape plans and specifications. General requirements include:

Trees:

Young trees should receive an inch of water each week for the first two years after planting. Transplanted trees should be fertilized on an annual basis.

Shrubs:

Proper pruning, watering, and application of fertilizer is necessary to maintain healthy and vigorous shrubs. A heavy layer of mulch reduces weeds and retains moisture.

Vines and Ground Cover:

Trim old growth as needed to improve the appearance of ground covers.

Seeding:

Seeded areas should be inspected for failure or limited growth. If vegetation fails to grow well and the soil has been sufficiently watered, test the soil for low pH or nutrient imbalances. On a typical disturbed site, full plant establishment usually requires refertilization in the second growing season. Soil tests will determine whether additional fertilizer should be added.

POST CONSTRUCTION METHODS

In many cases, revegetation can remain after the construction project has been completed to continue the same functions as described in this BMP. Include revegetated areas with the final site dress-up or landscaping plan. As with any final site landscaping, ongoing maintenance for vegetation including mowing, pruning, watering, fertilizing, and weed and pest control will be necessary after project completion.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

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Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1992, Virginia Erosion and Sedimentation Control Handbook, Thrid Edition.

Smolen, M.D., September 1988, North Carolina Erosion and Sediment Control Planning and Design Manual, North Carolina Sediment Control Commission, et al.

SPC-6 Revegetation Photos

Groundcover reduces the surface area of a site that is exposed to rainfall erosion.

SPC-7 Storm Drain Inlet Protection

DEFINITION

A variety of methods of intercepting sediment at low point inlets through the use of stone, filter fabric, inlet inserts, and other materials. This is normally located at the inlet, providing either detention or filtration to reduce sediment and floatable materials in stormwater.

GENERAL INFORMATION

Applicability - Effectiveness
Inlet Drain Protection - high
Channels and Medians - high
Perimeter and Access Controls - high

Most effective when used with:

An Erosion Control (EC) BMP

Alternative BMPs:

SPC-1 Organic Filter Barrier

SPC-2 Sand Bag Barrier

SPC-3 Gravel Filter Berms

SPC-5 Silt Fence

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance	X		
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment		X	
Floatable Material		X	
Metals			X
Other Construction Waste			X

FIGURES

Photos/Sketches

SPC-7 Storm Drain Inlet Protection Photos

CAD Drawings

Filter Fabric Fence Drop Inlet Filter

Curb Inlet Protection

PURPOSE

Storm drain inlet protection measures prevent soil and debris from site erosion from entering storm drain drop inlets and clogging them. Typically, these measures are temporary controls that are implemented prior to large-scale disturbance of the surrounding site. The early use of storm drains during project development significantly reduces the occurrence of future erosion problems.

APPROPRIATE APPLICATIONS

Storm drain inlet protection is appropriate where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. There are a variety of types of structures that are applicable to different conditions:

- Filter Fabric Fence – applicable where the inlet drains a relatively small (less than 1 acre) flat area (less than 5 percent slope). Intended for relatively low flows.
- Excavated Drop Inlet Sediment Trap – intended for relatively high flows. An excavated drop inlet trap provides protections against sediment entering a storm drain inlet can be provided by excavating an area in the approach to the drain. The excavation volume should be approximately 1800 to 3600 cubic feet per acre of disturbed area drained.
- Block and Gravel Protection – used when the flows exceed 0.5 cubic feet per second (cfs) and it is necessary to allow for overtopping to prevent flooding around the inlet area.
- Foam or Fiber Roll Barriers - use for relatively low flows in areas where they can be anchored to the surface. Most appropriate for inlets on an unpaved surface.

LIMITATIONS

- Special caution should be exercised when installing inlet protection on publicly traveled streets or in developed areas.
- Inlet protection is only viable at low point inlets. Inlets that are on slope can not be effectively protected because stormwater will bypass the inlet and continue downstream, causing an overload on downstream inlets.
- Ponding will occur at the inlet with possible short term flooding.
- Curb inlets on slopes cannot be effectively protected because the stormwater will bypass the inlet and continue downgrade.
- Filter fabric fences are limited to storm drain inlets for small drainage areas of five acres or less. Filter fabric fences are not appropriate in paved areas. For larger drainage areas, smaller sediment catchment areas are recommended.

PLANNING CONSIDERATIONS

Where storm sewers are made operational before their drainage area is stabilized, or where construction is adjacent to an existing storm sewer, large amounts of sediment may enter the storm sewer system. In cases of extreme sediment loading, the storm sewer itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

This practice contains several types of inlet filters and traps which have different applications dependent upon site conditions and type of inlet. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the local government.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Install inlet protection in accordance with the following:

- Filter fabric fence: Place 2 inch by 2 inch wooden stakes around the perimeter of the inlet a maximum of 3 feet apart and drive them at least 8 inches into the ground. Excavate a trench approximately 8 inches wide and 12 inches deep around the outside perimeter of the stakes. Staple the filter fabric (for material specifications, see SPC-5 Silt Fence to wooden stakes so that 32 inches of the fabric extends out and can be formed into the trench. Use heavy-duty wire staples at least 1/2 inch in length. Backfill the entire trench with 3/4 inch or less washed gravel.

- Excavated Drop Inlet Sediment Trap: Construct the inlet trap as shown in the Storm Drain Drop Inlet Protection Drawing. Ensure that the excavation volume can contain approximately 1800 to 3600 cubic feet per acre of disturbed area.

- Gravel Bag Filter: If there is a high content of clays and silts, use filter fabric in conjunction with gravel for additional filtering capacity. Construct the gravel bag filter as specified by Gravel Filter Berms.

- Foam or Fiber Roll Barrier: Foam or fiber roll is placed around the inlet and must be anchored to the curb surface, so that it is not carried away by runoff flows.

RECOMMENDED MAINTENANCE AND INSPECTION

For systems using filter fabric, inspections should be made on a regular basis, especially after large storm events. If the fabric becomes clogged, it should be replaced. Sediment should be removed when it reaches approximately half the height of the fence. If an excavated inlet sediment trap is used, sediment should be removed when it fills approximately half the depth of the hole.

POST CONSTRUCTION METHODS

Following the completion of construction projects in residential and municipal areas, more permanent drop-inlet protection devices can be installed in storm drain inlets. The link under the Vendor Products section lists several different drop-inlet protection devices.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

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Urban Drainage and Flood Control District, Construction BMPs Chapter of Urban Storm Drainage Criteria Manual, Vol. 3: Best Management Practices, 1999 Denver, Colorado.

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

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

Smolen, M.D., September 1988, North Carolina Erosion and Sediment Control Planning and Design Manual, North Carolina Sediment Control Commission, et al.

