Thurston County
Drainage Design and Erosion Control Manual

Volume II
Construction Stormwater Pollution Prevention

Prepared by
Thurston County Water Resources Division,
Department of Public Works

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Table of Contents

Chapter 1 - Introduction to Construction Stormwater Pollution Prevention 1-1

1.1 Purpose of this Volume 1-1
1.2 How This Volume is Organized 1-1
1.3 13 Elements of Construction Stormwater Pollution Prevention 1-2
1.4 Water Quality Standards 1-3
1.5 Other Applicable Regulations and Permits 1-3
1.5.1 Enforcement Guidelines 1-3
1.5.2 Compliance with Standards 1-4

Chapter 2 - Developing and Implementing a Construction Stormwater Pollution Prevention Plan 2-1

2.1 General Guidelines 2-1
2.1.1 What is a Construction Stormwater Pollution Prevention Plan? 2-1
2.1.2 What is an "Adequate" Plan? 2-2
2.1.3 BMP Standards and Specifications 2-3
2.1.4 General Principles 2-3
2.2 Construction SWPPP Submittal Components 2-6
2.3 Step-By-Step Procedure 2-7
2.3.1 Step 1 – Data Collection and Analysis 2-7
2.3.2 Step 2 – Select and Design BMPs 2-10
2.3.3 Step 3 – Development and Implementation of the Construction SWPPP 2-27
2.4 Construction SWPPP TESC Drawing Protocols 2-31
2.4.1 Required Drawing Protocol 2-31
2.4.2 General Drawing Requirements 2-31
2.4.3 Cover Sheet 2-32
2.4.4 General Drawing Site and/or Grading Plan Sheets 2-33
2.4.5 Plan and Profile Sheets (Roadway Projects) 2-35
2.4.6 Detail Sheets and Cross-Sections 2-36
2.4.7 Required Drawing Size 2-37
2.4.8 Plans and Specifications 2-37
2.5 Construction SWPPP Checklist 2-37
Section I – Construction SWPPP Narrative 2-38
Section II – Temporary Erosion and Sediment Control Plans 2-40

Chapter 3 - Standards and Specifications for Best Management Practices 3-1

3.1 Source Control BMPs 3-2
BMP C101: Preserving Natural Vegetation 3-3
BMP C102: Buffer Zones 3-8
BMP C103: High Visibility Fence 3-9

BMP C105: Stabilized Construction Entrance / Exit 3-10
BMP C106: Wheel Wash 3-14
BMP C107: Construction Road/Parking Area Stabilization 3-17
BMP C120: Temporary and Permanent Seeding 3-19
BMP C121: Mulching 3-26
BMP C122: Nets and Blankets 3-30
BMP C123: Plastic Covering 3-33
BMP C124: Sodding 3-35
BMP C125: Topsoiling / Composting 3-37
BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection 3-41
BMP C130: Surface Roughening 3-46
BMP C131: Gradient Terraces 3-49
BMP C140: Dust Control 3-52
BMP C150: Materials on Hand 3-54
BMP C151: Concrete Handling 3-56
BMP C152: Sawcutting and Surfacing Pollution Prevention 3-59
BMP C153: Material Delivery, Storage and Containment 3-61
BMP C154: Concrete Washout Area 3-64
BMP C160: Certified Erosion and Sediment Control Lead 3-72
BMP C162: Scheduling 3-74
3.2 Runoff Conveyance and Treatment BMPs 3-75
BMP C200: Interceptor Dike and Swale 3-76
BMP C201: Grass-Lined Channels 3-79
BMP C202: Riprap Channel Lining 3-85
BMP C203: Water Bars 3-87
BMP C204: Pipe Slope Drains 3-89
BMP C205: Subsurface Drains 3-93
BMP C206: Level Spreader 3-96
BMP C207: Check Dams 3-99
BMP C208: Triangular Silt Dike (Geotextile-Encased Check Dam) 3-103
BMP C209: Outlet Protection 3-105
BMP C220: Storm Drain Inlet Protection 3-107
BMP C231: Brush Barrier 3-116
BMP C232: Gravel Filter Berm 3-118
BMP C233: Silt Fence 3-119
BMP C234: Vegetated Strip 3-125
BMP C235: Wattles 3-127
BMP C236: Vegetative Filtration 3-131
BMP C240: Sediment Trap 3-134
BMP C241: Temporary Sediment Pond 3-137
BMP C250: Construction Stormwater Chemical Treatment 3-145
BMP C251: Construction Stormwater Filtration 3-155
BMP C252: Treating and Disposing of High pH Water 3-158
3.3 Low Impact Development BMPs 3-162
3.3.1 Introduction 3-162
3.3.2 Erosion and Sediment Control BMPs Applicable to LID 3-162

3.3.3 Additional Construction Techniques for LID BMPs 3-163
3.3.4 Construction Site Planning and Sequencing 3-164
3.3.5 Activities During Construction 3-165
3.3.6 BMP-specific Construction Techniques 3-166
3.3.7 Infiltration and Dispersion Facility Construction Techniques 3-167
3.3.8 Permeable Pavement 3-169
3.3.9 Bioretention Areas and Rain Gardens 3-169
3.3.10 Vegetated Roofs 3-170

Resource Materials R-1

Appendix II-A Recommended Standard Notes for Construction Stormwater Pollution Prevention Plans A-1

Appendix II-B Stormwater Pollution Prevention Site Plan Checklist A-3

Figures

Figure II - 3.1 Critical Root Zone (CRZ), in feet 3-6
Figure II - 3.2 Surface Roughening by Tracking and Contour Furrows 3-47
Figure II - 3.3 Gradient Terraces 3-49
Figure II - 3.4 Concrete Washout Area with Wood Planks 3-69
Figure II - 3.5 Concrete Washout Area with Straw Bales 3-70
Figure II - 3.6 Prefabricated Concrete Washout Container w/Ramp 3-71
Figure II - 3.7 Typical Grass-Lined Channels 3-79
Figure II - 3.8 Temporary Channel Liners 3-82
Figure II - 3.9 Water Bar 3-88
Figure II - 3.10 Pipe Slope Drain 3-90
Figure II - 3.11 Cross-Section of Level Spreader 3-97
Figure II - 3.12 Detail of Level Spreader 3-98
Figure II - 3.14 Block and Gravel Filter 3-110
Figure II - 3.15 Curb Inlet with Wooden Weir 3-112
Figure II - 3.16 Block and Gravel Curb Inlet Protection 3-114
Figure II - 3.17 Curb and Gutter Barrier 3-115
Figure II - 3.18 Brush Barrier 3-117
Figure II - 3.19 Silt Fence 3-119
Figure II - 3.20 Silt Fence Installation by Slicing Method 3-124
Figure II - 3.21 Straw Wattles 3-128
Figure II - 3.22 Manifold and Branches in wooded, vegetated spray field 3-133
Figure II - 3.23 Cross Section of Sediment Trap 3-135
Figure II - 3.24 Sediment Trap Outlet 3-135
Figure II - 3.25 Sediment Pond Plan View 3-140
Figure II - 3.26 Sediment Pond Cross-Section 3-140
Figure II - 3.27 Sediment Pond Riser Detail 3-140

Figure II - 3.28 Riser Inflow Curves 3-143

Tables

Table II - 3.1 Source Control BMPs by SWPPP Element 3-2
Table II - 3.2 Temporary Erosion Control Seed Mix 3-23
Table II - 3.3 Landscaping Seed Mix 3-23
Table II - 3.4 Low-Growing Turf Seed Mix 3-23
Table II - 3.5 Bioswale Seed Mix[a] 3-24
Table II - 3.6 Wet Area Seed Mix 3-24
Table II - 3.7 Meadow Seed Mix 3-25
Table II - 3.8 Mulch Standards and Guidelines 3-28
Table II - 3.9 PAM and Water Application Rates 3-42
Table II - 3.10 Materials on Hand 3-54
Table II - 3.11 Runoff Conveyance and Treatment BMPs by SWPPP Element 3-75
Table II - 3.12 Horizontal Spacing of Interceptor Dikes 3-77
Table II - 3.13 Water Bar Spacing 3-87
Table II - 3.14 Storm Drain Inlet Protection 3-108
Table II - 3.15 Geotextile Standards 3-120
Table II - 3.16 Vegetated Strips 3-125
Table II - 3.17 Wattle Spacing Table 3-130
Table II - 3.18 Flow Path Guidelines for Vegetative Filtration 3-132
Table II - 3.19 LID Construction BMPs 3-163
Table II - 3.20 Construction Sequencing 3-164
Table II - 3.21 LID Erosion Control Requirements 3-165
Table II - 3.22 Techniques for Protecting Infiltration and Dispersion Facilities 3-168

Acronyms

AKART	All known, available, and reasonable methods of prevention, control, and treatment.
ATB	Asphalt Treated Base
BFM	Bonded Fiber Matrix
BMPs	Best Management Practices
CESCL	Certified Erosion and Sediment Control Lead
CESCP	Contractor's Erosion and Sediment Control Plan
CFR	Code of Federal Regulations
CPESC	Certified Professional in Erosion and Sediment Control
CWSGP	Construction Stormwater General Permit
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESA	The Federal Endangered Species Act
ESC	Erosion and Sediment Control
FCWA	Federal Clean Water Act
FEMA	Federal Emergency Management Agency
IECA	International Erosion Control Association
MBFM	Mechanically Bonded Fiber Matrix
Min.	Minimum
NOEC	No observed effects concentration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service (Formerly SCS, Soil Conservation Service)
NTU	Nephelometric Turbidity Unit
PAM	Polyacrylamide
RUSLE	Revised Universal Soil Loss Equation
SWPPP	Stormwater Pollution Prevention Plan
TESC	Temporary Erosion and Sediment Control
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
WSDOT	Washington State Department of Transportation

Chapter 1 - Introduction to Construction Stormwater Pollution Prevention

1.1 Purpose of this Volume

This volume of the *Drainage Design and Erosion Control Manual (DDECM*) explains how to prevent adverse stormwater impacts from construction activities on downstream resources and on-site stormwater facilities. It should be used in developing your Construction Stormwater Pollution Prevention Plan (SWPPP), which is a required component of your Drainage Design and Erosion Control Plan (see Volume I, Chapter 3).

Information in this Volume applies to your project if you are required to address Core Requirement # 2 (See Volume I). This includes any project with 2,000 square feet, or more, of new plus replaced hard surface area, disturbs 7,000 sf or more of land, converts 3/4 acres or more of vegetation to lawn or landscaping, or that converts 2 ½ acres or more of native vegetation to pasture. If your project has greater than 1-acre of land disturbing activity and discharges to surface water, you may also be required to obtain an NPDES Construction Stormwater General Permit from the Department of Ecology. Projects not meeting the above thresholds may still be required to prepare an Abbreviated Drainage Plan that shall include appropriate elements from this Volume to minimize downstream impacts of your project.

Construction may take place over multiple seasons or years. Therefore, all management practices and control facilities used during construction shall be designed and sized to ensure protection during the anticipated construction period, including the appropriate selection of design storms as shown Chapter 3 for each BMP.

IMPORTANT: Linear construction projects such as roadway construction and utility installations are special cases and present their own unique set of stormwater protection challenges. You can adapt or modify many of the BMPs discussed in this volume to provide the controls needed to address these projects. You may also consider referring to the current edition of the WSDOT *Temporary Erosion and Sediment Control Manual* for additional guidance specific to linear projects. It may be advantageous to phase portions of long, linear projects and apply all necessary controls to individual phases.

1.2 How This Volume is Organized

Volume II is organized into three chapters that address key considerations and mechanics of construction stormwater BMPs:

Chapter 1 describes the 13 elements that must be considered when preparing a Stormwater Pollution Prevention Plan. It also includes additional regulatory requirements that may apply to construction sites and their stormwater discharges. This includes the Department of Ecology's (Ecology) National Pollutant Discharge

Elimination System (NPDES) discharge permit and Washington's Water Quality Standards pertaining to construction stormwater and how they apply to field situations.

Chapter 2 explains additional requirements for construction erosion control, including seasonal limitations and required components of the SWPPP.

Chapter 3 describes best management practices (BMPs) for construction stormwater control and site management, including source control for construction-related activities, runoff, conveyance, and treatment. The third section presents practices specifically to protect low impact development (LID) BMPs during construction. These practices are required as part of Element #13 (discussed in the next section). You can use various combinations of these BMPs in the Construction SWPPP to satisfy each of the 13 elements described in Section 1.3. Design and facility sizing information is included within the applicable BMP sections.

1.3 13 Elements of Construction Stormwater Pollution Prevention

The project proponent or designated project engineer shall develop a Construction Stormwater Pollution Prevention Plan (SWPPP). The goal of a SWPPP is to avoid immediate and long-term environmental loss and degradation caused by poorly managed construction sites. Additional information on erosion and sedimentation processes and factors influencing erosion potential may be found in the latest edition of Ecology's *Stormwater Management Manual for Western Washington*.

The following 13 elements address water quality protection strategies of limiting site impacts, preventing erosion and sedimentation, and managing activities and sources. Each element must be considered when developing the Construction SWPPP, unless site conditions make it unnecessary. If an element is unnecessary, the Construction SWPPP must justify the omission.

The 13 elements of a Construction SWPPP are:

1. Preserve Vegetation/Mark Clearing Limits
2. Establish Construction Access
3. Control Flow Rates
4. Install Sediment Controls
5. Stabilize Soils
6. Protect Slopes
7. Protect Drain Inlets
8. Stabilize Channels and Outlets
9. Control Pollutants
10. Control Dewatering
11. Maintain BMPs
12. Manage the Project
13. Protect Low Impact Development BMPs

Chapter 2 describes each element and its associated BMPs.

1.4 Water Quality Standards

Stormwater discharges from construction activity are subject to applicable state water quality standards. These discharges must not cause or contribute to violations of Washington State's surface water quality standards (Chapter 173-201A WAC), sediment management standards (Chapter 173-204 WAC), groundwater quality standards (Chapter 173-200 WAC), and human health based criteria in the National Toxics Rule (Federal Register, Vol. 57, No. 246, Dec. 22, 1992, pages 60848-60923).