SPC-7 Storm Drain Inlet Protection Photos

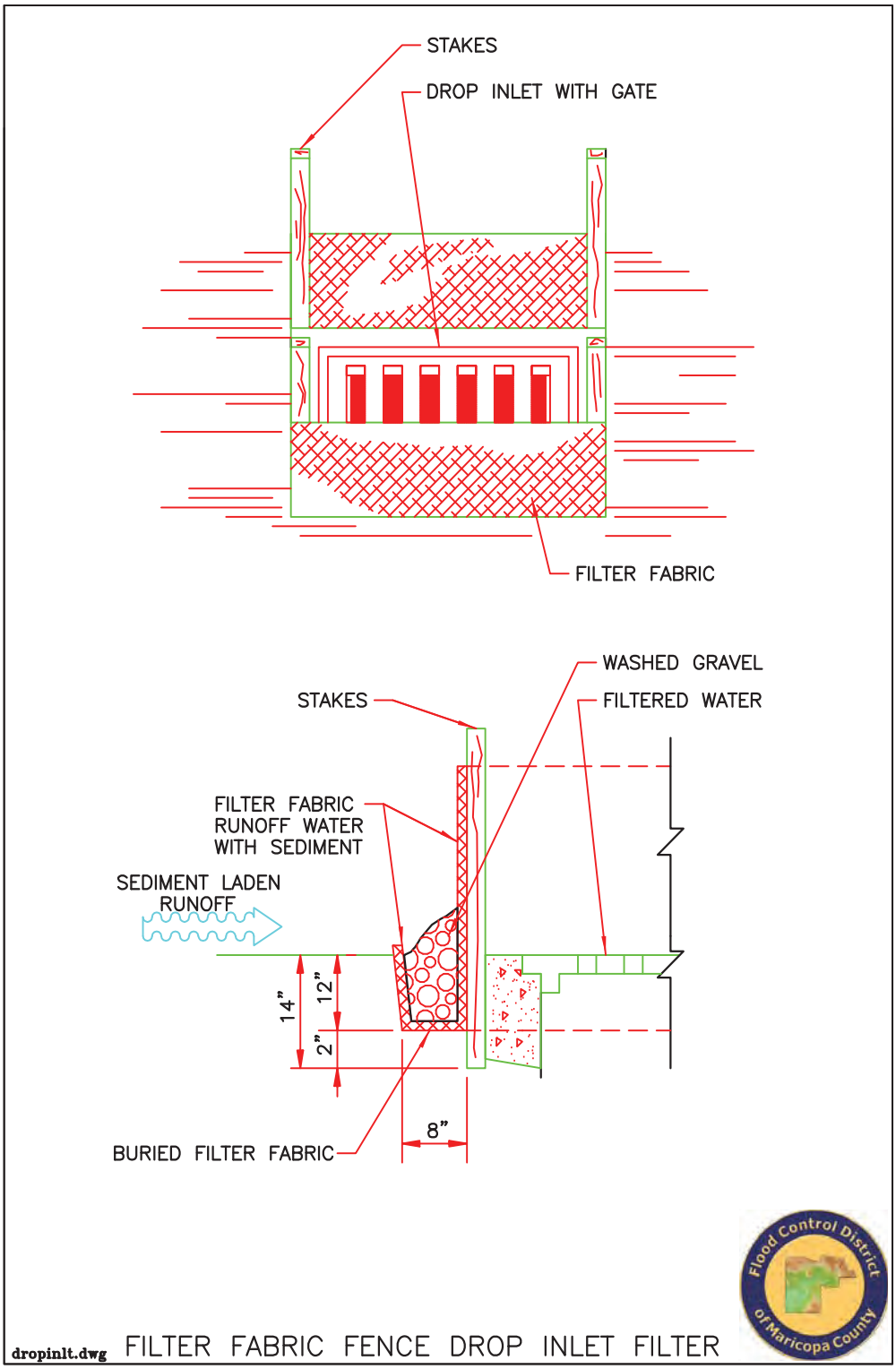
Coarse gravel and cinder blocks are often used to keep sediment and other pollutants out of storm drains.

Courtesy of EPA

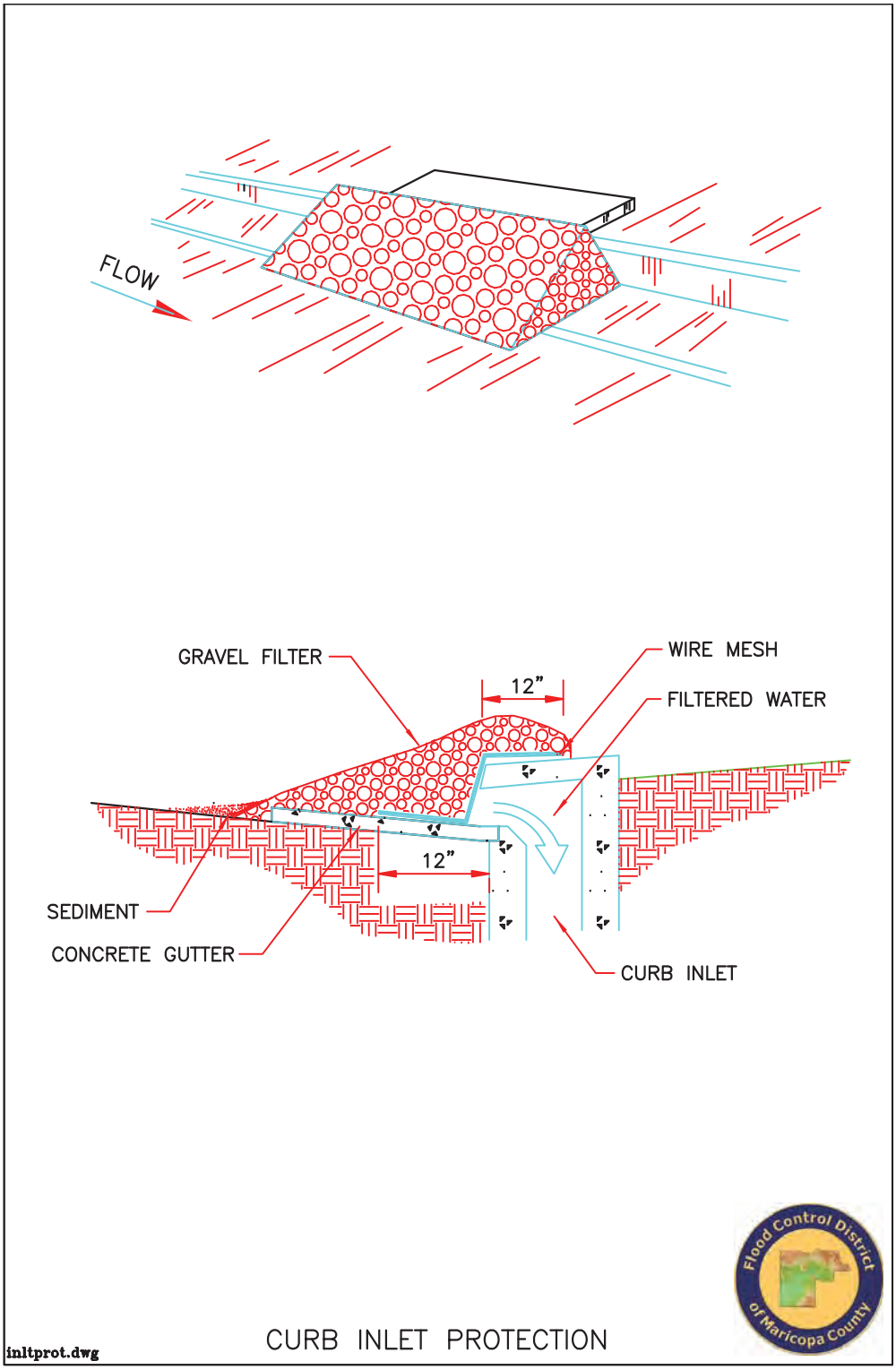
Straw wattle inlet drain protection.

Courtesy of Douglas County

SPC-7 Storm Drain Drop Inlet Protection Drawing



SPC-7 Storm Drain Curb Inlet Protection Drawing



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ASPC-8 Temporary Sediment Basins

DEFINITION

A temporary basin with a controlled storm water release structure formed by constructing an embankment of compacted soil across a drainage-way, or other suitable locations.

GENERAL INFORMATION

Applicability - Effectiveness

Slope Protection - high
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high
Landscaping and Vegetation - high

Most effective when used with:

An Erosion Control (EC) BMP

Alternative BMPs:

To treat lower flows and volumes than described in this BMP, consider SPC-9 Temporary Sediment Traps

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance		X	
Training			X
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients		X	
Sediment	X		
Floatable Material		X	
Metals		X	
Other Construction Waste			X

FIGURES

Photos/Sketches

SPC-8 Temporary Sediment Basins Photos

CAD Drawings

Temporary Sediment Basins

PURPOSE

To collect and store sediment from sites cleared and/or graded during construction or for extended periods of time before reestablishment of permanent vegetation and/or construction of structures. It is intended to help prevent damaging erosion on the site which results in silt-laden runoff. The basin is a temporary measure (with a design life less than 1 year) and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

APPROPRIATE APPLICATIONS

Sedimentation basins are suitable for nearly all types of construction projects. Basins should be located at the storm water outlet from the site. A typical application would include temporary dikes (berms) and/or channel to divert runoff to the basin inlet.

Many development projects in Maricopa County will be required by local ordinances to provide a storm water retention basin which may be easily converted from a sedimentation basin.

LIMITATIONS

Sediment basins must be installed only within the property limits where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment basins and basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to if fencing of the basin is required, the type of fence and its location shall be shown on the SWPPP.

- Generally temporary sedimentation basins are for disturbed upstream drainage areas of 10 acres or more.
- Because of additional detention time, sediment basins may be capable of trapping smaller sediment particles than traps. However, they are most effective when used in conjunction with other BMPS such as seeding or mulching.
- Basins may become an “attractive nuisance” and care must be taken to adhere to all safety practices.
- Sediment basins are only practical and effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) will pass through untreated emphasizing the need to control erosion to the maximum extent first.