A Site Development Permit does not authorize violation of these standards. Thurston County expects that the selection and implementation of appropriate BMPs outlined in this volume will result in compliance with water quality standards. Proper implementation and maintenance of BMPs is critical to adequately control adverse water quality impacts from construction activity. If observations reveal that installed BMPs do not adequately maintain flow and water quality standards, additional BMPs must be installed.

1.5 Other Applicable Regulations and Permits

In addition to Thurston County regulations, other regulations and permits may require the implementation of BMPs to control pollutants in construction site stormwater runoff. These include but are not limited to the following (principal permitting agency in parentheses):

- Construction General Permit under NPDES (Ecology)
- Total Maximum Daily Load (TMDLs) or Water Clean Up Plans (Ecology)
- Endangered Species Act – ESA (NOAA Fisheries or U.S. Fish & Wildlife)
- Hydraulic Project Approval Permits (WA Dept. of Fish & Wildlife)
- General provisions from the WSDOT (WA Dept. of Transportation)
- Contaminated site remediation agreements.

See the Introduction Section of this manual (preceding Volume I) for more information about these regulations and permits.

1.5.1 Enforcement Guidelines

The purpose of compliance monitoring is to ensure protection of water resources and stormwater infrastructure, not punish violators. Therefore, the initial and primary enforcement tool shall be a correction notice. Correction notices may be verbal or written. If the situation is not corrected within the timelines set in the correction notice, all construction work will be halted with a stop work order if necessary, until appropriate erosion prevention and sediment control BMPs are in place, and runoff meets applicable discharge and water quality standards.

If a timely and adequate response does not occur, or in cases of severe repeated violations, the County shall, at their discretion, issue infraction notices or citations carrying monetary penalties.

The Washington State Department of Ecology will also be contacted at this stage to help aid with enforcement under the responsible party's individual NPDES Construction Permit.[1]

1.5.2 Compliance with Standards

Stormwater discharges from construction sites must not cause or contribute to violations of Washington State's surface water quality standards (WAC 173-201A), sediment management standards (WAC 173-204), and human health based criteria in the National Toxics Rule (40 CFR Part 131.36).

Before the site can discharge stormwater and non-stormwater to waters of the State, all known, available, and reasonable methods of prevention, control, and treatment (AKART) must be applied. This includes preparing and implementing a Construction SWPPP, with all appropriate BMPs installed and maintained in accordance with the SWPPP and the terms and conditions of the Construction Stormwater General Permit (if one is required).

In accordance with Chapter 90.48 RCW, compliance with water quality standards is presumed unless discharge monitoring data or other site specific information demonstrates otherwise, when the applicant fully:

- Complies with permit conditions for planning, sampling, monitoring, reporting and recordkeeping; and
- Implements the BMPs contained in this manual or BMPs that are demonstrably equivalent to BMPs contained in this manual, including the proper selection, implementation, and maintenance of all applicable and appropriate BMPs for on-site pollution control.

The following discharge standard applies:

Runoff leaving the construction site shall be free of settleable solids, as measured with an Imhoff Cone, turbidity meter or transparency tube and in accordance with Standard Methods for the Examination of Water and Wastewater, most recent addition, American Water Works Association. "Free of settleable solids" shall be defined as measuring less than 2.5 mg/L/hr. for storms up to the water quality design event. Generally, if turbidity is visible in runoff, it does not meet this standard.

Pollutants that might be expected in the discharge from construction sites are turbidity, pH, and petroleum products. The surface water quality standards for turbidity and pH for waters designated for salmon and trout spawning, core rearing, and migration use are:

[1] Please see Thurston County Public Works Policy POL-820 on DDECM webpage at http://www.co.thurston.wa.us/stormwater/manual/manual-home.html

Turbidity: For storms up to the water quality design event, turbidity downstream of a construction site may not increase more than 5 NTU, if upstream turbidity is 50 NTU or less, and may not increase more than 10 percent, if upstream turbidity is over 50 NTU. To the extent practicable, samples shall be taken far enough downstream so that the construction site discharge has been well-mixed with surface water.

pH: Shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a human-caused variation within a range of less than 0.2 units. For Class A and lower water classifications, the permissible induced increase is 0.5 units.

Petroleum: Although there is no specific surface or groundwater quality standard for petroleum products, narrative surface water quality criteria prohibits any visible sheen in a discharge to surface water.

Whenever inspection or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be fully resolved and implemented within 10 days of the inspection, Thurston County may approve additional time when an extension is requested within the initial 10-day response period.

Chapter 2 - Developing and Implementing a Construction Stormwater Pollution Prevention Plan

This chapter describes the important components and process necessary for developing and implementing a Construction Stormwater Pollution Prevention Plan (SWPPP).

Section 2.1 provides general guidelines for plan format and content, and ideas for creating an effective plan.

Section 2.2 lists the components to be submitted with the SWPPP.

Section 2.3 describes a step-by-step procedure for developing a Construction SWPPP, from data collection to finished product, to meet the 13 required elements. This section also includes a checklist for developing a construction SWPPP.

Section 2.4 lists drawing protocols for the SWPPP.

See Chapter 3 for design standards and specifications for BMPs referred to in this chapter.

2.1 General Guidelines

2.1.1 What is a Construction Stormwater Pollution Prevention Plan?

A Construction Stormwater Pollution Prevention Plan (SWPPP) means a written plan to implement measures to identify, prevent, and control the contamination of point source discharges of stormwater during construction. The Construction SWPPP explains and illustrates the measures, usually in the form of best management practices (BMPs), to take on a construction site to control potential pollution problems.

The Construction SWPPP consists of a Temporary Erosion and Sediment Control (TESC) Plan and a narrative that addresses the 13 required elements described in section 1.3 above. The TESC is a set of plan sheets showing BMP locations and other features such as topography and sensitive areas, and includes construction details for BMPs, construction notes and specifications.

The Narrative supplements the TESC and is a written statement to explain and justify the pollution prevention decisions made for a particular project. The narrative contains site specific information about existing conditions, construction schedules, a description of the project, a description of how each of the 13 elements are addressed, and design calculations for specific BMPs including calculation of runoff volumes and flows for the design storm. See Section 2.2 for detailed submittal requirements for the TESC and Narrative.

A Construction SWPPP is required for projects that exceed the thresholds of Volume I, Chapter 2 and are subject to Core Requirement #2. For projects not required to meet

Core Requirement #2 that result in less than 2,000 square feet of new plus replaced hard surface area or less than 7,000 square feet of land disturbing activity that qualify for the Abbreviated Drainage Plan, a Stormwater Pollution Prevention Site Plan Checklist shall be submitted to ensure consideration of the thirteen Construction SWPPP elements and development of controls for all elements that pertain to the site (see Appendix II-C).

A copy of the TESC drawings must always be kept on the construction site and the Construction SWPPP must be located either on the construction site or within reasonable access of construction and inspection personnel. As site work progresses, the plan must be modified to reflect changing site conditions.

The owner or lessee of the land being developed is responsible for preparing and submitting the Construction SWPPP to the County. The owner or lessee may designate someone (i.e., an engineer, architect, contractor, etc.) to prepare the Construction SWPPP, but the owner retains the ultimate responsibility for environmental protection at the site.

2.1.2 What is an "Adequate" Plan?

The Construction SWPPP must contain sufficient information to satisfy the County that sediment, erosion and pollution problems have been adequately addressed for the proposed project.

An adequate Construction SWPPP includes a narrative and drawings. The narrative is a written statement to explain and justify the pollution prevention decisions made for a particular project. The narrative contains concise, site specific, information about existing site conditions, construction schedules, and other pertinent items that are not contained on the drawings. The drawings show, on a site map, the specific BMPs which shall be installed. Provide text notes on the drawings to describe the performance standards the BMPs should achieve, and actions to take if the performance goals are not achieved.

On construction sites that discharge to surface water, the primary concern in the preparation of the Construction SWPPP is compliance with Washington State Water Quality Standards. Each of the 13 elements (Section 2.3.2) must be included in the Construction SWPPP, unless an element is determined to not be applicable to the project and the exemption is justified in the narrative.

On construction sites that infiltrate all stormwater runoff, the primary concern in the preparation of the Construction SWPPP is the protection of the infiltration facilities from fine sediments during the construction phase and protection of groundwater from other pollutants.

Reports summarizing the scope of inspections, the personnel conducting the inspection, the date(s) of the inspection, major observations relating to implementing the Construction SWPPP, and action taken as a result of these inspections must be prepared and retained as part of the Construction SWPPP.

The step-by-step procedure outlined in Section 2.3 of this Volume is recommended for the development of the Construction SWPPP. The checklists in Section 2.5 may be helpful in preparing and reviewing the Construction SWPPP.

2.1.3 BMP Standards and Specifications

BMPs refer to schedules of activities; prohibitions of practices; maintenance procedures; and other physical, structural, and/or managerial practices to prevent or reduce the pollution of waters of the State. BMPs include treatment systems, operating procedures, and practices to control:

- Stormwater associated with construction activity
- Groundwater associated with construction activity
- Spillage or leaks
- Sludge or waste disposal
- Drainage from raw material storage

Chapter 3 contains standards and specifications for the BMPs referred to in this chapter. Wherever any BMPs are used on a site, reference the specific title and number of the BMP in the narrative and mark it on construction drawings.

The standards and specifications in Chapter 3 of this volume are not intended to limit any innovative or creative effort to effectively control erosion and sedimentation. If the BMPs in this chapter are not adequate to meet regulatory requirements, experimental management practices can be considered. Minor modifications to standard practices may also be employed. However, such practices must be pre-approved by both the County and Ecology before being used. All experimental management practices and modified standard practices are required to meet or exceed the performance of the BMPs listed in Chapter 3.

2.1.4 General Principles

The Construction SWPPP shall first consider the use of on-site practices to provide erosion and sediment control. On-site practices include design and construction practices that focus on preserving vegetation and native soils, minimizing impervious surfaces, and selecting construction materials and BMPs that mimic the natural hydrology of a site as much as possible.

NOTE: Projects incorporating on-site measures are not exempt from flow control and runoff treatment requirements and must be in compliance with applicable standards in this manual. For guidance on modeling hydrologic performance of on-site BMPs, see Volume III.

1. Minimize Clearing and Grading

Keep grading to a minimum by incorporating natural topographic depressions into the project and limiting the amount of cut and fill on those portions of the site with permeable soils. At a minimum, the following standards shall be used:

Preserve native soils and vegetation by retaining the duff layer, native topsoil, and natural vegetation in an undisturbed state to the maximum extent possible

Limit clearing to road, utility, building pad, lawn areas, and the minimum amount of extra land necessary to maneuver machinery (e.g., a 10-foot perimeter around a building). All other land outside these areas shall be protected with construction fencing to prevent intrusion and compaction by construction equipment or other types of vehicles.

Keep distances for overland flow short to promote sheet flow and minimize concentration of runoff.

Grading shall not increase angle or length of steep, continuous slopes.

Minimize the amount and time that graded areas are left exposed by completing construction and erosion control in one section of the site before beginning operation on the next.

Limit secondary excavations and heavy equipment use by shaping final lot grades and topographic features at the site development stage.

Reuse native topsoil elsewhere on the site to amend areas with sparse or nutrient-deficient topsoil.

Do *not* relocate topsoil or other material to critical areas where they can cover critical root zones, suffocate vegetation, or erode into adjacent streams.

Stockpile materials in areas designated for clearing and grading (such as parking areas and future roadways).

To prevent erosion, cover small stockpiles with weed barrier material that sheds moisture but allows air transmission. Large stockpiles may need to be seeded and/or mulched.

2. Incorporate Erosion Control Techniques

On-site best management practices to control erosion and sediment include the following:

Use effective revegetation methods to reduce erosion, including:

- Establish vegetation quickly, particularly during seasons that have the most rainfall.
- Use native plant species adapted to the local environment.

- Plant during seasons that provide the best opportunity for survival of vegetation (usually late fall, winter, or early spring months).
- Control excess surface water runoff to prevent erosion.
- Use proper seedbed preparation.
- Fertilize as needed and mulch to protect germinating plants.
- Protect areas designated for revegetation from soils compaction by restricting heavy equipment.
- Provide proper soil amendments where necessary (see BMP C120).
- Protect native topsoil during the construction phase. Native topsoil has a high organic content and native seed sources, which are excellent for reestablishing permanent vegetation.
- Limit clearing and grading during heavy rainfall seasons. Construction activities should begin during the season of lowest precipitation and end when conditions are favorable for the establishment of vegetation.
- Incorporate natural drainage features whenever possible, using adequate buffers and protecting areas where flow enters the drainage system.
- Direct runoff to areas of permeable soils or natural depressions to promote infiltration.
- Reduce runoff velocities to prevent channel erosion.
- Prevent offsite tracking of sediment.
- Reduce the number and width of construction access roads. Locate access roads where future roads and utility corridors will be placed.
- Perform preconstruction, routine, and post-construction inspections:
- Conduct a preconstruction inspection to determine that adequate barriers have been placed around vegetation retention areas and structural controls are properly implemented.
- Conduct routine inspections to verify that structural controls are being maintained and operating effectively throughout construction.
- Conduct a final inspection to verify that revegetation areas are stabilized and that stormwater management systems are in place and functioning properly.

3. Select Appropriate BMPs

In addition to the general erosion and sediment control BMPs for construction, on-site stormwater management principles to use in preparing your Construction SWPPP include:

- Prevent pollutant release. Select source control BMPs as a first line of defense. Prevent erosion rather than treat turbid runoff.
- Select BMPs depending on site characteristics (topography, drainage, soil type, ground cover, and critical areas) and the construction plan.
- Divert runoff away from exposed areas wherever possible. Keep clean water clean.
- Select appropriate BMPs for the control of non-sediment pollutants.
- Be realistic about the limitations of controls that you specify and the operation and maintenance of those controls. Anticipate what can go wrong, how to prevent it, and how to fix it.
- Monitor all construction BMPs for effectiveness and have a plan to address any failures, including lack of vegetative establishment.

2.2 Construction SWPPP Submittal Components

The Construction SWPPP is intended to be a stand-alone document that supplements other project documentation. The Construction SWPPP shall contain the components listed below. Some of these components may be derived from the Drainage and Erosion Control Report, Drainage Plans (drawings), Engineered Abbreviated Drainage Plan, or Abbreviated Drainage Plan prepared for the project.

1. Cover sheet
2. Project engineer's certification (where required)
3. Table of contents
4. Construction SWPPP Narrative
5. Construction SWPPP TESC Drawings including:
    - Coversheet and project information
    - TESC Plan
    - TESC Details
    - TESC Notes and Specifications
6. Inspection forms and inspection record.

Note that a Short Form Construction SWPPP can be submitted for projects that disturb less than 1- acre and require only an Abbreviated or Engineered Abbreviated Drainage Plan. See Appendix II-C for a template.

2.3 Step-By-Step Procedure

There are three basic steps in producing a Construction SWPPP:

Step 1: Document existing site conditions

Step 2: Select and design BMPs

Step 3: Develop and Implement Construction SWPPP.

2.3.1 Step 1 – Data Collection and Analysis

Evaluate existing site conditions and gather information that will help develop the most effective Construction SWPPP. Use collected data to visualize potential problems and limitation of the site. The applicant shall show the information gathered on the TESC drawings and detail it in the narrative. Give special consideration to those areas that have critical erosion hazards or erosion potential when evaluating existing site conditions. The following are some important factors to consider in data collection and analysis:

1. **Project Location**: Determine precise location of the construction site, adjacent roads and receiving waters:

    - Indicate locations on a Vicinity Map for inclusion in the narrative and on TESC drawings.
    - Describe project including locations in Project Description.

2. **Property Boundaries and Zoning**: Determine the legal property boundaries and zoning requirements for the site.

    - Indicate Legal Property Boundaries and Zoning on the TESC drawings.
    - Discuss zoning requirements in Existing Site Conditions section of the narrative.

3. **Topography**: Prepare a topographic drawing of the site to show existing contour elevations at intervals of 1 to 5 feet depending upon the slope of the terrain (see Section 2.4for drawing protocols). Evaluate topography for erosion potential. The primary topographic considerations are slope steepness and slope length. Because of the effect of runoff, the longer and steeper the slope, the greater the erosion potential. Erosion potential should be determined by a qualified engineer, soil professional, or certified erosion control specialist.

    - Show existing topography on the TESC drawings.

- Discuss topographic considerations in the Existing Site Conditions section of the narrative.

4. **Ground Cover:** Label existing vegetation on the TESC drawing. Show features such as tree clusters, grassy areas, and unique or sensitive vegetation. Unique vegetation may include existing trees above a given diameter. Investigate requirements for tree preservation. (At a minimum, the applicant shall comply with provisions for native vegetation preservation and/or replacement as set forth in applicable Thurston County Code including critical areas, zoning, grading and forest practices.) Also indicate existing denuded or exposed soil areas.

   Ground cover is the most important factor in erosion prevention. Existing vegetation that can be saved will usually prevent erosion better than constructed BMPs. Trees and other vegetation protect the soil structure. If the existing vegetation cannot be saved, consider practices like phasing construction, temporary seeding, and mulching. Phasing of construction involves stabilizing one part of the site before disturbing another. In this way, the entire site is not disturbed at once.

   - Show existing vegetation on TESC drawings.
   - Discuss vegetation in the Existing Site Conditions section of the narrative.

5. **Drainage**: Locate and clearly mark existing drainage swales and patterns on the TESC drawings, including existing storm drain pipe systems. The drawings should distinguish between natural and man-made drainage. Use natural drainage paths (e.g., overland flow, swales and **depressions**) to convey runoff through the site to avoid constructing an artificial drainage system. Man-made ditches and waterways will become part of the erosion problem if not properly stabilized. Ensure that increased runoff from the site will not erode or flood the existing natural drainage system. Consider possible sites for temporary stormwater retention and detention. Direct construction away from areas of saturated soil - areas where groundwater may be encountered - and critical areas where drainage will concentrate. Preserve natural drainage patterns on the site.

   - Show existing Drainage on TESC drawings.
   - Discuss Drainage in Existing Site Conditions section of the narrative.

6. **Soils**: Identify and **label** soil type(s) and erodibility (slight, moderate, severe, very severe or an index value from the NRCS manual) on the drawings and in the narrative.

   Soils must be characterized for permeability, water holding capacity, percent organic matter, and effective depth by a qualified soil professional or engineer. Express these qualities in averaged or nominal terms for the subject site or

project. This information is typically available in the published NRCS Soil Survey of Thurston County.

- A sieve analysis of the soils
- Permeability (in/hr)
- Available water-holding capacity (in/in)
- The percent of organic matter.

Evaluate soil properties such as surface and subsurface runoff characteristics, depth to impermeable layer, depth to seasonal groundwater table, permeability, shrink-swell potential, texture, settleability, and erodibility. Develop the Construction SWPPP based on known soil characteristics. Properly protect infiltration sites from clay and silt disturbed during construction activities, which reduce infiltration capacities.

- Show soils information on TESC Plan Sheet and include soil descriptions on the TESC Notes sheet.
- Discuss in Soils in the narrative.

7. **Critical Areas**: Delineate and describe critical areas adjacent to or within the site on the drawings and in the narrative. Critical areas that receive runoff from the site shall be described up to ¼ mile away. Describe special requirements for working near or within these areas. Show features such as steep slopes, streams, floodplains, lakes, wetlands, sole source aquifers, and geologic hazard areas. Delineate setbacks and buffer limits for these features on the TESC drawings. Other related jurisdictional boundaries, such as Shorelines Management and the Federal Emergency Management Agency (FEMA) base floodplain shall also be shown on the TESC drawings. Critical areas per Thurston County Critical Areas Ordinance (CAO) , may include aquifer recharge areas, geologic hazard areas, floodplains, streams, critical habitat and wetlands.

   The existence of critical areas near the project exerts a strong influence on land development decisions. Critical areas and their buffers shall be delineated on drawings and clearly flagged in the field. Fencing may be more useful than flagging to assure that equipment operators stay out of critical areas. Only unavoidable work should take place within critical areas or their buffers, and will require special BMPs, permit restrictions, and mitigation plans.

   - Show critical areas on the TESC Plan.
   - Discuss critical area in the Critical Areas section of the narrative.

8. **Adjacent Areas:** Identify existing buildings, roads, and facilities adjacent to or within the project site on the TESC drawings. **Identify** existing and proposed utility locations, construction clearing limits and erosion and sediment control

BMPs on the drawings. An analysis of adjacent properties should focus on areas upslope and downslope from the construction project. Water bodies that will receive direct runoff from the site are a major concern. Evaluate the types, values, sensitivities of and risks to downstream resources, such as private property, stormwater facilities, public infrastructure, or aquatic systems. Select erosion and sediment controls accordingly.

- Show adjacent areas on the TESC Plan.
- Discuss adjacent areas in the Adjacent Areas section of the narrative.

9. **Existing Encumbrances:** Identify wells, existing and abandoned septic drain fields, utilities, easements, setbacks, and site constraints.

   - Show existing encumbrances on the TESC Plan.
   - Discuss existing encumbrances in the Existing Encumbrances section of the narrative.

10. **Precipitation Records and Stormwater Design Flows**: see Volume III to determine the **required** rainfall records and the method of analysis for design of BMPs.

    - Include stormwater design flows for sediment control BMPs on the TESC Plan. Show basins for which the design flows are applicable.
    - Discuss rainfall data and stormwater design flows and volumes in the Engineering Calculations section of the Narrative.

11. **Timing of the Project**: Describe the construction schedule. An important consideration in selecting BMPs is the timing and duration of the project. Projects that will proceed during the wet season and projects that will last through several seasons must take all necessary precautions to remain in compliance with the water quality standards.

    - Describe design considerations based on timing in the Narrative.
    - Prepare a construction schedule and include in the TESC drawings and the narrative.
    - Include 13 elements in timeline as applicable.

2.3.2 Step 2 – Select and Design BMPs

After collecting and analyzing the data to determine the site limitations, BMPs can be selected and designed. **Each of the 13 elements below must be considered and included in the Construction SWPPP unless site conditions render the element unnecessary.** Justification for exempting an element must be clearly explained in the narrative of the SWPPP.

On-site stormwater management general principles and BMPs should be given primary consideration when designing a SWPPP. On-site elements were already discussed under Section 2.1.4 – General Principles. In certain cases, the County may require written justification on why on-site techniques are not deemed practicable.

Element #1: Preserve Vegetation/Mark Clearing Limits

- Prior to beginning land disturbing activities, including clearing and grading, clearly mark all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area. These shall be clearly marked, both in the field and on the plans, to prevent damage and offsite impacts.
- Clearly visible plastic, metal, or stake wire fence may be used to mark the clearing limits.
- The duff layer, native topsoil, and natural vegetation shall be retained in an undisturbed state to the maximum degree practicable. If it is not practicable to retain the duff layer in place, stockpile it on-site, cover it to prevent erosion, and replace it immediately upon completion of the ground disturbing activities.

Suggested BMPs:

- BMP C100: Preservation of Native Topsoil (On-site)
- BMP C101: Preserving Natural Vegetation (On-site)
- BMP C102: Buffer Zones
- BMP C103: High Visibility Plastic Fence.
- BMP C233: Silt Fence

Element #2: Establish Construction Access

- Limit construction vehicle access and exit to one route, if possible, or two for linear projects such as roadways where more than one access is necessary for large equipment maneuvering.
- Stabilize access points with a pad of quarry spalls or crushed rock, or equivalent BMP prior to traffic leaving the construction site to minimize the tracking of sediment onto public roads.
- Wheel wash or tire baths should be located on site, if the stabilized construction entrance is not effective in preventing sediment from being tracked on public roads.
- If sediment is tracked off site, clean the affected roadway thoroughly at the end of each day, or more frequently as necessary (for example during wet weather) to prevent sediment from entering waters of the state. Remove

sediment from roads by shoveling or pickup sweeping and transport to a controlled sediment disposal area. Street washing is allowed only after sediment is removed in this manner.

- Control street wash wastewater by pumping back on site to an approved infiltration facility, or otherwise preventing it from discharging into systems tributary to the county municipal separated storm sewer system (MS4), wetlands, or waters of the State. Other options include discharge to the sanitary sewer, or discharge to an approved offsite treatment system. For discharges to the sanitary sewer, permits must be obtained from the local jurisdiction providing the sewer.

Suggested BMPs:

- BMP C105: Stabilized Construction Entrance/Exit
- BMP C106: Wheel Wash
- BMP C107: Construction Road/Parking Area Stabilization.

Element #3: Control Flow Rates

- Protect properties and waterways downstream from development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site.
- Downstream analysis is necessary if changes in offsite flows could impair or alter conveyance systems, stream banks, bed sediment, or aquatic habitat. See Volume I, Chapter 2, for potential offsite analysis requirements and guidelines (Core Requirement #11).
- Where necessary to comply with Core Requirement #7, construct stormwater retention/detention facilities as one of the first steps in grading. Ensure that detention BMPs are functional prior to construction of site improvements (e.g., impervious surfaces).
- Control structures designed for permanent detention BMPs are not appropriate for use during construction without modification. If used during construction, modify the control structure to allow for long-term storage of runoff and enable sediment to settle. Verify that the BMP is sized appropriately for this purpose. Restore BMPs to their original design dimensions, remove sediment, and install a final control structure at completion of the project.
- Sites that must implement flow control (Core Requirement #7) for the developed site condition must also control stormwater release rates during construction. Construction site stormwater discharges shall not exceed the discharge durations of the pre-developed condition for the range of

pre-developed discharge rates from ½ of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. Match the pre-developed condition to the land cover condition immediately prior to the development project.

- The County may require infiltration or detention BMP designs that provide additional or different stormwater flow control if necessary, to address local conditions or to protect properties and waterways downstream from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site.
- If permanent infiltration BMPs are used for temporary flow control during construction, protect them from siltation during the construction phase.
- Even gently sloped areas need flow controls such as BMP C235: Wattles or other energy dissipation/filtration structures. Place dissipation facilities closer together on steeper slopes. These methods prevent water from building higher velocities as it flows downstream within the construction site.
- Velocity of water leaving the site should not exceed 3 feet/second if the discharge is to a stream or ditch. Install velocity dissipation, such as BMP C207: Check Dams or BMP C202: Riprap Channel Lining to ensure reduction of the flow velocity to a non-erosive level.
- If the discharge from a project site is to the County's municipal storm drainage system, the allowable discharge rate may be limited by the capacity of the public system. It may be necessary to clean the municipal drainage system prior to the start of the discharge to prevent scouring solids from the drainage system. Obtain permission from the County before discharging to it. Ensure that no downstream pipes are surcharged as a result of increased flows from the project site.
- If the discharge from a project site is directly to a flow control exempt receiving water or to an infiltration system, there is no discharge flow limit.

Suggested BMPs:

- BMP C203: Water Bars
- BMP C207: Check Dams
- BMP C209: Outlet Protection
- BMP C235: Wattles
- BMP C240: Sediment Trap
- BMP C241: Temporary Sediment Pond
- Refer to Volumes III and V for site suitability and sizing for infiltration facilities and for design of Detention and Infiltration BMPs for flow control.