PLANNING CONSIDERATIONS

Effectiveness

- Sediment basins are at best only 70-80 percent effective in trapping sediment which flows into them. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc. To reduce the amount of sediment flowing into the basin.
- Whenever possible, construct the sedimentation basins before clearing and grading work begins.

Location

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

RECOMMENDED STANDARDS AND SPECIFICATIONS

The sediment basin may be formed by partial excavation and/or by construction of a compacted embankment. It may have one or more inflow points carrying polluted rtmoff. Baffles to spread the flow throughout the basin should be included. A securely anchored riser pipe is the principal discharge mechanism along with an emergency overflow spillway. The riser pipe shall be solid with two l-inch diameter dewatering holes located at the top of the sediment storage volume on opposite sides of the riser pipe as shown in the attached figure. Outlet protection is provided to reduce erosion at the pipe outlet.

- The sediment basin volume is the sum of the sediment storage (1 foot in depth) & a settling volume of 2 to 4 feet in depth. The total volume is 3,600 cubic feet per acre of upstream disturbed soil for a sediment basin.

Commuting the settling zone volume: the settling zone volume may be approximated by assuming a 2 foot depth above the sediment storage volume and extending the 3:1 side slopes as necessary, or by computing the precise volume as outlined below. The maximum settling zone depth shall be 4 feet.

Basin surface area:

The settling zone volume is determined by the basin surface area which is computed using the following equation: (sa) = 1.2q10/vsed

Where q10, is the design inflow based on the peak discharge from a 10-year, 24-hour duration design storm event from the tributary drainage area as computed using the methods described in flood control district of Maricopa county's hydrologic design manual. Provide a minimum of 3600 cubic feet total volume per acre of drainage.

The settling velocity of the design soil particle which is medium silt (0.02 mm) has a settling velocity (vsed) of 0.00096 ft/sec. As a rule it will not be necessary to use a particle size of less than 0.02 mm for a temporary sediment basin. Note that in choosing vsed of 0.00096 ft/sec the surface area equates to a surface area (sa) of 1250 sq. Ft. Per cfs of inflow (reference 1).

Settling depth (sd) should not be less than 2 feet and is also governed by the sediment storage volume surface area and relationship to the basin length (l). The basin length is defined as the average distance from the inlet to the outlet of the basin.

The ratio of l/sd should be less than 200.

The settling volume is therefore the surface area (sa) times (sd), required settling depth.

To complete the design of the sediment basin:

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

A. The details shown in the attached figure may be useful in designing the sediment basin.
B. Determine basin geometry for the sediment storage volume calculated above using 3 feet in depth and 3:1 side slopes tom the bottom of the basin. Note, the basin bottom is level.
C. Extend the basin side slopes (at 3:1 max.) As necessary to obtain the settling zone volume at 2 foot depth minimum or as determined above.
D. Adjust the geometry of the basin to effectively combine the settling zone volume and sediment storage volumes while preserving the depth and side slope criteria.
E. Provide an emergency spillway with a crest elevation 1 foot above the top of the riser pipe.
F. Provide baffles to prevent short-circuiting. A 6:1 aspect ratio between the basin length and width of the basin is desirable.

MAINTENANCE AND INSPECTION

Inspections should be made regularly, especially after each storm event of 0.5 inches or more. Sediment should be removed when it fills one half of the basin's total sediment storage area. The effectiveness of a sediment basin is based less on its size than on regular sediment removal.

POST CONSTRUCTION METHODS

Sediment basins can be converted to permanent structures after completion of the construction project. Remove all excess sediment from the basin. The containment volume of permanent sediment basins will need to be expanded to meet the design storm requirements in the Maricopa County Drainage Regulations. The inside of a permanent sediment basin should either be vegetated or rock lined. Alternatively, if the permeability of the soil is high and groundwater is close to the ground surface, a clay or synthetic liner may be installed. Ensure that the sedimentation basin has a stabilized outlet (see EC-11 Outlet Protection, Velocity Dissipation Devices).

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

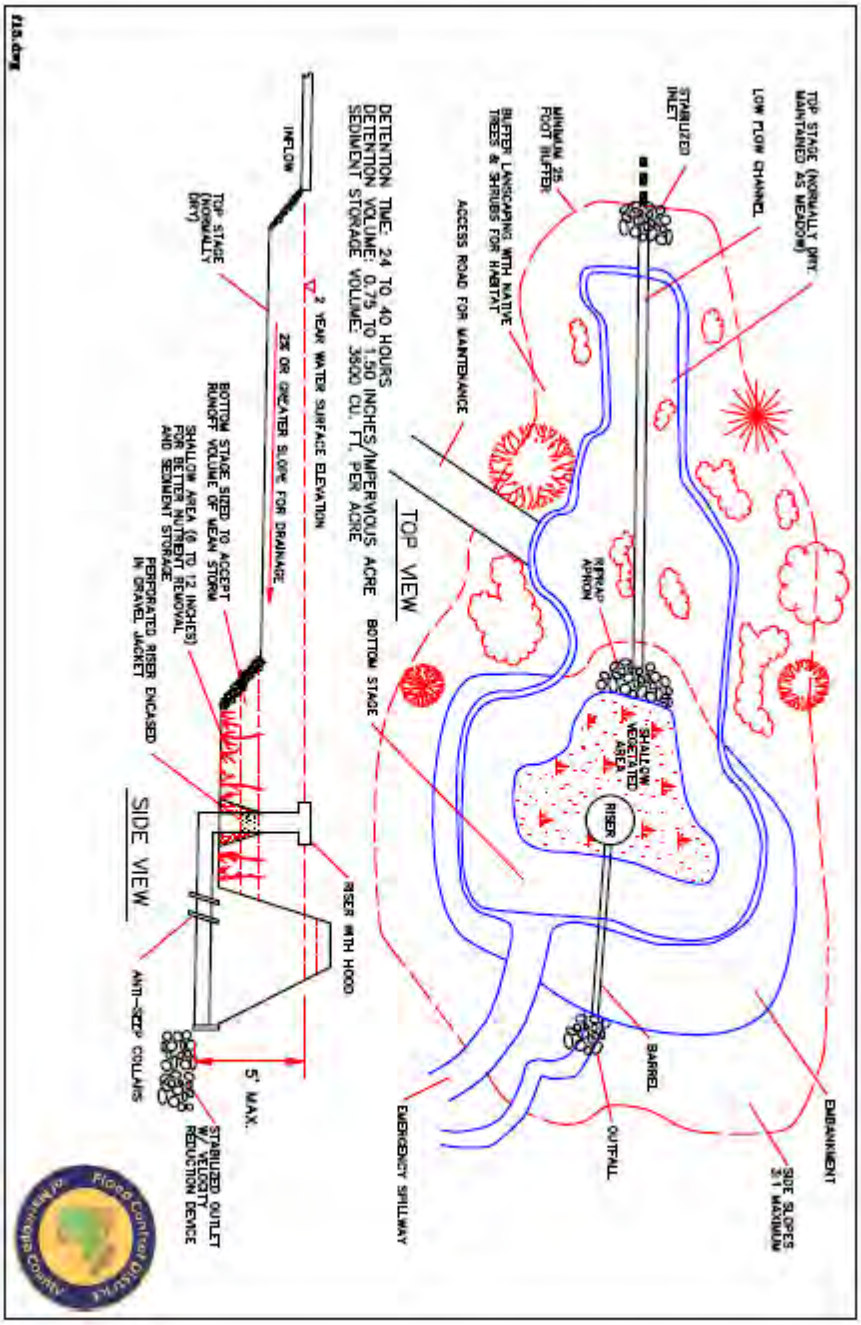
North Central Texas Council of Governments, December 2003, integrated Storm Water

ASPC-8 Temporary Sediment Basins Photos

Temporary sediment basin with outlet protection.

Temporary sediment basins provide strormwater storage during the construction process.

ASPC-8 Temporary Sediment Basins Drawing



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ASPC-9 Temporary Sediment Traps

DEFINITION

A sediment trap is a temporary containment area that allows sediment in collected stormwater to settle out during infiltration or before the runoff is discharged through a stabilized spillway. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway or low drainage area. Sediment traps are smaller and less expensive to install than sediment basins, but generally settle out coarser particles than sediment basins.