Element #4: Install Sediment Controls

- Design, install, and maintain effective erosion and sediment controls to minimize the discharge of pollutants.
- Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltration, unless infeasible.
- Prior to leaving a construction site or prior to discharge to an infiltration facility, direct stormwater runoff from disturbed areas through a temporary sediment pond or other appropriate sediment removal BMP.
- Runoff from fully stabilized areas may be discharged without a sediment removal BMP but must meet the flow control performance standard of Element #3: Control Flow Rates. Full stabilization means concrete or asphalt paving; quarry spalls used as ditch lining; or the use of rolled erosion products, a bonded fiber matrix product, or vegetative cover in a manner that will fully prevent soil erosion. The County shall inspect and approve areas fully stabilized by means other than pavement or quarry spalls.
- Construct sediment ponds, vegetated buffer strips, sediment barriers or filters, dikes, and other BMPs intended to trap sediment on site as one of the first steps in grading. Ensure that these BMPs are functional before other land disturbing activities take place.
- Where feasible, design outlet structures that withdraw impounded water from the surface to avoid discharging sediment that is still suspended lower in the water column.
- Seed and mulch earthen structures such as dams, dikes, and diversions according to the timing indicated in Element #5.
- Locate BMPs intended to trap sediment on site in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.,
- Outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column are for the construction period only. If installing a floating pump structure, include a stopper to prevent the pump basket from hitting the bottom of the pond.

Suggested BMPs:

- BMP C231: Brush Barrier

- BMP C232: Gravel Filter Berm
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- BMP C235: Wattles
- BMP C240: Sediment Trap
- BMP C241: Temporary Sediment Pond
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration.

Element #5: Stabilize Soils

- Stabilize all exposed and un-worked soils by application of effective BMPs that prevent erosion; protect the soil from the erosive forces of raindrop impact, flowing water, and wind.
- Control stormwater volume and velocity within the site to minimize erosion; and control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.
- From October 1 through April 30, no soils shall remain exposed and un-worked for more than 2 days. From May 1 to September 30, no soils shall remain exposed and un-worked for more than 7 days. This condition applies to all soils on site, whether at final grade or not. These time limits may be adjusted by the County if it can be shown that the average time between storm events justifies a different standard.
- Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast. Applicable practices include, but are not limited to, temporary and permanent seeding, sodding, mulching, plastic covering, erosion control fabrics and matting, soil application of polyacrylamide (PAM), the early application of gravel base on areas to be paved, and dust control.
- Soil stabilization BMPs should be appropriate for the time of year, site conditions, estimated duration of use, and potential water quality impacts that stabilization agents may have on downstream waters or groundwater.
- Soil stockpiles must be stabilized from erosion, protected with sediment trapping measures, and when possible, be located away from storm drain inlets, waterways and drainage channels.
- Minimize the amount of soil exposed during construction activity.
- Minimize the disturbance of steep slopes.

- Minimize soil compaction and, unless infeasible, preserve topsoil.
- Ensure that gravel base used for stabilization is clean and does not contain fines or sediment.
- Linear construction activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall be conducted to meet the soil stabilization requirements and time periods set forth above.

Suggested BMPs:

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering
- BMP C124: Sodding
- BMP C125: Topsoiling/Composting
- BMP C126: Polyacrylamide for Soil Erosion Protection
- BMP C130: Surface Roughening
- BMP C131: Gradient Terraces
- BMP C140: Dust Control

Element #6: Protect Slopes

- Design and construct cut and fill slopes in a manner that will minimize erosion.
- Consider soil type and its potential for erosion.
- Reduce slope runoff velocities by reducing the length of continuous slope with terracing and diversions, reducing slope steepness, and roughening slope surface.
- Divert offsite stormwater (run-on) or groundwater away from slopes and disturbed areas with interceptor dikes, pipes, and/or swales. Manage offsite stormwater separately from stormwater generated on the site.
- At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion. Temporary pipe slope drains must be sized to convey the flow rate calculated by one of the following methods:
    - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm.

OR

Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step.

The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas shall be modeled as "landscaped" area.

- Permanent pipe slope drains shall be sized for the 100-year, 24-hour event.
- Provide drainage to remove groundwater intersecting the slope surface of exposed soil areas.
- Place excavated material on the uphill side of trenches, consistent with safety and space considerations.
- Place check dams at regular intervals within constructed channels that are cut down a slope.
- Stabilize soils on slopes, as specified in Element #5.
- BMP combinations are the most effective method of protecting slopes with disturbed soils. For example using both mulching and nets and blankets in combination.

Suggested BMPs:

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering
- BMP C124: Sodding
- BMP C130: Surface Roughening
- BMP C131: Gradient Terraces
- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels
- BMP C203: Water Bars
- BMP C204: Pipe Slope Drains
- BMP C205: Subsurface Drains
- BMP C206: Level Spreader

- BMP C207: Check Dams
- BMP C208: Triangular Silt Dike (Geotextile-Encased Check Dam).

Element #7: Protect Drain Inlets

- Protect all storm drain inlets made operable during construction so that stormwater runoff does not enter the conveyance system without first being filtered or treated to remove sediment.
- Keep all approach roads clean. Do not allow sediment and street wash water to enter storm drains without prior and adequate treatment unless treatment is provided before the storm drain discharges to waters of the State.
- Inspect inlets weekly at a minimum and daily during storm events. Clean inlet protection devices or remove and replace when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).

Suggested BMPs:

- BMP C220: Storm Drain Inlet Protection.

Element #8: Stabilize Channels and Outlets

- Design, construct, and stabilize all on-site conveyance channels to prevent erosion from the flow rate calculated by one of the following methods:
  - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm.

  OR

  - Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step.

The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas shall be modeled as “landscaped” area.

- Provide stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches at the outlets of all conveyance systems.
- The best method for stabilizing channels is to completely line the channel with a blanket product first, then add check dams as necessary to function as an anchor and to slow the flow of water.

Suggested BMPs:

- BMP C122: Nets and Blankets
- BMP C202: Riprap Channel Lining
- BMP C207: Check Dams
- BMP C209: Outlet Protection

Element #9: Control Pollutants

- Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants.
- The project proponent must handle and dispose all pollutants, including waste materials and demolition debris that occur on-site, in a manner that does not cause contamination of stormwater. Woody debris may be chipped, ground, or chopped and spread on site.
- The project proponent must provide cover, containment, and protection from vandalism for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health or the environment. On-site fueling tanks must include secondary containment. Secondary containment means placing tanks or containers within an impervious structure capable of containing 110% of the volume contained in the largest tank within the containment structure. Double-walled tanks do not require additional secondary containment.
- Use spill prevention and control measures when conducting fueling, maintenance and repair of heavy equipment and vehicles including oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff. Clean contaminated surfaces immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.
- The project proponent must discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as a closed-loop recirculation system, or to the sanitary sewer, with local sewer district approval.

- The project proponent must apply agricultural chemicals, including fertilizers and pesticides, in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Follow manufacturers' label requirements for application rates and procedures.
- The project proponent must use BMPs to prevent contamination of stormwater runoff by pH modifying sources. These sources for this contamination include, but are not limited to recycled concrete stockpiles, bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, dewatering concrete vaults, concrete pumping and mixer washout waters.
- The project proponent must adjust the pH of stormwater if necessary, to prevent violations of the water quality standards. Projects must obtain written approval from the Department of Ecology prior to using chemical treatment other than CO2, dry ice, or food grade vinegar to adjust pH.
- The project proponent must assure that washout of concrete trucks is performed off-site or in designated concrete washout areas only. Do not wash out concrete truck drums or concrete handling equipment onto the ground, or into storm drains, open ditches, streets, or streams. Do not dump excess concrete on site, except in designated concrete washout areas. Concrete spillage or concrete discharge directly to groundwater or surface waters of the State if prohibited. Do not wash out to formed areas awaiting infiltration BMPs or use upland land applications for discharging wastewater from concrete washout areas.
- Wheel wash and/or tire bath wastewater can be combined with wastewater from concrete washout areas if the wastewaters will be properly disposed of at an offsite location or treatment facility.
- Uncontaminated water from water-only based shaft drilling for construction of building, road, and bridge foundations may be infiltrated provided the wastewater is managed in a way that prohibits discharge to surface waters. Prior to infiltration, water from water-only based shaft drilling that comes into contact with curing concrete must be neutralized until the pH is in the range of 6.5 to 8.5 (su).

Suggested BMPs:

- BMP C151: Concrete Handling
- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C153: Material Delivery, Storage and Containment
- BMP C154: Concrete Washout Area
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration

- BMP C252: Treating and Disposing of High pH Water
- See Volume IV – Source Control BMPs.

Element #10: Control De-Watering

- Discharge foundation, vault, and trench de-watering water, which have similar characteristics to stormwater runoff at the site, into a controlled conveyance system prior to discharge to a sediment trap or temporary sediment pond. Channels must be stabilized, as specified in Element #8.
- Discharge clean, non-turbid de-watering water, such as well-point groundwater, to systems tributary to, or directly into surface waters of the State, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters or interfere with operation of the system. Do not route clean dewatering water through stormwater sediment BMPs. Note that “surface waters of the State” may exist on a construction site as well as off site; for example, a creek running through a site.
- Handle highly turbid or otherwise contaminated dewatering water from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, separately from stormwater.
- Discharging sediment-laden (muddy) water into waters of the State likely constitutes violation of water quality standards for turbidity. The easiest way to avoid discharging muddy water is through infiltration and preserving vegetation.
- Other dewatering treatment or disposal options, depending on site constraints, may include:
  - Infiltration
  - Transport offsite in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters.
  - Ecology-approved on-site chemical treatment or other suitable treatment technologies.
  - Sanitary sewer discharge with local sewer district approval, if there is no other option.
  - Use of a sedimentation bag that discharges to a ditch or swale for small volumes of localized dewatering.
- Dewatering water from contaminated sites must be handled separately from stormwater. Direct contaminated stormwater to a sanitary sewer where allowed by the local sewer authority, or to other approved treatment.

Suggested BMPs:

- BMP C203: Water Bars
- BMP C236: Vegetative Filtration

Element #11: Maintain BMPs

- Maintain and repair all temporary and permanent erosion and sediment control BMPs as needed to assure continued performance of their intended function in accordance with BMP specifications.
- Remove all temporary erosion and sediment control BMPs within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Remove or stabilize trapped sediment on site. Permanently stabilize disturbed soil resulting from removal of BMPs or vegetation.
- Protect all BMPs installed for the permanent control of stormwater from sediment and compaction. All BMPs that are to remain in place following completion of construction shall be examined and placed in full operating condition. If sediment enters the BMPs during construction, it shall be removed, and the facility shall be returned to the conditions specified in the construction documents.
- Some temporary erosion and sediment control BMPs are biodegradable and designed to remain in place following construction. BMP C122: Nets and Blankets is an example of a BMP with biodegradable options.

Suggested BMPs

- BMP C150: Materials On Hand
- BMP C160: Certified Erosion and Sediment Control Lead

Element #12: Manage the Project

- Phase projects to the maximum degree practicable and take into account seasonal work limitations.
- Inspect, maintain and repair all BMPs as needed to assure continued performance of their intended function. Projects regulated under the Construction Stormwater General Permit (CSWGP) must conduct site inspections and monitoring in accordance with Special Condition S4 of the CSWGP.
- Maintain, update, and implement the Construction SWPPP.

- Projects that disturb one or more acres must have site inspections conducted by Certified Erosion and Sediment Control Lead (CESCL). Project sites disturbing less than one acre may have a CESCL or a person without CESCL certification conduct inspections. B the initiation of construction, the Construction SWPPP must identify the CESCL or inspector, who must be present on site or on-call at all times.
- The project manager must ensure that the project is built in such a way to comply with all Construction SWPPP Elements, as detailed in this section. Considerations for the project manager include, but are not limited to:
    - Construction phasing
    - Seasonal work limitations
    - Coordination with utilities and other contractors
    - Inspection
    - Monitoring
    - Maintaining and updated construction SWPPP

Phasing of Construction:

- Phase development projects where feasible in order to prevent soil erosion and, the transport of sediment from the site during construction. Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.
- Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan (e.g., subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. When establishing these permitted clearing and grading areas, minimize the removal of existing trees and the disturbance/compaction of native soils except as needed for building purposes. Delineate the permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas as may be required by the County, on the site plans and the development site.

Seasonal Work Limitations:

- From October 1 through April 30, clearing, grading, and other soil disturbing activities will not be permitted unless it is shown to the satisfaction of the County that silt-laden runoff will be prevented from leaving the site through a combination of the following:

  - Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters; and
  - Limitations on activities and the extent of disturbed areas; and
  - Proposed erosion and sediment control measures.

- Based on the information provided and/or local weather conditions, the County may expand or restrict the seasonal limitation on site disturbance. The County shall take enforcement action – such as a notice of violation, administrative order, penalty, or stop-work order under the following circumstances:
  - If, during the course of any construction activity or soil disturbance during the seasonal limitation period, sediment leaves the construction site causing a violation of the surface water quality standard; or
  - If clearing and grading limits or erosion and sediment control measures shown in the approved plan are not maintained.
- The following activities are exempt from the seasonal clearing and grading limitations:
  - Routine maintenance and necessary repair of erosion and sediment control BMPs;
  - Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
  - Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

Coordination with Utilities and Other Contractors:

The primary project proponent shall evaluate, with input from utilities and other contractors, the stormwater management requirements for the entire project, including the utilities, when preparing the Construction SWPPP.

Inspection and Monitoring:

- For construction sites 1 acre or larger that discharge stormwater to surface waters of the State, a Certified Erosion and Sediment Control Lead (CESCL) must be identified in the Construction SWPPP and must be on-site or on-call at all times. Certification must be obtained through an approved training program that meets the erosion and sediment control training standards established by Ecology.
- Project sites less than one acre (not part of a larger common plan of development or sale) may have a person without CESCL certification

conduct inspections. The person shall be identified in the Construction SWPPP and shall be on-site or on-call at all times.

- All BMPs must be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections must be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. The CESCL or inspector (project sites less than one acre) must have the skills to:

  1) Assess the site conditions and construction activities that could impact the quality of stormwater, and

  2) Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

- The CESCL or inspector must examine stormwater visually for the presence of suspended sediment, turbidity, discoloration, and oil sheen. They must evaluate the effectiveness of BMPs and determine if it is necessary to install, maintain, or repair BMPs to improve the quality of stormwater discharges.

- Appropriate BMPs or design changes shall be implemented as soon as possible whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of, or potential to discharge a significant amount of any pollutant.

- Based on the results of the inspection, construction site operators must correct the problems identified by:

  - Reviewing the Construction SWPPP for compliance with the 13 elements and making appropriate revisions within 7 days of the inspection.
  - Immediately beginning the process of fully implementing and maintaining appropriate source control and/or treatment BMPs as soon as possible, addressing the problems no later than within 10 days of the inspection. If installation of necessary treatment BMPs is not feasible within 10 days, the construction site operator may request and extension from the County within the initial 10-day response period.
  - Documenting BMP implementation and maintenance in the site log book (applies only to sites that have coverage under the Construction Stormwater General Permit).
  - The CESCL or inspector must inspect all areas disturbed by construction activities, all BMPs, and all stormwater discharge points at least once every calendar week and within 24 hours of any discharge from the site. (For purposes of this condition,

individual discharge events that last more than one day do not require daily inspections. For example, if a stormwater pond discharges continuously over the course of a week, only one inspection is required that week). The CESCL or inspector may reduce the inspection frequency for temporarily stabilized, inactive sites to once every calendar month.

- The CESCL or inspector must inspect all areas disturbed by construction activities, all BMPs, and all stormwater discharge points at least once every calendar week and within 24 hours of any discharge from the site. (For purposes of this condition, individual discharge events that last more than one day do not require daily inspections. For example, if a stormwater pond discharges continuously over the course of a week, only one inspection is required that week.) The CESCL or inspector may reduce the inspection frequency for temporary stabilized, inactive sites to once every calendar month.

Maintaining an Updated Construction SWPPP:

- The Construction SWPPP shall be retained on-site or within reasonable access to the site.
- The Construction SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.
- The Construction SWPPP must be modified if, during inspections or investigations conducted by the owner/operator, Thurston County or a state regulatory authority, it is determined that the Construction SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The Construction SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the Construction SWPPP shall be completed within seven (7) days following the inspection.

Suggested BMPs

- BMP C150: Materials On Hand
- BMP C160: Certified Erosion and Sediment Control Lead
- BMP C162: Scheduling

Element #13: Protect Low Impact Development BMPs

- Protect all LID BMPs (including, but not limited to bioretention, rain gardens, and permeable pavements from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the LID BMPs.

- Restore the LID BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden Bioretention/Rain Garden soils and replacing the removed soils with soils meeting the design specification.
- Maintain the infiltration capacities of LID BMPs by protecting against compaction by construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.
- Protect surrounding land uses from erosion and manage to avoid introducing sediment onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-lade runoff onto permeable pavements or base materials.
- Clean permeable pavements fouled with sediments or no longer passing an initial infiltration test using procedures acceptable to the County or in accordance with manufacturer's procedures.
- Keep heavy equipment off of existing soils under LID BMPs that have been excavated to final grade to retain the infiltration rate of the soils.

Suggested BMPs

- BMP C102: Buffer Zone
- BMP C103: High Visibility Fence
- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels
- BMP C207: Check Dams
- BMP C208: Triangular Silt Dike (Geotextile-Encased Check Dam).
- BMP C231: Brush Barrier
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- Additional Guidance: See Chapter 5: Precision Site Preparation and Construction in the LID Technical Guidance Manual for Puget Sound for more detail on protecting LID integrated management practices.

2.3.3 Step 3 – Development and Implementation of the Construction SWPPP

The Construction SWPPP must include all of the components specified in Construction SWPPP Submittal Requirements (Section 2.2) and the information required from Step 1 (Section 2.3.1). Refer to the checklist (Section 2.5).

A plan showing the overall project, clearly delineating phase boundaries, and estimating dates of construction, shall be part of any initial submittal. Phased projects shall be completed in accordance with approved plans and in accordance with phased development requirements placed upon the development by the County. Phasing of projects does not reduce drainage and erosion control requirements.

Submit three copies of the plan, bound, and 8.5 x 11 inches in size, with the exception of required engineered drawing sheets which shall meet the criteria established within this general Section 3.4.1. Where possible, sheets shall be folded or rolled as small as possible, but not smaller than 8.5 x 11 inches.

Number all pages.

Detailed Components of SWPPP Narrative

1. **Cover Sheet**: The Construction SWPPP narrative will include a cover sheet that includes:

   a) Project name

   b) Applicant, and owner's name, address, and telephone number

   c) Project engineer's name, address and telephone number

   d) Date of submittal

   e) Contact's name, address, and telephone number

   f) Contractor's name, address and telephone number.

2. **Table of Contents**: Show the page number for each section of the report. Show page numbers of appendices.

3. **Project Engineer's Certification**: For smaller projects, the SWPPP need not be developed by a professional engineer. However, for more complex projects where a Drainage Control Plan is also required or where the SWPPP involves engineering calculations, the SWPPP must be developed by a professional engineer licensed to practice in the State of Washington. For projects where a PE is required, all plans and specifications, calculations, certifications, "as-built" drawings, and all other submittals which will become part of the permanent record of the project must be dated and bear the project engineer's official seal and signature.

   The Construction SWPPP shall contain a page with the project engineer's seal with the following statement:

   "I hereby state that this Construction SWPPP for
   _____ (name of project) has

been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that Thurston County does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me."

4. **Inspection Report:** All projects required to have a Construction SWPPP must conform to the inspection guidelines stated in Element 12: Manage **Project**. In summary, site inspections shall be conducted by a person who is knowledgeable in the principles and practices of ESC. For construction sites that will disturb 1 acre or more and that discharge stormwater to surface waters of the state, a Certified Erosion and Sediment Control Lead (CESCL) shall be identified in the Construction SWPPP and Construction SWPPP and shall be on-site or on-call at all times.

   In addition, for complex projects where a Stormwater Site Plan is required or where the SWPPP involves engineering calculations, the applicant shall have a professional engineer file with the County an Engineer's Inspection Report Form as shown in Appendix I-C before the project is accepted by the County as complete. The report will consist of a completed form and sufficient additional text to describe all factors relating to the construction and operation of the system to meet treatment, erosion control, detention/retention, flow control, and conveyance requirements.

5. **Narrative Discussion: Evaluate** the following subject areas for inclusion in the Construction SWPPP narrative.

   a) **General Information on the Existing Site and Project**

      1) Project description: Describe the nature and purpose of the construction project. Include the total size of the area; any increase in existing impervious area; the total are expected to be disturbed by clearing, grading, excavation or other construction activities, including off-site borrow and fill areas; and the volumes of grading cut and fill that are proposed.

      2) Existing site conditions: Describe the existing topography, vegetation, and drainage. Include a description of any structures or development on the parcel including the area of existing impervious surfaces.

      3) Soils: Describe the soil on the site, including information such as soil names, mapping unit, erodibility, settleability, permeability, depth, depth to groundwater, texture, and soil structure.

4) Critical Areas: Describe areas on-site or adjacent to the site that are classified as critical areas, including critical areas up to ¼ mile away that receive runoff from the site. Describe special requirements for working near or within these areas. This may include federal, state, and/or local permit requirements.

5) Adjacent Areas: Describe adjacent areas, including streams, lakes, wetlands, residential areas, and roads that the construction project might affect. Provide a description of the upstream drainage leading to the site and the downstream drainage leading from the site to the receiving body of water.

6) Potential erosion problem areas: Describe areas on the site that have potential erosion problems.

b) **13 Elements:** Describe how the Construction SWPPP addresses each of the 13 required elements. Include the type and location of BMPs used to satisfy the required element. If an element is not applicable to a project, provide a written justification for why it is not necessary. If a permanent BMP is proposed to be used as temporary storage, provide the plan to return the BMP to the designed condition prior to leaving the site.

c) **Construction Schedule and Phasing:** Describe the construction schedule. If the schedule extends into the wet season, describe **activities** that will continue during the wet season and how the transport of sediment from the construction site to receiving waters will be prevented. Describe the intended sequence and timing of construction activities and any proposed construction phasing.

d) **Financial/ownership responsibilities:** Describe ownership and obligations for the project. Include bond forms and other evidence of **financial** responsibility for environmental liabilities associated with construction.

e) **Engineering calculations:** Attach any calculations made for the design of such items as sediment ponds, diversions, waterways, as well as calculations for runoff and stormwater detention design (if applicable). Engineering calculations must bear the signature and stamp of an engineer licensed in the state of Washington.

f) **Certified Erosion and Sediment Control Lead (CESCL):** Identify along with their contact information and expiration of their CESCL certification.

2.4 Construction SWPPP TESC Drawing Protocols

Where applicable, TESC drawings for the SWPPP shall conform to the following drawing protocols:

2.4.1 Required Drawing Protocol

All sheets will have a north arrow, scale, a benchmark reference, the section, township, and range. Each set of drawings shall have a legend to define map symbols.

All lettering shall be one-tenth of an inch or greater. Existing spot elevations will be no smaller than one-twentieth of an inch or greater than one-tenth of an inch.

All submittals shall be stamped, signed, and dated by a licensed professional engineer prior to review by the County.

2.4.2 General Drawing Requirements

All drawings shall contain the following:

- Road alignments with 100-foot stationing, preferably increasing to the north or east and reading from left to right; stationing at points of curve, tangent, and intersection, with ties to section or quarter corners or other established and monumented survey control points to include at the intersection of any proposed road or roads and any existing county road or state highway. All lettering shall be right reading.
- Bearing on all centerlines.
- Curve data including radius, delta, and arc length on all horizontal lines.
- Right-of-way, easement, tract lines, and dimensions for all existing and proposed facilities, including proposed roads and intersecting roads. The plans shall show properly dimensioned lot lines and lot numbers, and locate and dimension all tract and easement areas.
- All topographic features within project limits and a sufficient area beyond (50-ft minimum), to resolve questions of setback, slope, drainage, access onto abutting property, and road continuations.
- Existing contours and drainage basins and the direction of flow for the different drainage areas. Maximum contour intervals on the site plan shall be as follows:

Slope (%)	Contour Interval (feet)
Up to 10	2

>10 to <20	5
≥ 20	10

- Topography must be field verified for drainage easements and conveyance systems. Contours shall extend a minimum of 50 feet beyond property lines and extend sufficiently to depict existing conditions. If survey is restricted to the project site due to lack of legal access, contours shall be provided by other means; i.e., Thurston County Geodata, USGS, etc.

- All ditch flow lines, all drainage structures with invert elevations, utility locations, fences, structures, existing curbing and approaches, pertinent trees and shrubbery, and other appurtenances which would affect the construction of the project.

- Identification of all existing public roads and adjoining subdivisions when it is pertinent to the scope of the project.

- Scale: 1 inch = 20 feet or 1 inch = 50 feet (1 inch = 100 feet may be used with prior county approval) for public facilities and roads to be dedicated to the County.

- Scale: 1 inch = 50 feet for plats, 1 inch = 20 feet, 30 feet, or 40 feet for all others.

- North arrow shall point to the top or to the left of the sheet.

- Existing features will be ghosted or shaded.

- A legend.

2.4.3 Cover Sheet

Any drawing sets submitted for review and acceptance by the County containing three or more sheets shall have a cover sheet.

The cover sheet shall be sheet one of the drawing set and contain the following information:

- A simple vicinity map, with north arrow oriented to the top of the sheet, showing project site, existing public road system, receiving waters and any other pertinent information. Minimum scale shall be 4 inches = 1 mile.

- An overall site plan or location map showing the project site(s). Road and stormwater drainage system network including its connection to an existing public road or state highway. This does not have to be to scale.

- The applicant and project engineer's, firm, name, address, and telephone numbers, current owner, and parcel numbers.
- An index table of drawings.
- Title block descriptive of project.

2.4.4 General Drawing Site and/or Grading Plan Sheets

In addition to the general drawing requirements the site and/or grading plan sheets shall show the features below. The site and/or grading plan sheet requirements may be met using multiple plan sheets for ease of legibility.

- A legal description of the property boundaries or an illustration of property lines (including distances and bearings).
- Proposed storm drainage and easements, tracts, drainage facilities, all buffer and screening areas, offsite and on-site existing drainage courses, delineated wetlands, and associated buffers, FEMA base flood boundaries, and Shoreline Management boundaries.
- Soil logs and soil log locations.
- Wells – existing and proposed.
- Topographic information including contour lines of the property in its existing condition. County or U.S. Geological Survey (USGS) topographic mapping must be field verified and supplemented with additional field topographic information when necessary to provide an accurate depiction of the property. Maximum contour intervals shall be as follows:

Slope (%)	Contour Interval (feet)
Up to 10	2
>10 to <20	5
≥ 20	10

- The boundaries of and labels indicating different soil types and areas of potential erosion problems.
- Final and interim grade contours as appropriate, drainage basins, and flow arrows designating the direction of stormwater flow during and upon completion of construction.

- Areas of soil disturbance, including all areas affected by clearing, grading and excavation.
- Locations where stormwater discharges to surface water during and upon completion of construction.
- Existing unique or valuable vegetation and the vegetation that is to be preserved.
- Cut and fill slopes indicating top and bottom of slope catch lines.
- Stockpile, waste storage, and vehicle storage/maintenance areas.
- Total cut and fill quantities and the method of disposal for excess material.
- Property lines, parcel numbers and ownership.
- Conveyance systems: Show on the site map the following temporary and permanent conveyance features:

    1) Locations for temporary and permanent swales, interceptor trenches, or ditches.

    2) Drainage pipes, ditches, or cut-off trenches associated with erosion and sediment control and stormwater management.

    3) Temporary and permanent pipe inverts and minimum slopes and cover.

    4) Grades, dimensions, and direction of flow in all ditches, swales, culverts, and pipes.

    5) Details for bypassing off-site runoff around disturbed areas.

    6) Locations and outlets of any dewatering systems.