GENERAL INFORMATION

Applicability - Effectiveness

Slope Protection - high
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high
Landscaping and Vegetation - high

Most effective when used with:

An Erosion Control (EC) BMP

Alternative BMPs:

To treat higher flows and volumes than described in this BMP, consider SPC-8 Temporary Sediment Basins

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients		X	
Sediment		X	
Floatable Material		X	
Metals		X	
Other Construction Waste			X

FIGURES

Photos/Sketches

SPC-9 Temporary Sediment Traps Photos

CAD Drawings

Excavated Drop Inlet Sediment Trap

Temporary Sediment Trap

PURPOSE

Sediment traps generally remove larger particles (gravel and sand) than sediment basins, and some metals that settle out with the sediment. The trap is a temporary measure (with a design life of approximately 6 months) and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

APPROPRIATE APPLICATIONS

Sediment traps are generally temporary control measures to slow concentrated runoff velocity and catch sediment, and they can be used with other temporary stormwater control measures. Traps should be placed where sediment laden stormwater enters a storm drain or watercourse. They are commonly used at the outlets of stormwater diversion structures, channels, slope drains, construction site entrance wash racks, or any other runoff conveyance that discharges waters containing erosion sediment and debris. Sediment traps can also be used as part of a stormwater drop intake protection system when the inlet is located below a disturbed area and will receive runoff with large amounts of sediment. Sediment traps may be used on construction projects where the drainage area is less than 5 acres.

LIMITATIONS

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, and requires protective fencing.
- Not to be located in live streams.
- Size may be limited by availability of right-of-way.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SPC-8 Temporary Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment must be removed from the trap after each significant rainfall event. Plans should detail how this sediment is to be disposed of, either using in-fill areas onsite or removal to an approved offsiteoffsite dump. Sediment traps, along with other perimeter controls, should be installed before any land disturbance takes place in the drainage area.

Sediment traps and ponds must be installed only on sites where failure of the structure would not result in loss of life, damage to home or buildings, or interruption of use of service public roads or utilities. Also, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

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

RECOMMENDED STANDARDS AND SPECIFICATIONS

Design and Sizing Criteria

Grates and spaces of all inlets should be secured to prevent seepage of sediment-laden water. All inlet protection measures should include sediment sumps of 1 to 2 feet in depth and with 2:l side slopes.

Installation Procedure for Filter Fabric Fence

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

RECOMMENDED MAINTENANCE AND INSPECTION

For systems using filter fabric: inspections should be made on a regular basis, especially after large storm events. If the fabric becomes clogged, it should be replaced. Sediment should be removed when it reaches approximately one-half the height of the fence. If a sump is used, sediment should be removed when it fills approximately one-half the depth of the hole.

POST CONSTRUCTION METHODS

None.

REFERENCES

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

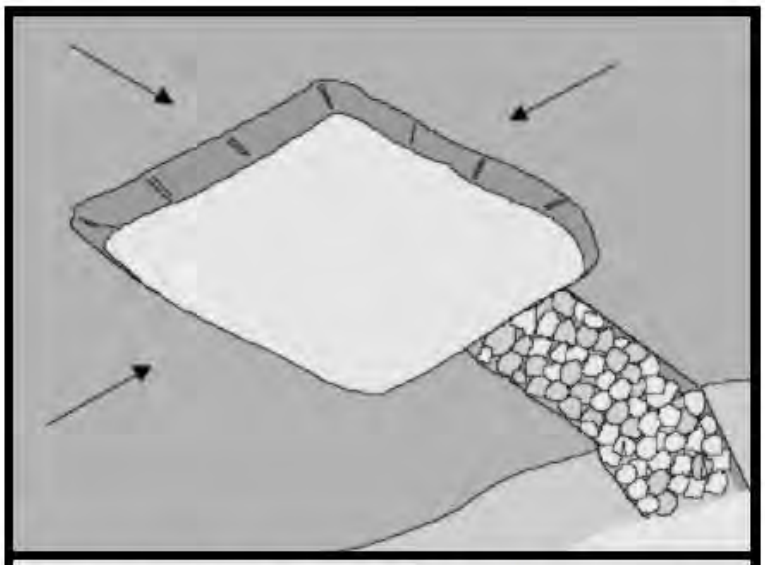
Center for Watershed Protection, Inc., Stormwater Manager's Resource Center (SMRC). http://www.stormwatercenter.net/

Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA.

City of Austin, Texas, March, 2004, Environmental Criteria Manual.

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

ASPC-9 Temporary Sediment Traps Photos



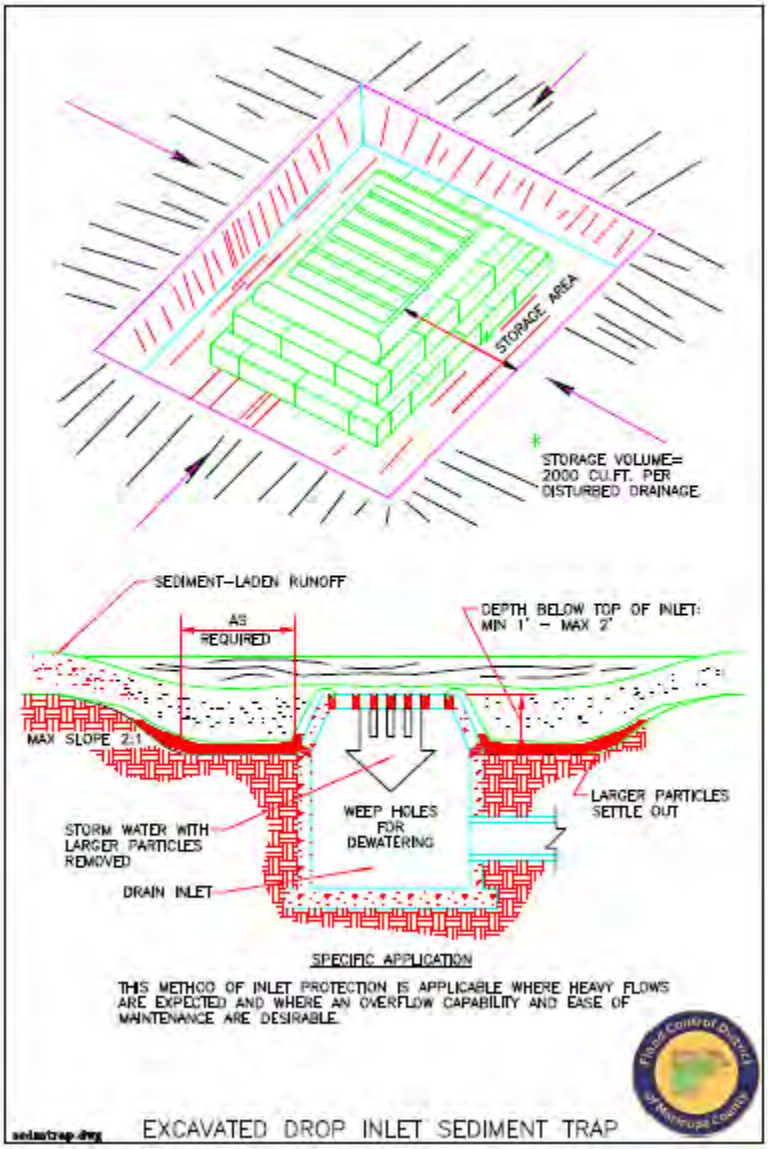
Schematic of sediment trap and outlet protection.

Courtesy of CALTRANS

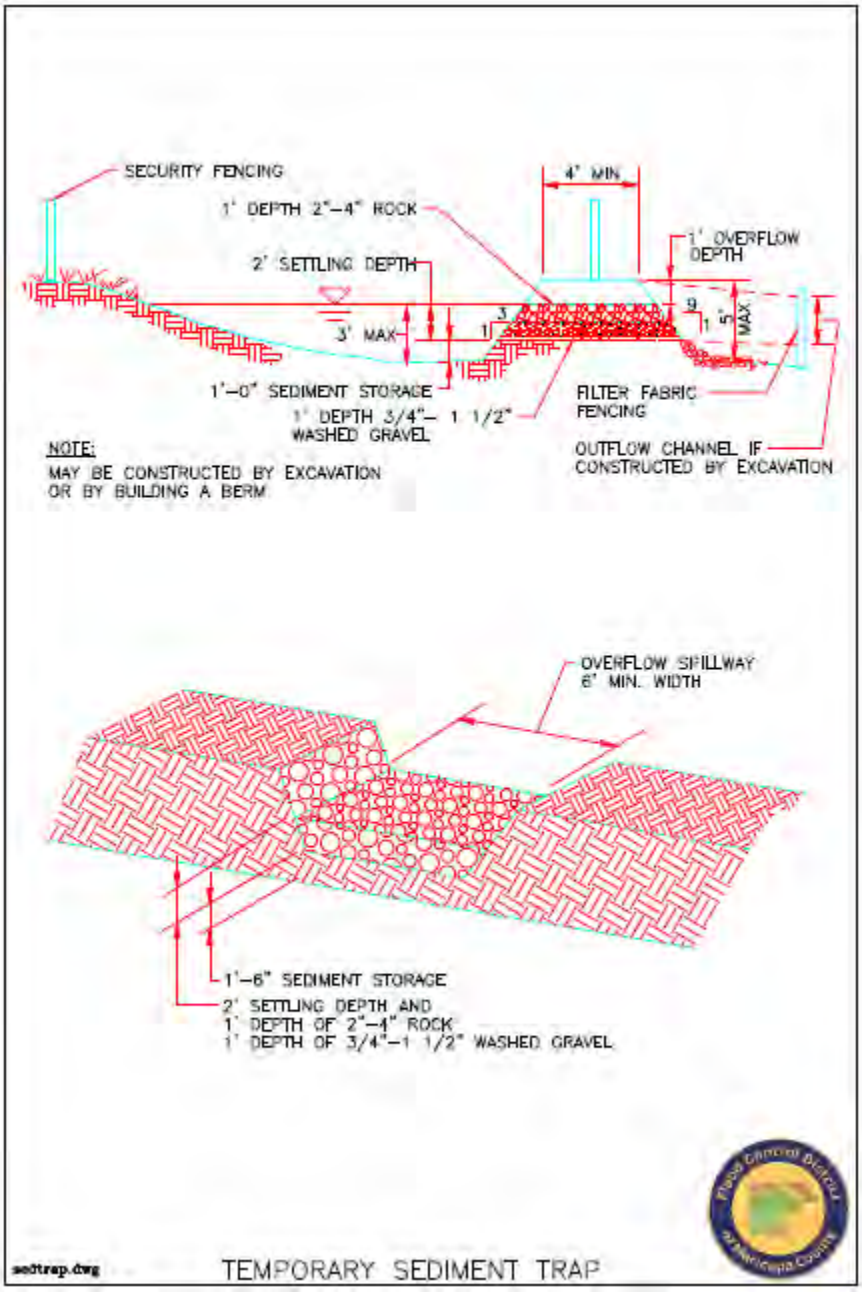
Sediment traps are used to collect sediment laden runoff from disturbed areas on construction sites.

Courtesy of Douglas County

ASPC-9 Temporary Sediment Traps Drawing



ASPC-9 Temporary Sediment Traps Drawing



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SPC-10 Sediment Dewatering Operations

DEFINITION

A filtration bag or sediment bag is a large bag made of geotextile that is used for filtering water pumped as part of dewatering a worksite. The bag is hooked up to a hose and water is pumped through the bag. The water seeps through the geotextile fabric and the sediment is trapped in the bag.

GENERAL INFORMATION

Applicability - Effectiveness

Slope Protection - moderate
Excavated Areas (trenches, pits, etc.) - high
Perimeter and Access Controls - high

Most effective when used with:

Protect excavated areas before runoff enters by using:

SPC-1 Organic Filter Barrier

SPC-2 Sand Bag Barrier

SPC-3 Gravel Filter Berms

For flows or sediment loads too large for a dewatering treatment device, consider:

SPC-9 Temporary Sediment Traps

Alternative BMPs:

For more efficient removal, use with:

SPC-8 Temporary Sediment Basins

SPC-9 Temporary Sediment Traps

RATINGS

Associated Costs	H	M	L
Implementation	X		
Maintenance	X		
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease		X	
Nutrients			X
Sediment	X		
Floatable Material		X	
Metals		X	
Other Construction Waste		X	

FIGURES

Photos/Sketches

SPC-10 Sediment Dewatering Operations Photos

CAD Drawings

None

PURPOSE

After storm events, dewatering of non-stormwater and accumulated rainfall from excavated work areas is often necessary before work can proceed. In the process of removing stormwater, certain measures must be taken to correctly discharge it.

APPROPRIATE APPLICATIONS

Dewatering is often implemented for discharges of non-stormwater from excavated work areas such as utility repairs and construction sites. Non-stormwater includes groundwater, water from cofferdams, water diversions, and water from drilling and other construction operations. Dewatering is also appropriate for removal of accumulated precipitation from depressed areas on a construction site.

LIMITATIONS

Dewatering controls described in this BMP are intended for control of sediment particles. Other control methods (i.e. sediment basins and sediment traps) may allow for longer settling time of sediment particles, and thus greater efficiency of removal, than dewatering controls. Dewatering operations that discharge water offsite will require an AZPDES De Minimus Discharge General Permit. Refer to ADEQ website (www.azdeq.gov/environ/water/permits/gen.html#demi) for more information. Dewatering discharges can be avoided by using the water for dust control or diverting it to an infiltration basin.

Specific limitations for sediment filter bags include:

- Filtration bags full of sediment are heavy and may need to be lifted with a front-end loader.
- As bags fill up with sediment, they become clogged and may “explode” from force of pump if not removed in time.
- Sediment filter bags may not work with very fine particulates.

PLANNING CONSIDERATIONS

Before starting a dewatering operation, one or more of the following mechanisms must be in place to treat water during dewatering operations:

- Sediment basin
- Sediment trap
- Weir tanks
- Dewatering tanks

- Gravity bag filter

Alternatively, excavated areas can be protected before runoff enters by using: Organic Filter Barrier, Sand Bag Barrier, or Gravel Filter Berms.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Sediment basin

Sediment basins are relatively large structures that are effective during dewatering operations for the removal of gravel, sand, silt, and some metals that settle out with the sediment as well as trash. Refer to Temporary Sediment Basins for a more detailed description.

Sediment trap

Sediment traps are smaller structures that mainly remove larger particles (gravel and sand) and are less effective at removing fines and associated metals than sediment basins. Refer to Temporary Sediment Traps for a more detailed description.

Weir tanks

Weir tanks separate waste from water through a series of weirs. The tank can remove trash, some settleable solids (gravel, sand, and silt), oil and grease, and some metals (removed with the sediment). For higher levels of flow, multiple tanks can be used in parallel, or if additional treatment is desired, the tanks can be placed in series or as pre-treatment in conjunction with other methods. For additional removal of fine sediment particles, consider adding a coagulant to the collected water in the weir tank. Note that periodic cleaning is required based on visual inspection or reduced flow. Any accumulated oil and grease must be disposed of by a licensed waste disposal company.

Dewatering tanks

A dewatering tank removes debris and sediment by passing the dewatered effluent through a fabric filter at the top and discharging it through the bottom of the tank. The filter separates trash, some settleable solids (gravel, sand, and silt), oil and grease, and some metals (removed with the sediment). Similar to weir tanks, for higher levels of flow, multiple tanks can be used in parallel, or if additional treatment is desired, the tanks can be placed in series or as pre-treatment in conjunction with other methods. For additional removal of the sediment particles, consider adding a coagulant to the dewatering tank. Note that periodic cleaning is required based on visual inspection or reduced flow. Any accumulated oil and grease must be disposed of by a licensed waste disposal company.

Gravity bag filter

A gravity bag filter, also referred to as a dewatering bag, is a rectangular bag made of non-woven geotextile fabric for effective removal of sediments (gravel, sand, and silt). Some metals are

removed with the sediment. Depending on size, the bag can handle up to 1500 gallons per minute. The bag should be installed on a slight slope so that water flows through the length of the bag. Place straps underneath the bag so that when full, the bag may be more easily lifted. Insert the hose (up to 4 inches in diameter) into the neck of the dirtbag. Tie off the neck with baling wire and/or duct tape. Filtration bags come in sizes up to 15 feet by 15 feet. When filled with trapped sediment, it requires heavy equipment or a crew of men to lift it.