- Other pollutant BMPs: Indicate on the site map the location of BMPs to be used for the control of pollutants other than sediment such as high or low pH and hydrocarbons.
- Monitoring locations: Indicate on the site map the water quality sampling locations (if applicable).
- Location of detention BMPs: Show on the site map the locations of stormwater detention BMPs.
- Erosion and Sediment Control (ESC) BMPs: Show on the site map all major structural and nonstructural ESC BMPs including:

1) The location of sediment pond(s), pipes and structures.

2) Dimension pond berm widths and inside and outside pond slopes.

3) The trap/pond storage required and the depth, length, and width dimensions.

4) Spacing for rock check dams as required.

5) Location of silt fence

6) Construction entrance location.

2.4.5 Plan and Profile Sheets (Roadway Projects)

Show the following:

- Original ground line at 100-foot stations and at significant ground breaks and topographic features, with accuracy to within 0.1 feet on unpaved surface and 0.01 feet on paved surfaces.
- Typical roadway/storm drainage cross-sections when applicable.
- Existing and proposed drainage features, indicating direction of flow, size, and kind of each drainage channel, pipe and structure. The status of existing drainage structures must be clarified as either, “existing-abandon” or “existing-remove.”
- Final surface and storm drain profile with stationing the same as the site/grading plan sheets. Preferably reading from left to right, to show stationing of points of curve, tangent, and intersection of vertical curves, with elevations to 0.01 feet.
- Surface grade and vertical curve data; roads to be measured at centerline.
- Datum and all benchmark information shall use established U.S.C. and G.S. control or county benchmarks when there is an existing benchmark within one-half mile of the project.
- Vertical scale 1 inch = 5 feet. Clarifying details may be drawn to a convenient scale. Use 1 inch = 10 feet for vertical scale when horizontal scale is at 1 inch = 100 feet.
- When roads end at a property line, the existing ground profile shall be continued a minimum of 200 feet to show the proposed vertical alignment is reasonable.

- When intersecting road profile grades have a difference of 1 percent or less, a vertical curve is not required. All other vertical grade intersections will require a minimum 50-foot vertical curve.

- Storm drainage text to be shown in profile only to avoid duplication of text. Number of structures will be shown in the plan and profile views. The following information shall be shown in the profile view:

    - Type of structure
    - Structure number
    - Stationing/offsets (coordinates to be shown in the plan view)
    - Rim elevation
    - Invert elevations (in)
    - Invert elevations (out)
    - Pipe length, pipe size, material and slope (percent).

2.4.6 Detail Sheets and Cross-Sections

Include the following, as applicable on the detail sheets:

- All applicable standard notes (Appendix II-A). Notes addressing construction phasing and scheduling must be included on the drawings.

- A minimum of two cross-sections of each retention/detention pond and sediment pond/trap showing original property lines, slope catch points, and all other pertinent information to adequately construct the pond.

- Typical details of gravel cone and standpipe, and/or other filtering devices.

- Stabilization technique details for inlets and outlets.

- Control/restrictor device details.

- Rock specifications and details for rock check dam, if used.

- Front and side sections of rock check dams.

- Details for silt fence.

- Details for construction entrance.

- Standard open conveyance system cross-sections, if applicable.

- Detailed drawings: Any structural control practices used that are not referenced in this manual must be explained and illustrated with detailed drawings.

- Right-of-way cross-sections as required by the County.
- Construction recommendations from a soils report, if applicable.

2.4.7 Required Drawing Size

Drawings shall be 22” x 34”. Original sheets shall be Mylar or photo Mylar.

2.4.8 Plans and Specifications

The most recently adopted editions of standard specifications and standard plans (see Glossary in Volume I, Appendix I-A) shall be the standards for all design and construction of drainage facilities not explicitly described herein. In the event of a conflict between the standard specifications, standard plans, and the manual, this manual shall prevail. When required by the County, standard specifications and general provisions for construction must be submitted with any road construction plans.

2.5 Construction SWPPP Checklist

The checklists on the following pages can be used in the preparation of the Construction SWPPP to ensure that all required information is provided or addressed. Section I of the checklist addresses the preparation of the Construction SWPPP narrative; Section II of the checklist addresses the preparation of the Construction SWPPP Temporary Erosion and Sediment Control (TESC) Plan.

Section I – Construction SWPPP Narrative

Construction Stormwater Pollution Prevention Elements

1. ____Describe how each of the Construction Stormwater Pollution Prevention Elements has been addressed through the Construction SWPPP.
2. ____Identify the type and location of BMPs used to satisfy the required element.
3. ____Provide written justification identifying the reason an element is not applicable to the proposal.

Thirteen Required Elements – Construction SWPPP

1. ____Mark Clearing Limits
2. ____Establish Construction Access
3. ____Control Flow Rates
4. ____Install Sediment Controls
5. ____Stabilize Soils
6. ____Protect Slopes
7. ____Protect Drain Inlets
8. ____Stabilize Channels and Outlets
9. ____Control Pollutants
10. ____Control De-Watering
11. ____Maintain BMPs
12. ____Manage the Project
13. ____Protect Low Impact Development BMPs

Project Description

1. ____Total project area
2. ____Total proposed impervious area
3. ____Total proposed area to be disturbed, including off-site borrow and fill areas
4. ____Total volumes of proposed cut and fill

Existing Site Conditions

1. ____Description of the existing topography
2. ____Description of the existing vegetation
3. ____Description of the existing drainage

Adjacent Areas

1. ____Description of adjacent areas which may be affected by site disturbance or drain to project site.
    a. ____Streams

b. ____Lakes
c. ____Wetlands
d. ____Residential Areas
e. ____Roads
f. ____Other

2. ____Description of the downstream path leading from the site to the receiving body of water. (Minimum distance of 400 yards.)

Critical Areas

1. ____Description of critical areas that are on or adjacent to the site.
2. ____Description of special requirements for working in or near critical areas.

Soils

1. ___Description of on-site soils.
   a. ____Soil name(s)
   b. ____Soil mapping unit
   c. ____Erodibility
   d. ____Settleability
   e. ____Permeability
   f. ____Depth
   g. ____Texture
   h. ____Soil structure

Erosion Problem Areas

1. ____Description of potential erosion problems on site.

Construction Phasing

1. ____Construction sequence
2. ____Construction phasing (if proposed)

Construction Schedule

1. ____Provide a proposed construction schedule.
2. ____Wet season construction activities
   a. ____Proposed wet season construction activities.
   b. ____Proposed wet season construction restraints for environmentally sensitive/critical areas.

Financial/Ownership Responsibilities

1. ____Identify the property owner responsible for the initiation of bonds and/or other financial securities.
2. ____Describe bonds and/or other evidence of financial responsibility for liability associated with erosion and sedimentation impacts.

Engineering Calculations

1. ____Provide design calculations
    a. ____Sediment ponds/traps
    b. ____Diversions
    c. ____Waterways
    d. ____Runoff/Stormwater detention calculations

Section II – Temporary Erosion and Sediment Control Plans

General

1. ____Vicinity map
2. ____Thurston County clearing and grading approval block
3. ____Erosion and Sediment Control Notes

Site Plan

1. ____Note legal description of subject property.
2. ____Show north arrow.
3. ____Indicate boundaries of existing vegetation, e.g. tree lines, pasture areas, etc.
4. ____Identify and label areas of potential erosion problems.
5. ____Identify on-site/adjacent surface waters, critical areas and associated buffers.
6. ____Identify FEMA base flood boundaries and Shoreline Management boundaries.
7. ____Show existing and proposed contours.
8. ____Indicate drainage basins and direction of flow for individual drainage areas.
9. ____Label final grade contours and identify developed condition drainage basins.
10. ____Delineate areas that are to be cleared and graded.
11. ____Show all cut and fill slopes indicating top and bottom of slope catch lines.

Conveyance Systems

1. ____Designate locations for swales, interceptor trenches, or ditches.

2. ____Show all temporary and permanent drainage pipes, ditches, or cut-off trenches required for erosion and sediment control.
3. ____Provide minimum slope and cover for all temporary pipes or call out pipe inverts.
4. ____Show grades, dimensions, and direction of flow in all ditches, swales, culverts and pipes.
5. ____Provide details for bypassing off-site runoff around disturbed areas.
6. ____Indicate locations and outlets of any dewatering systems.

Location of Detention BMPs

1. ____Identify location of detention BMPs.

Erosion and Sediment Control Facilities

1. ____Show the location of sediment trap(s), pond(s), pipes and structures.
2. ____Dimension pond berm widths and inside and outside pond slopes.
3. ____Indicate trap/pond storage required and the depth, length, and width dimensions.
4. ____Provide typical section views through pond and outlet structure.
5. ____Provide typical details of gravel cone and standpipe, and/or other filtering devices.
6. ____Detail stabilization techniques for outlet/inlet.
7. ____Detail control/restrictor device location and details.
8. ____Specify mulch and/or recommended cover of berms and slopes.
9. ____Provide rock specifications and detail for rock check dam(s), if applicable.
10. ____Specify spacing for rock check dams as required.
11. ____Provide front and side sections of typical rock check dams.
12. ____Indicate the locations and provide details and specifications for silt fabric.
13. ____Locate the construction entrance and provide detail.

Detailed Drawings

1. ____Any structural practices used that are not referenced in the Thurston County Drainage Design and Erosion Control Manual should be explained and illustrated with detailed drawings.

Other Pollutant BMPs

1. ____Indicate on the site plan the location of BMPs to be used for the control of pollutants other than sediment, e.g. concrete wash water.

Monitoring Locations

1. ____Indicate on the site plan the water quality sampling locations to be used for monitoring water quality on the construction site, if applicable.

Chapter 3 - Standards and Specifications for Best Management Practices

Best Management Practices (BMPs) are activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices that, prevent or reduce the release of pollutants to the waters of Washington State. This chapter contains standards and specifications for temporary BMPs for use during the construction phase of a project. Often using BMPs in combination is the best method to meet Construction Stormwater Pollution Prevention Plan (SWPPP) requirements.

None of the BMPs listed below will work successfully through the construction project without inspection and maintenance. Regular inspections to identify problems with the operation of each BMP, and the timely repair of any problems are essential to the continued operation of the BMPs.

Section 3.1 contains the standards and specifications for source control BMPs.

Section 3.2 contains the standards and specifications for runoff conveyance and treatment BMPs.

Standards for each BMP are divided into four sections:

1. Purpose
2. Conditions of Use
3. Design and Installation Specifications
4. Maintenance Standards

Note that “Conditions of Use” always refers to site conditions. As site conditions change, BMPs must change to remain in compliance.

Information on streambank stabilization is available in the *Integrated Streambank Protection Guidelines*, Washington State Department of Fish and Wildlife, 2003, or as updated/amended.

Section 3.3 contains required practices to protect LID BMPs during construction, per Core Requirement #2, Element #13.

3.1 Source Control BMPs

This section contains the standards and specifications for Source Control BMPs. Table II - 3.1, below, shows the relationship of the BMPs in Section 3.1 to the Construction Stormwater Pollution Prevention Plan (SWPPP) Elements described in Section 2.3.2. Elements not shown on Table II - 3.1 are not satisfied through installation of Source Controls.

Table II - 3.1 Source Control BMPs by SWPPP Element

BMP or Element Name	Element #1 Preserve Vegetation/Mark Clearing Limits	Element #2 Establish Construction Access	Element #5 Stabilize Soils	Element #6 Protect Slopes	Element #9 Control Pollutants	Element #11 Maintain BMPs	Element #12 Manage the Project	Element #13 Protect LID BMPs
BMP C101: Preserving Natural Vegetation	✓							
BMP C102: Buffer Zones	✓							✓
BMP C103: High Visibility Fence	✓							✓
BMP C105: Stabilized Construction Entrance/Exit		✓						
BMP C106: Wheel Wash		✓						
BMP C107: Construction Road/Parking Area Stabilization		✓						
BMP C120: Temporary and Permanent Seeding			✓	✓				
BMP C121: Mulching			✓	✓				
BMP C122: Nets and Blankets			✓	✓				
BMP C123: Plastic Covering			✓					
BMP C124: Sodding			✓					
BMP C125: Topsoiling/Composting			✓					
BMP C126: Polyacrylamide for Soil Erosion Protection			✓					
BMP C130: Surface Roughening			✓	✓				
BMP C131: Gradient Terraces			✓	✓				
BMP C140: Dust Control			✓					
BMP C150: Materials On Hand						✓	✓	
BMP C 151: Concrete Handling					✓			
BMP C152: Sawcutting and Surfacing Pollution Prevention					✓			
BMP C153: Material Delivery, Storage and Containment					✓			
BMP C154: Concrete Washout Area					✓			
BMP C160: Certified Erosion and Sediment Control Lead						✓	✓	
BMP C162: Scheduling							✓	

BMP C101: Preserving Natural Vegetation

Purpose

Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers hold up to 50 percent of all rain that falls on them during a storm, with the size of the storm playing a large factor. As much as 30 percent of rain, on average, may never reach the ground but is taken up by the tree or evaporates. The rain held in the tree is released slowly to the ground after the storm.

Preserving natural vegetation is an important LID technique. It can help protect water quality and preserve the natural hydrology of a site by maintaining the infiltration capacity of soils, reducing impervious surfaces, and reducing fertilizer and irrigation requirements required to establish new vegetation.

Conditions of Use

- Preserve natural vegetation on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.
- Where established native plants or ground cover are present, or where underlying soils have good infiltrative properties (Natural Resource Conservation Service Hydrologic Group A or B) they should be preserved to the maximum extent possible.
- At a minimum, the applicant shall comply with provisions for native vegetation preservation and/or replacement as set forth in applicable Thurston County Code including critical areas, zoning, grading and forest practices.
- Phase construction to preserve natural vegetation on the project site for as long as possible during the construction period.

Design and Installation Specifications

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines. The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- Is the plant worth saving? Consider the location, species, size, age, vigor, and the work involved.
- Fence or clearly mark areas around trees to be saved. Keep ground disturbance at least outside the tree's dripline and preferably outside the critical root zone, see Figure II - 3.1.