RECOMMENDED MAINTENANCE AND INSPECTION

Soil from full dewatering bags can either be reapplied to the site as it often contains nutrient rich top soil or should be properly disposed of offsite.

POST CONSTRUCTION METHODS

None.

REFERENCES

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual.
http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

SPC-10 Sediment Dewatering Operations Photos

Dewatering sediment bag.

Courtesy of www.stormwater-products.com

Dewatering tanks.

Courtesy of CALTRANS

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GH General Housekeeping

General housekeeping refers to any management and/or work practices implemented on a construction site to prevent the contamination of stormwater by materials other than sediment. General housekeeping practices involve proper management of chemicals and other potentially hazardous construction materials, equipment, and wastes. Managing potential pollutants offsite (i.e. conducting equipment maintenance back at the maintenance shop rather than at the site) is an effective method of eliminating potential spills and contamination on the construction site. If a pre-manufactured product is to be implemented on a site for general housekeeping, the contractor should always follow the manufacturer's installation and maintenance recommendations as the primary reference for implementation.

VENDOR PRODUCTS

See vendor products for General Housekeeping BMPs.

Disclaimer

Any hyperlinks in the vendor products table will direct you out of the Flood Control District of Maricopa County (FCDMC) domain. FCDMC is providing the following vendor information for possible assistance to any interested parties, but does not necessarily endorse any of the information, recommendations or products provided by the vendors.

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GH-1 Chemical Management

DEFINITION

Chemical management includes the proper labeling, handling, storage and disposal of chemical products.

GENERAL INFORMATION

Applicability - Effectiveness

Inlet Drain Protection - high
Debris Management, Cleanup, and Washout - moderate
Equipment Storage/Maintenance - high

Most effective when used with:

Protect excavated areas before runoff enters by using:

GH-2 Solid Waste Management

GH-3 Equipment Maintenance Procedures

GH-5 Spill Containment Plan

Alternative BMPs:

None

RATINGS

Associated Costs	**H**	**M**	**L**
Implementation		X	
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease	X		
Nutrients	X		
Sediment			X
Floatable Material			X
Metals	X		
Other Construction Waste	X		

FIGURES

Photos/Sketches

GH-1 Chemical Management Photos

CAD Drawings

None

PURPOSE

Proper chemical management prevents, or at least minimizes stormwater runoff from being polluted through spills or other forms of contact. It is not intended to supercede or replace normal site assessment and remediation procedures.

APPROPRIATE APPLICATIONS

Chemical management practices, along with the applicable OSHA, DOT, and EPA guidelines, should be incorporated at all construction sites that use or generate potentially hazardous wastes. Target chemicals include:

- Paints, solvents, and stains
- Wood preservatives
- Fuel, lube oils, grease, and cutting oils
- Roofing tar
- Pesticides, herbicides, and fertilizer
- Antifreeze

LIMITATIONS

- Chemical management practices are not intended to address site-assessments and pre-existing soil and water contamination. Major contamination and large spills require immediate response from spill-response personnel.
- Demolition activities and potential pre-existing materials, such as lead-based paint and asbestos in building materials, are not addressed by this practice.
- Chemical management practices cover general procedures and are not intended for products and uses that may require additional safeguards.

RECOMMENDED STANDARDS AND SPECIFICATIONS

The best method for controlling chemical pollution is to provide adequate controls at the point of storage and use. The following recommendations are intended to prevent, and/or minimize contamination of runoff:

Storage and Labeling Procedures

- Where possible, cover stockpiled materials indoors or with a temporary roof structure. Do not allow water to pond around stored drums.

- Do not pinch a drum with a forklift when unloading or moving.
- If moving multiple drums (i.e. on a pallet), make sure they are held together with shrink wrap or a steel band.
- Mark any damaged containers.
- Do not store chemicals, drums, and bagged materials directly on the ground. Use secondary containment platforms or wooden pallets.
- Provide spill containment dikes around chemical and fuel storage tanks. Line with plastic film to prevent soil contamination.
- When possible, keep chemical products in their original containers, bungs on lids closed (except during use), and labeled in accordance with DOT and EPA regulations. Use proper devices to transfer chemicals from one container to another.
- Containment areas that have collected precipitation should not be drained until the site supervisor has ensured that the drainage will not contaminate surrounding soil.

Waste Handling and Disposal Procedures

- Ensure that adequate hazardous waste storage space is available, hazardous waste collection containers are conveniently located, and that adequate cleanup and containment materials are available onsite.
- Store hazardous wastes in an appropriate type of container and properly labeled per EPA, OSHA, and DOT regulations.
- Consult with the local municipality jurisdiction as to whether wash up water from water-based paints may go into a sanitary sewer.
- Regularly dispose of oil-based paints, solvents, thinners, and mineral spirits through a licensed waste management firm.
- Follow the recommendations of the manufacturer to dispose of construction chemicals such as curing compounds, form releases, etc.
- Follow the manufacturer's instructions regarding the intended use, protective equipment, ventilation, flammability, and mixing of chemicals.

The effectiveness of chemical management is enhanced when the following BMPs are also implemented: Solid Waste Management, Equipment Maintenance Procedures, and Spill Containment Plan

RECOMMENDED MAINTENANCE AND INSPECTION

Various components of a Chemical Management program must be continually maintained and revised:

Educating workers

- Safety procedures for proper construction site chemical storage and management.
- Identification of potential sources of chemical pollutants.
- Spill prevention and response procedures.
- Potential dangers to humans and the environment from chemical pollutants.
- Establish a continuing education program to educate new employees.

Quality Assurance

- Foreman and/or construction supervisor should monitor onsite chemical storage and disposal procedures.
- Educate and if necessary, retain and/or discipline workers who violate procedures.
- Ensure the hazardous waste disposal contractor is reputable and licensed.

Emergency Response Plan

As specified by the local Fire Department, revisions may be necessary to the Protected Chemical and Materials Storage Area Plan during the course of construction based upon materials to be stored on site.

If a spill occurs which equals or exceeds the reportable quantity (RQ) for a 24-hour period as defined by the EPA in 40 CFR Part 110, 40 CFR Part 117, and 40 CFR Part 302, then:

- Report spill to the National Response Center, 1-800-424-8802, within 24 hours. Also notify the Arizona Emergency Response Commission and the Maricopa County Emergency Management Department.
- Revise the Stormwater Pollution Prevention Plan (SWPPP) to show corrective actions.
- Notify local EPA Region IX office within 14 days.

POST CONSTRUCTION METHODS

If hazardous materials are stored onsite after the development is completed, proper chemical management procedures and structures should be maintained.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

Smolen, M.D., September 1988, North Carolina Erosion and Sediment Control Planning and Design Manual, North Carolina Sediment Control Commission, et al.

GH-1 Chemical Management Photos

Secondary drum containment platform.

Courtesy of Interstate Products, Inc.

Secondary drum containment covered storage.

Courtesy of Interstate Products, Inc.

GH-2 Solid Waste Management

DEFINITION

The routine collection, recycling, and disposal of accumulated solid waste generated at the construction site.

GENERAL INFORMATION

Applicability - Effectiveness

Debris Management, Cleanup, and Washout - moderate

Trash Collection/Management - high

Most effective when used with:

GH-1 Chemical Management

GH-3 Equipment Maintenance Procedures

GH-5 Spill Containment Plan

Alternative BMPs:

None

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients		X	
Sediment			X
Floatable Material	X		
Metals	X		
Other Construction Waste	X		

FIGURES

Photos/Sketches

Solid Waste Management Photos

CAD Drawings

None

PURPOSE

Solid waste is one of the major pollutants caused by construction activities. By limiting the trash and debris on site and through proper disposal methods, stormwater quality is improved and there is reduced clean up at the completion of a project.

APPROPRIATE APPLICATIONS

Proper solid waste management is applicable to all construction activities. Solid wastes include, but are not limited to:

- Construction wastes including plastic, glass, rubber, brick, mortar, timber, steel and metal scraps, sawdust, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials, materials from the demolition of structures. Highway planting wastes, including vegetative material, plant containers, and packaging materials.

- Domestic waste products, including sanitary wastes, food containers, beverage cans, coffee cups, paper bags, plastic wrappers, cigarettes, and litter generated by the public.

LIMITATIONS

- Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

- This practice only applies to non-hazardous solid waste.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Education

- Site supervisor or other designated personnel should oversee and enforce proper solid waste procedures and practices.