Take the following steps to protect vegetation during construction:

- Map natural resource protection areas on all plans and delineate these areas on the site with silt, construction, or other appropriate fencing to protect soils and vegetation from construction damage.
- Meet and walk property with equipment operators to clarify construction boundaries and limits of disturbance.
- Protect drainage areas during construction. If an area has any type of channel or drainage swale that provides a hydrologic connection to vegetation protection area(s), the channel must also be protected throughout the construction phase by fencing and erosion control measures to prevent untreated runoff from the construction site to flow into the channel.
- Install signs and fences to identify and protect natural resource protection areas.
- Protect trees and tree root systems using the following methods:
    - Reduce soil compaction during the construction phase by protecting critical tree root zones that extend beyond the trees canopy or drip line. Determine the critical tree root zone using the tree's diameter breast height (6-inch diameter breast height = 8-foot radius; 10-inch diameter breast height = 10-foot radius, 30-inch diameter breast height = 45-foot radius) (see Figure II - 3.1).
    - Prohibit excavation within the critical tree root zone.
    - Prohibit stockpiling or disposal of excavated or construction materials in vegetation retention areas to prevent contaminants from damaging vegetation and soils.
    - Changing the natural grade level around a tree affects the tree's ability to obtain the necessary air, water and minerals. Avoid excavation or grade changes near trees designated for protection. If raising the grade level around a tree, a dry rock wall or rock well shall be constructed around the tree. The wall or well shall be placed at least outside of the dripline of tree canopy plus 5 feet and preferably outside of the critical root zone.
    - When there are fills more than 3 inches, it is necessary to supply air to the roots of trees. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. A tile system protects a tree from a raised grade. The tile system should be laid out on the original grade leading from a drywell around the

tree trunk. The system should then be covered with small stones to allow air to circulate over the root area.

- When there are cuts required around trees, keep the cut at least outside of the drip line plus 5 feet and preferably outside the critical root zone. Use retaining walls if necessary, to retain as much of the natural grade as possible.
- Restrict trenching in critical tree root zone areas. Where possible, the trenches should be routed around trees and large shrubs. If this is not possible, it is best to tunnel under them. Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots. If it is not possible to route the trench around plants to be saved or tunnel beneath them, then the following should be observed:
  - Cut as few roots as possible. When you have to cut, cut clean. Cover exposed roots with a heavy, wet material, such as burlap, and keep it moist. Remove material before backfilling the trench.
  - When roots will be exposed for more than an hour, wrap all exposed roots over 1.5 inches in diameter with a heavy, wet material, such as burlap, and keep moist until backfilling the trench. Remove material before backfilling.
  - Backfill the trench as soon as possible.
- Prevent wounds to tree trunks and limbs during the construction phase.
- Prohibit installation of impervious surfaces in critical root zone areas (see Figure II - 3.1). Where road or sidewalk surfaces are needed under a tree canopy, use un-mortared porous pavers or flagstone (rather than concrete or asphalt) or bridging techniques.

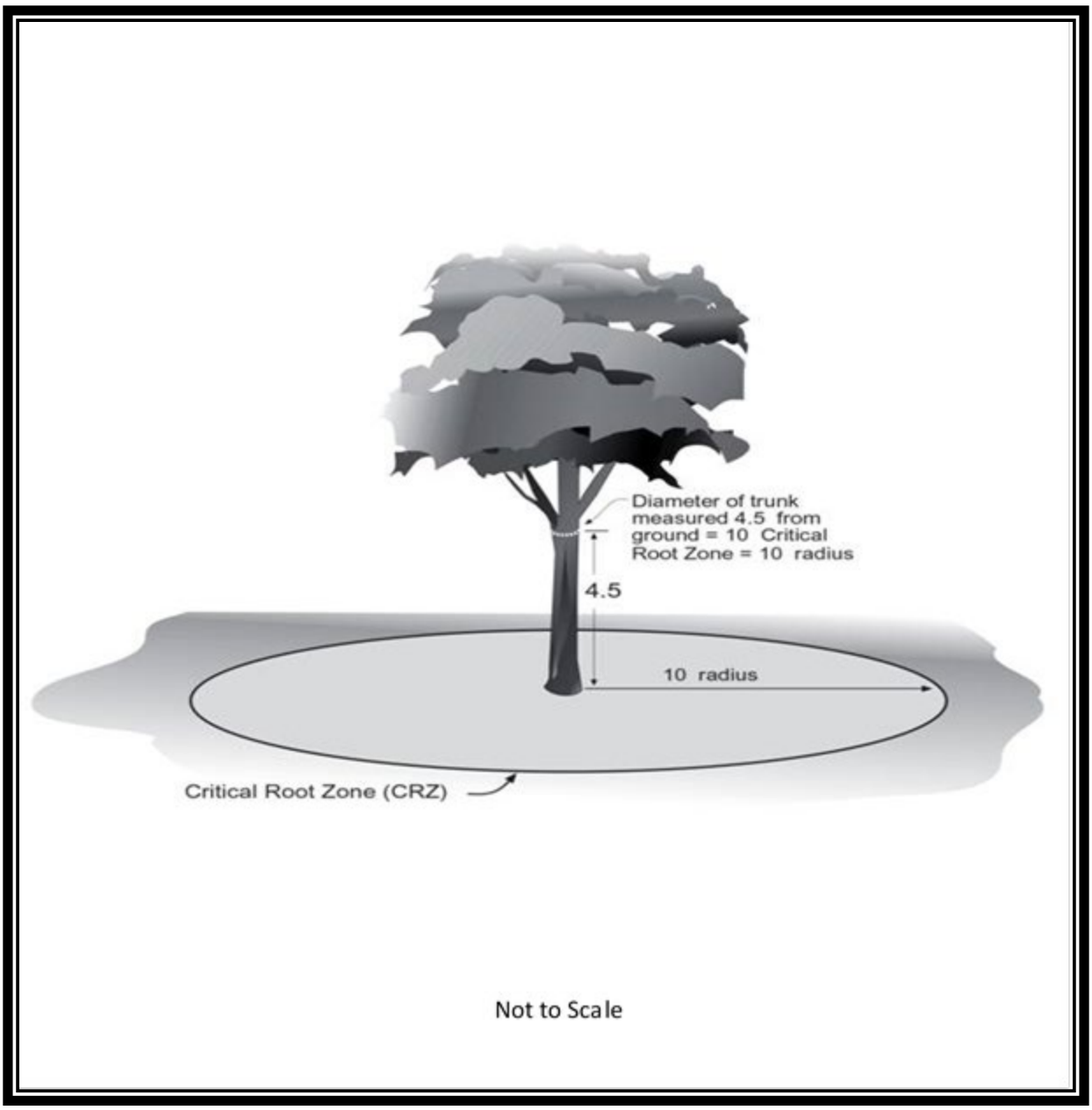


Figure II - 3.1 Critical Root Zone (CRZ), in feet

- Prepare tree conservation areas to better withstand the stresses of the construction phase by fertilizing (if necessary), watering, pruning, and mulching around them well in advance of construction activities. Mulch with a thin layer of compost to add nutrients and organic matter to the soil. Water areas around trees during and after construction to reduce stress and enhance recovery.

Problems that can be encountered with a few specific trees include:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar, and Douglas fir do not readily adjust to changes in environment, so take special care to protect these trees.

- The windthrow hazard of Pacific Silver Fir and Madrona is high, while that of Western hemlock is moderate. The danger of windthrow increases where dense stands have been thinned. Other species (unless they are on shallow, wet soils less than 20 inches deep) have a low windthrow hazard.

- Cottonwoods, maples, and willows have water-seeking roots that can infiltrate and block sewer lines, drain fields, and infiltration systems. However, these trees thrive in high moisture conditions that other trees would not.

- Thinning operations in pure or mixed stands of Grand Fir, Pacific Silver Fir, Noble Fir, Sitka Spruce, Western Red Cedar, Western Hemlock, Pacific Dogwood, and Red Alder can cause serious disease problems. Disease can become established through damaged limbs, trunks, roots, and freshly cut stumps. Diseased and weakened trees are also susceptible to insect attack.

Maintenance Standards

Inspect flagged and/or fenced areas regularly to make sure flagging or fencing has not been removed or damaged. If the flagging or fencing has been damaged or visibility reduced, it shall be repaired or replaced immediately, and visibility restored.

If tree roots have been exposed or injured, “prune” cleanly with an appropriate pruning saw or loppers directly above the damaged roots and re-cover with native soils. Treatment of sap flowing trees (fir, hemlock, pine, soft maples) is not advised as sap forms a natural healing barrier.

BMP C102: Buffer Zones

Purpose

Creation or preservation of an undisturbed area or strip of natural vegetation to provide a living filter to reduce soil erosion and runoff velocities.

Conditions of Use

Natural buffer zones are used along streams, wetlands, and other bodies of water that need protection from erosion and sedimentation. Vegetative buffer zones can protect natural swales and can be incorporated into natural landscaping.

Do not use critical-areas buffer zones as sediment treatment areas. These areas shall remain completely undisturbed. The County may expand the buffer widths temporarily to allow the use of the expanded area for removal of sediment.

Design and Installation Specifications

- Preserving natural vegetation or plantings in clumps, blocks, or strips is the easiest and most successful method.
- Leave all unstable steep slopes in natural vegetation.
- Mark clearing limits and keep all equipment and construction debris out of the natural areas and buffer zones. Steel construction fencing is the most effective method in protecting sensitive areas and buffers. High visibility plastic fencing and wire-backed silt fence on steel posts is marginally effective. Flagging alone is typically not effective.
- Keep all excavations outside the dripline of trees and shrubs.
- Do not push debris or extra soil into the buffer zone area because it will cause damage from burying and smothering.
- Vegetative buffer zones for streams, lakes or other waterways are established by the County or other state or federal permits or approvals.

Maintenance Standards

Inspect the area frequently to make sure fencing or flagging remains in place and the area remains undisturbed. Replace all damaged fencing or flagging immediately.

BMP C103: High Visibility Fence

Purpose

Fencing is intended to:

1. Restrict clearing to approved limits
2. Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed.
3. Limit construction traffic to designated construction entrances, exits or internal roads.
4. Protect areas where survey tape markers may not provide adequate protection.

Conditions of Use

To establish clearing limits plastic, fabric, or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared.
- As necessary to control vehicle access to and on the site.

Design and Installation Specifications

High visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least 4 feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every 6 inches with a polyethylene tie. The fence color shall be high visibility orange. The fence tensile strength shall be 360 lbs./ft. using the ASTM D4595 testing method.

If appropriate install fabric silt fence in accordance with BMP C233 to act as high visibility fence. Silt fence shall be at least 3 feet high and must be highly visible to meet the requirements of this BMP.

Metal fences shall be designed and installed according to the manufacturer's specifications. Metal fences shall be at least 3 feet high and must be highly visible.

Fences shall not be wired or stapled to trees.

Maintenance Standards

If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately, and visibility restored.

BMP C105: Stabilized Construction Entrance/Exit

Purpose

To reduce the amount of sediment transported onto paved roads by vehicles or equipment by constructing a stabilized pad of quarry spalls at entrances and exits for construction sites.

Conditions of Use

Construction entrances shall be stabilized wherever traffic will enter or leave a construction site if paved roads or other paved areas are within 1,000 feet of the site.

For residential construction, such as within a subdivision, provide stabilized construction entrances for each residence, rather than only at the main subdivision entrance. Stabilized surfaces shall be of sufficient length/width to provide vehicle access/parking, based on lot size/configuration.

On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized entrances not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

Design and Installation Specifications

See Figure II - 3.2 for details. Note: the 100 foot minimum length of the entrance shall be reduced to the maximum practicable size when the size or configuration of the site does not allow the full length (100 feet).

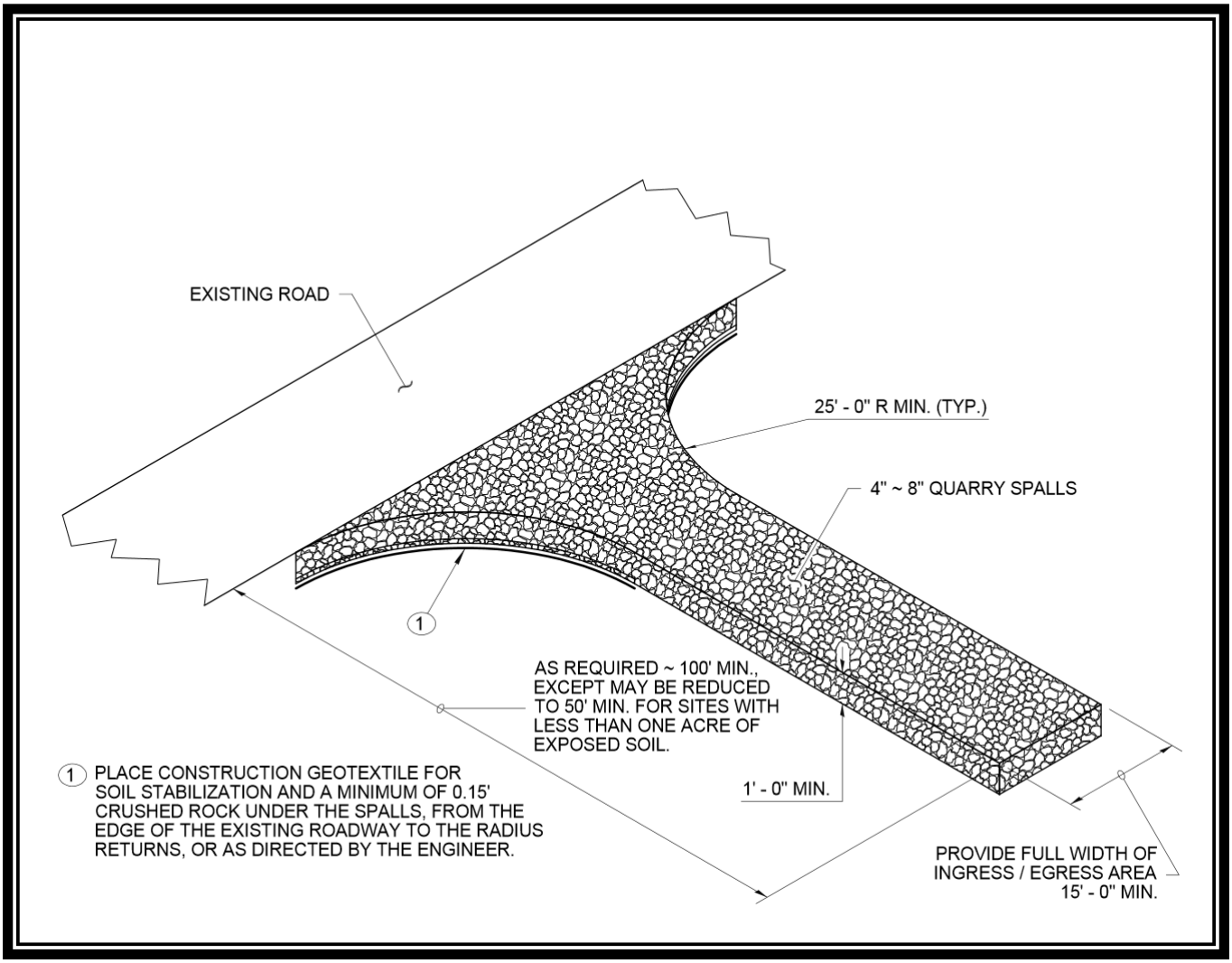


Figure II - 3.2 Stabilized Construction Entrance.
(Drawing courtesy of WSDOT Standard Plans)

Construct stabilized construction entrances with a 12-inch thick pad of 4-inch to 8-inch quarry spalls, a 4-inch course of asphalt treated base (ATB), or use existing pavement. Do not use crushed concrete, recycled concrete, cement, or calcium chloride for construction entrance stabilization because these products raise pH levels in stormwater and concrete discharge to surface waters of the State is prohibited.