- Instruct employees and subcontractors on identification of solid waste and hazardous waste, solid waste storage and disposal procedures. Require that employees and subcontractors follow solid waste handling and storage procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

- Prohibit littering by employees, subcontractors, and visitors.

- Wherever possible, minimize production of solid waste materials.

Collection, Storage, and Disposal

- Covered dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project operations.
- Prevent clogging of the storm drainage system by removing litter and debris from drainage grates, trash racks, and ditch lines.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Construction debris and litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, stormwater drainage systems, or watercourses.
- Full dumpsters should be removed from the project site.
- Litter stored in collection areas and containers should be handled and disposed of by trash hauling contractors every two weeks or more frequently, if necessary. Notify trash hauling contractors that only watertight dumpsters are acceptable for use onsite. Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Stormwater runoff should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures.
- Solid waste storage areas should be located more than 50 ft from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Dumpster washout on the project site is not allowed.
- Keep the site clean of litter debris.

Hazardous Waste Management

- Segregate potentially hazardous waste from non-hazardous construction site waste. Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris. For disposal of hazardous waste, see Chemical Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.

Recycling

- Salvage or recycle useful vegetation debris, packaging and/or surplus building materials when practical. For example, trees and shrubs from land clearing can be converted into

wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Sanitary Waste Management

- Educate employees, subcontractors, and suppliers on sanitary/septic waste storage and disposal procedures and potential dangers to humans and the environment from sanitary/septic wastes.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings) and to educate new employees.
- Locate portable toilets a minimum of 20 feet away from storm drain inlets, drainage facilities, watercourses, and from traffic circulation. If unable to meet the 20-foot distance requirement, provide secondary containment for portable toilets.
- Properly connect temporary sanitary facilities that discharge to the sanitary sewer system to avoid illicit discharges. Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- If using an on site disposal system, such as a septic system, comply with local health agency requirements.
- Ensure that sanitary/septic facilities are maintained in good working order by a licensed service. Use only reputable, licensed sanitary/septic waste haulers.

The effectiveness of solid waste management is enhanced when the following BMPs are also implemented: Chemical Management, Equipment Maintenance Procedures, and Spill Containment Plan.

RECOMMENDED MAINTENANCE AND INSPECTION

- Onsite trash should be collected and disposed of on a regular basis. Sanitary systems should also be regularly serviced.
- Repair trash containers and dumpsters on an as needed basis. Where possible provide cover for waste containers to prevent the entry of rainwater and loss of contents by wind.
- Maintain a contingency plan in the case that hazardous or toxic materials are discovered onsite.

POST CONSTRUCTION METHODS

Long term solid waste practices should be implemented (i.e. dumpsters, and regular trash pick-ups, etc.)

REFERENCES

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

GH-2 Solid Waste Management Photos

Separate out different wastes from each other for recycling.

Place signage on the dumpster to prevent improper disposal of hazardous wastes.

GH-3 Equipment Maintenance Procedures

DEFINITION

Establish a program of equipment maintenance procedures, which will reduce contamination of onsite soils.

GENERAL INFORMATION

Applicability - Effectiveness

Equipment Storage/Maintenance - high
Debris Management, Cleanup, and Wash-out- moderate
Trash Collection/Management - moderate

Most effective when used with:

GH-1 Chemical Management

GH-4 Designated Washdown Areas

GH-5 Spill Containment Plan

Alternative BMPs:

None

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease	X		
Nutrients			X
Sediment			X
Floatable Material			X
Metals	X		
Other Construction Waste		X	

FIGURES

Photos/Sketches

Equipment Maintenance Procedures Photos

CAD Drawings

None

PURPOSE

Non-sediment stormwater pollution can occur through improper disposal of equipment fluids and disposables such as filters, batteries, and tires. An established program of maintenance procedures can prevent job site pollution and contamination of stormwater.

APPROPRIATE APPLICATIONS

These procedures are applied on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles. Perform equipment maintenance, if possible, back at the maintenance shop.

LIMITATIONS

None identified.

RECOMMENDED STANDARDS AND SPECIFICATIONS

- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- All maintenance areas are required to have spill kits and/or use other spill protection devices.
- Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Absorbent spill clean-up materials should be available in maintenance areas and should be disposed of properly after use. Substances used to coat asphalt transport trucks and asphalt spreading equipment should be non-toxic.
- Use offsite maintenance facilities whenever practical.
- For long-term projects, consider constructing roofs or portable tents over maintenance areas.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials. Do not dump fuels and lubricants onto the ground, place used oil in a dumpster, or pour into a storm drain or watercourse. Repair fluid and oil leaks immediately. Provide spill containment dikes or secondary containment around stored oil and chemical drums.
- Properly dispose or recycle used batteries.

The effectiveness of equipment maintenance procedures is enhanced when the following BMPs are also implemented: GH-1 Chemical Management, GH-4 Designated Washdown Areas and GH-5 Spill Containment Plan.

RECOMMENDED MAINTENANCE AND INSPECTION

- Maintain waste fluid containers in leak proof condition.
- Vehicle and equipment maintenance areas should be inspected regularly.
- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

POST CONSTRUCTION METHODS

None.

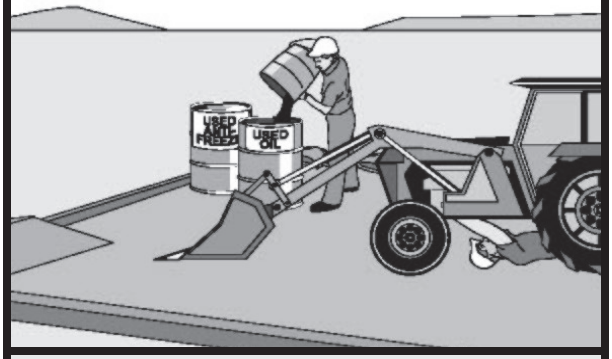
REFERENCES

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

GH-3 Equipment Maintenance Procedures Photos



Schematic of used oil containment.

Courtesy of CALTRANS

Enclosed area maintenance.

Courtesy of EPA

AGH-4 Designated Washdown Areas

DEFINITION

A temporary pit or bermed area for washout of concrete trucks, tools, mortar mixers, etc. The concrete wash-out area must be located as far as possible away from the watercourse and other drainage ways. Unless the entire project site is located within the floodplain, the concrete wash-out area must also be located above the floodplain. The washout area must be contained by constructing a temporary sub-surface pit or by using impervious structural barriers to contain concrete waste while it hardens. The wash-out area must be lined with an impervious material to hold wash water while it evaporates. The wash-out area must be built with adequate capacity to hold concrete wastes and potential rainfall, and prevent overtopping and runoff.

GENERAL INFORMATION

Applicability - Effectiveness
Inlet Drain Protection - high
Debris Management, Cleanup, and Washout - high

Most effective when used with:

GH-1 Chemical Management

GH-3 Equipment Maintenance Procedures

GH-5 Spill Containment Plan

Alternative BMPs:

None

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance		X	
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease		X	
Nutrients			X
Sediment			X
Floatable Material			X
Metals		X	
Other Construction Waste	X		

PURPOSE

Improper washout of concrete trucks, tools, etc. may allow fresh concrete or cement laden mortar to enter a storm drainage system.

APPROPRIATE APPLICATIONS

Concrete transit mixers must be cleaned in the designated wash-out area only.

Effective when vehicles, tools, and mixers can be moved to the pit location.

Where this is not practical, temporary ponds may be constructed to allow for settling and hardening of cement and aggregates. Washout area/pits are appropriate for minor amounts of wash water which result from cleaning of aggregate materials or concrete trucks, tools, etc.

LIMITATIONS

None

PLANNING CONSIDERATIONS

1. Wash out into a slurry pit which will later be backfilled. Do this only with the approval of the property owner.
2. Wash out into a temporary pit where the concrete wash can harden, be broken up, and then properly disposed of off-site.

RECOMMENDED STANDARDS AND SPECIFICATIONS

Design & Standards Criteria

1. Locate wash out pits away from storm drains, open ditches, or storm water receiving waters.
2. DO NOT wash out concrete trucks into-storm drains, sanitary sewers, street gutters, or stormwater channels.
3. Washout cannot be connected to any storm water facilities, or retention basins.

RECOMMENDED MAINTENANCE AND INSPECTION

Properly dispose of hardened concrete products on a routine basis to prevent the buildup of waste materials to an unmanageable size and to maintain percolation of water. All materials used to construct the temporary wash-out area must be removed from the construction site following construction. Ground disturbance at the wash-out area must be permanently stabilized at the end of construction.

POST CONSTRUCTION METHODS

None.

REFERENCES

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual.
http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II.
http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

North Central Texas Council of Governments, December 2003, integrated Storm Water Management (iSWM) Design Manual for Construction.

Washington Department of Ecology, August 2001, Stormwater Management Manual for Western Washington, Publications #99-11 through 99-15.

AGH-4 Designated Washdown Areas Photos

Concrete washout container.

Courtesy of Concrete Washout Systems, Inc.

Concrete washout area.

Courtesy of Douglas County

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GH-5 Spill Containment Plan

DEFINITION

An emergency plan to contain spills of dangerous, hazardous, or toxic wastes which mitigates environmental damage and provides prompt notice to proper authorities.

GENERAL INFORMATION

Applicability - Effectiveness
Inlet Drain Protection - high
Debris Management, Cleanup, and Washout - high

Most effective when used with:

GH-1 Chemical Management

GH-3 Equipment Maintenance Procedures

GH-4 Designated Washdown Areas

Alternative BMPs:

None

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance			X
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease	X		
Nutrients			X
Sediment			X
Floatable Material			X
Metals		X	
Other Construction Waste		X	

FIGURES

Photos/Sketches

GH-5 Spill Containment Plan Photos

CAD Drawings

None

PURPOSE

These procedures and practices are implemented to prevent and control spills in a manner that minimizes or prevents the discharge of spilled material to the drainage system or watercourses.

APPROPRIATE APPLICATIONS

This best management practice (BMP) applies to all construction projects. Spill control procedures are implemented any time chemicals and/or hazardous substances are stored. Substances may include, but are not limited to:

- Soil stabilizers/binders.
- Dust Palliatives.
- Herbicides.
- Growth inhibitors.
- Fertilizers.
- Deicing chemicals.
- Fuels.
- Lubricants.
- Other petroleum distillates.
- Sanitary and septic wastes.

To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110, 117, and 302.

LIMITATIONS

- The procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite.
- This BMP only applies to *emergency* spill response. Refer to Chemical Management for proper storage, use, and disposal of dangerous, hazardous, and toxic wastes that should be observed at all times to minimize the potential for a spill.

PLANNING CONSIDERATIONS

Education

- Educate employees and subcontractors on what a significant spill is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings) and establish a program to instruct new employees.

Spill Response Procedures

- Significant/Hazardous Spills - for significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Immediately notify the following:
    - Site supervisor and follow up with a written report.
    - Local emergency response (Fire department).
    - A spills contractor or a Haz-Mat team immediately. Construction personnel should not attempt to clean up the spill until the appropriate and qualified staff have arrived at the job site.
    - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center (see contact number in table below).
  - Any applicable divisions within ADEQ should also be contacted. Notification should first be made by telephone and followed up with a written report.

Agency	Situation	Phone
Arizona Department of Environmental Quality (ADEQ) -Emergency Response Unit	Emergency	602-771-2330 800-234-5677
Arizona Department of Environmental Quality (ADEQ) -Emergency Response Unit	Routine Business	602-771-4106 602-771-4155
National Response Center	Emergency	800-424-8802
Local Fire Department/District	Emergency	911

Other ADEQ Contact Numbers	
ADEQ front desk	602-771-2300
Air Quality Division	602-771-2308
Waste Programs Division	602-771-4209
Pollution Prevention/TRI	602-771-4235
Water Quality Division	602-771-2306
Stormwater	**602-771-4574**

Post Spill Response Procedures

- Spills should not be buried or washed with water.
- Used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose should be stored and disposed of in conformance with the special provisions.
- Water used for cleaning and decontamination should not be allowed to enter storm drains or watercourses and should be collected and disposed of in accordance with GH-1 Chemical Management. Water overflow or minor water spillage should be contained and should not be allowed to discharge into drainage facilities or watercourses.
- Proper storage, clean-up and spill reporting instruction for hazardous materials stored or used on the project site should be posted at all times in an open, conspicuous and accessible location.
- Waste storage areas should be kept clean, well organized and equipped with ample clean-up supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers and liners should be repaired or replaced as needed to maintain proper function.

The effectiveness of spill containment is enhanced when the following BMPs are also implemented: GH-1 Chemical Management, GH-3 Equipment Maintenance Procedures, and GH-4 Designated Washdown Areas.

RECOMMENDED MAINTENANCE AND INSPECTION

- Comply with suggestions and requirements set by local fire department.
- Verify weekly that spill control clean up materials are located near material storage, unloading, and use areas. Restock appropriate clean-up materials after a spill incident has occurred.

- Update spill prevention and control plans and stock appropriate clean-up materials whenever changes occur in the types of chemicals used or stored onsite, or after a spill incident has occurred.

POST CONSTRUCTION METHODS

None.

REFERENCES

Tacoma Public Works Environmental Services, January 1993, City of Tacoma Surface Water Management Manual Volume II, Construction Stormwater Pollution Prevention. http://www.cityoftacoma.org/Page.aspx?hid=951#manual

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

U.S. Environmental Protection Agency, December 1999, Construction Site Storm Water Runoff Control, National Menu of Best Management Practices for Storm Water Phase II. http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm

GH-5 Spill Containment Plan Photos

Provide temporary inlet protection against any spills approaching drain inlets to a stormwater collection system.

Absorbent snakes can be used to protect storm drains from spills.

Courtesy of Stormwater 911

Containing leaks from equipment

Courtesy of Stormwater 911

GH-6 Road Sweeping/Trackout Cleaning

DEFINITION

Road trackout cleaning procedures refer to methods to remove tracked sediment around construction site points of egress.

GENERAL INFORMATION

Applicability - Effectiveness
Perimeter and Access Controls - high
Debris Management, Cleanup, and Washout - high

Most effective when used with:

EC-5 Stabilized Construction Entrance

EC-6 Construction Road Stabilization

EC-7 Dust Control

Alternative BMPs:

None

RATINGS

Associated Costs	H	M	L
Implementation		X	
Maintenance	X		
Training		X	
Target Pollutants Removal	**H**	**M**	**L**
Oil and Grease			X
Nutrients			X
Sediment	X		
Floatable Material	X		
Metals		X	
Other Construction Waste	X		

FIGURES

Photos/Sketches

GH-6 Road Sweeping/Trackout Cleaning Photos

CAD Drawings

None

PURPOSE

Cleaning road trackout prevents the sediment from entering a storm drain or watercourse.

APPROPRIATE APPLICATIONS

These practices are implemented anywhere sediment is tracked from the project site onto public or private paved roads, typically at points of ingress/egress. Studies have shown that vacuum or regenerative air street sweepers can effectively remove fine dust particles and yield significant runoff quality benefits.

- Limitations
- Sweeping and vacuuming may not be effective when soil is wet or muddy.
- Mechanical brush sweepers may only remove coarser particles.

RECOMMENDED STANDARDS AND SPECIFICATIONS

- Visible sediment tracking should be swept and/or vacuumed daily. For smaller areas of trackout, kick brooms can be used. For larger areas, consider mechanical brush or vacuum sweepers. Some mechanical sweepers can remove debris and dust particles down to 2.5 microns.
- Conduct sweepings at least once per week during the project operations. During rainy seasons, implement sweepings on a more frequent basis.
- Consider incorporating the removed sediment back into the project, rather than hauling offsite to disposal.

RECOMMENDED MAINTENANCE AND INSPECTION

- Inspect ingress/egress access points daily and sweep tracked sediment as needed.
- Properly dispose of any unknown substances or objects that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, sweeper water can be reused or disposed of at an approved dump-site.
- The operator is responsible for compliance with Maricopa County Dust Control Rules for Trackout Control.

POST CONSTRUCTION METHODS

In most cases, the municipality will continue with road sweeping operations after construction is complete.

REFERENCES

CALTRANS, State of California Department of Transportation, March 2003, Construction Site Best Management Practices (BMPs) Manual. http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm

Kamber Engineering Gaithersberg, Maryland, April, 1991, Sedimentation and Erosion Control, An Inventory of Current Practices, USEPA.

GH-6 Road Sweeping/Trackout Cleaning Photos

Road sweeping

Courtesy of Douglas County