A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:

- Grab Tensile Strength (ASTM D4751): 200 psi min.
- Grab Tensile Elongation (ASTM D4632): 30% max.
- Mullen Burst Strength (ASTM D3786-80a): 400 psi min.
- AOS (ASTM D4751): 20-45 (U.S. standard sieve size).

- Fencing (see BMP C103) shall be installed as necessary to restrict traffic to the construction entrance.
- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance.
- Consider early installation of the first lift of asphalt in areas that will be paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose.
- Construction entrances should avoid crossing existing sidewalks and back of walk drains. If a construction entrance must cross a sidewalk or back of walk drain, the full length of the sidewalk and back of walk drain must be covered and protected from sediment leaving the site.

Products Approved as Equivalent

Products approved by Ecology as equivalent to meet the requirements of BMP C105 are acceptable for use in Thurston County. The products that Ecology has approved as functionally equivalent are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

Maintenance Standards

Quarry spalls shall be added if the pad is no longer in accordance with the specifications.

- A volume of quarry spalls equal to 5% of the surface area X the depth must be kept on site for maintenance purposes.
- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include replacement/cleaning of the existing quarry spalls, street sweeping, an increase in the dimensions of the entrance or the installation of a wheel wash.
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, construct a small sump to contain the wash water if possible. Wash the sediment into the sump where it can be controlled.

- Perform street sweeping by hand or with a high efficiency sweeper. Do not use a non-high efficiency mechanical sweeper because this creates dust and throws soils into storm systems or conveyance ditches.

- Any quarry spalls loosened from the pad, that end up on the roadway shall be removed immediately.

- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMP C103) shall be installed to control traffic.

- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized.

BMP C106: Wheel Wash

Purpose

To reduce the amount of sediment transported onto paved roads by motor vehicles.

Conditions of Use

- Use a wheel wash when a stabilized construction entrance (see BMP C105) is not preventing sediment from being tracked off site.
- Wheel washing is generally an effective BMP when installed with careful attention to topography. However, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where water from the dripping truck can run unimpeded into the street, for example.
- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective.
- Wheel wash wastewater is not stormwater. It is commonly called process water and must be discharged to a separate on-site treatment system that prevents discharge to surface water, such as a closed-loop recirculation system to conserve water use, or to the sanitary sewer with local sewer district approval.
- Wheel wash or tire bath wastewater should not include wastewater from concrete washout areas.
- When practical, the wheel wash should be placed in sequence with BMP C105: Stabilized Construction Entrance/Exit. Locate the wheel wash such that vehicles exiting the wheel wash will enter directly onto BMP C105: Stabilized Construction Entrance/Exit. In order to achieve this, BMP C105: Stabilized Construction Entrance/Exit may need to be extended beyond the standard installation to meet the exit of the wheel wash.

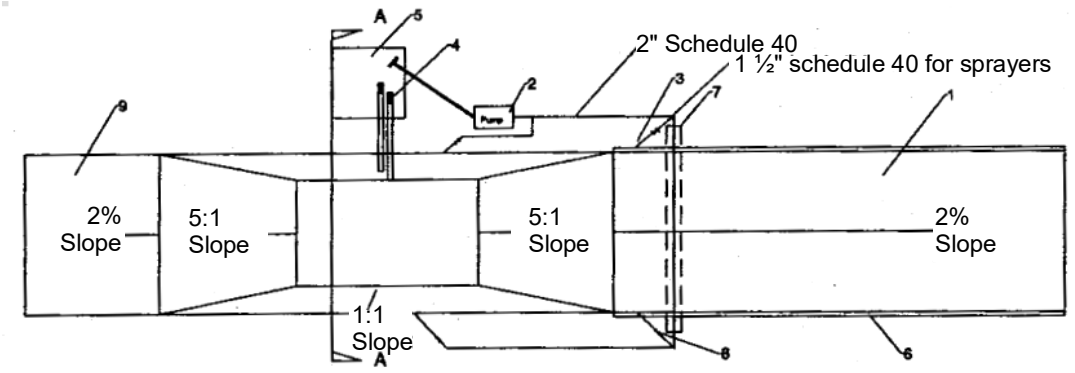
Design and Installation Specifications

- Suggested details are shown in Figure II - 3.3. A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash.
- Use a low clearance truck to test wheel wash clearance before paving. Either a belly dump or lowboy will work well to test clearance.
- Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water.

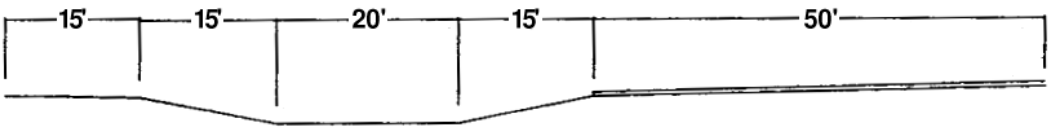
- Midpoint spray nozzles are only needed in extremely muddy conditions.
- Design wheel wash systems with a small grade change (6 to 12 inches for a 10-foot-wide pond) to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment. Install a drainpipe with a 2- to 3-foot riser on the low side of the pond to allow for easy cleaning and refilling. Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 – 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water.

Maintenance Standards

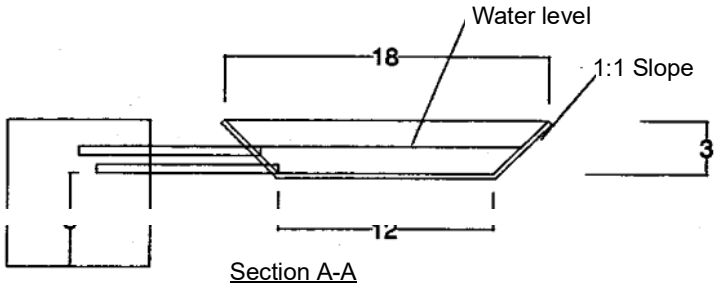
- The wheel wash should start each day with fresh water.
- Change the wash water a minimum of once per day. On large earthwork jobs where more than 10 to 20 trucks per hour are expected, the wash water will need to be changed more often.



Wheel Wash Plan



Elevation View



Section A-A
N.T.S.

Notes:
1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8 foot x 8 foot sump with 5 feet of catch. Build so can be cleaned with track hoe.
6. Asphalt curb on the low roadside to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15 foot. ATB apron to protect ground from splashing water.

Figure II - 3.3 Wheel Wash

BMP C107: Construction Road/Parking Area Stabilization

Purpose

To reduce erosion caused by construction traffic or runoff by stabilizing roads, parking areas, and other on-site vehicle transportation routes immediately after grading.

Conditions of Use

Roads and parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.

High Visibility Fencing (see BMP C103) shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized.

Design and Installation Specifications

- On areas that will receive asphalt as part of the project, install the first lift as soon as possible.

- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for road base stabilization, pH monitoring and BMPs (BMP C252 and C253) are necessary to evaluate and minimize the effects on stormwater. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade.

- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP.

- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with a well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation, then it is preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands or their buffers. If runoff is allowed to sheet flow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created.

- Storm drain inlets shall be protected to prevent sediment-laden water entering the storm drain system (see BMP C220).

Maintenance Standards

- Inspect stabilized areas regularly, especially after large storm events.
- Crushed rock, gravel base, etc. shall be added as required to maintain a stable driving surface and to stabilize any areas that have eroded.
- Following construction, these areas shall be restored to pre-construction condition or better to prevent future erosion.
- Perform street cleaning at the end of each day or more often if necessary.

BMP C120: Temporary and Permanent Seeding

Purpose

Seeding reduces erosion by stabilizing exposed soils. A well-established vegetative cover is one of the most effective methods of reducing erosion.

Conditions of Use

- Seeding shall be used throughout the project on disturbed areas that have reached final grade or that will remain unworked for more than 30 days.
- The optimum seeding windows for western Washington are April 1 through June 30 and September 1 through October 1.
- Between July 1 and August 30 seeding requires irrigation until 75 percent grass cover is established.
- Between October 1 and March 30 seeding requires a cover of mulch or an erosion control blanket until 75 percent grass cover is established.
- Mulch is required at all times for seeding because it protects seeds from heat, moisture loss, and transport due to runoff. Mulch can be applied on top of the seed or simultaneously by hydroseeding. See BMP C121: Mulching for specifications.
- All disturbed areas shall be reviewed in late August to early September and all seeding should be completed by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.
- At final site stabilization, all disturbed areas not otherwise vegetated or stabilized shall be seeded and mulched. Final stabilization means the completion of all soil disturbing activities at the site and the establishment of a permanent vegetative cover, or equivalent permanent stabilization measures (such as pavement, riprap, gabions or geotextiles) which will prevent erosion. See BMP LID.02: Post-Construction Soil Quality and Depth

Design and Installation Specifications

General

- Install channels intended for vegetation before starting major earthwork and hydroseed with a Bonded Fiber Matrix. For vegetated channels that will have high flows, install erosion control blankets over hydroseed. Before allowing water to flow in vegetated channels, establish 75 percent vegetation cover. If

vegetated channels cannot be established by seed before water flow; install sod in the channel bottom – over hydromulch and erosion control blankets.

- To prevent seed from being washed away, confirm that all required surface water control measures have been installed.

- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 2 percent tackifier. See BMP C121: Mulching for specifications.

- Areas that will have seeding only and not landscaping may need compost or meal-based mulch included in the hydroseed in order to establish vegetation. Re-install native topsoil or use BMP LID.02 - Post-Construction Soil Quality and Depth on the disturbed soil surface before application.

- When installing seed via hydroseeding operations, only about 1/3 of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. To overcome this, consider increasing see quantities by up to 50 percent.

Roughening and Rototilling

- The seedbed should be firm and rough. All soil shall be roughened regardless of slope. If compaction is required for engineering purposes, slopes must be track walked before seeding. Backblading or smoothing of slopes greater than 4:1 is not allowed if they are to be seeded.

- New and more effective restoration-based landscape practices rely on deeper incorporation than that provided by a simple single-pass rototilling treatment. Wherever practical, initially rip the subgrade to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use BMP LID.02 - Post-Construction Soil Quality and Depth to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8 inches, perform the rototilling process in multiple lifts, or the prepared soil system shall be prepared properly and then placed to achieve the specified depth.

Fertilizers

- Organic matter is the most appropriate form of “fertilizer” because it provides nutrients (including nitrogen, phosphorus, and potassium) in the least water-soluble form. A natural system typically releases 2 to 10 percent of its nutrients annually. Chemical fertilizers have since been formulated to simulate what organic matter does naturally.

- In general, 10-4-6 N-P-K (nitrogen-phosphorus-potassium) fertilizer can be used at a rate of 90 pounds per acre. Slow-release fertilizers should always be used because they are more efficient and have fewer

environmental impacts. It is recommended that areas being seeded for final landscaping conduct soil tests to determine the exact type and quantity of fertilizer needed. This will prevent the over-application of fertilizer. Fertilizer should not be added to the hydromulch machine or agitated more than 20 minutes before it is to be used. If agitated too much, the slow-release coating is destroyed. Do not use fertilizers in areas that have been amended with compost or used BMP LID.02 - Post-Construction Soil Quality and Depth.

- There are numerous products available on the market that take the place of chemical fertilizers. These include several with seaweed extracts that are beneficial to soil microbes and organisms. If 100 percent cottonseed meal is used as the mulch in hydroseed, chemical fertilizer may not be necessary. Cottonseed meal is a good source of long-term, slow-release, available nitrogen.

Bonded Fiber Matrix and Mechanically Bonded Fiber Matrix

- On steep slopes, use bonded fiber matrix (BFM) or mechanically bonded fiber matrix (MBFM) products. BFM/MBFM products are applied at a minimum rate of 3,000 pounds per acre of mulch with approximately 10 percent tackifier. Application is made so that a minimum of 95 percent soil coverage is achieved. Numerous products are available commercially and should be installed per manufacturer's instructions. Most products require 24 to 36 hours to cure before a rainfall and cannot be installed on wet or saturated soils. Generally, these products come in 40 to 50 pound bags and include all necessary ingredients except for seed and fertilizer.

- Install products per manufacturer's instructions.

- BFMs and MBFMs have some advantages over blankets, including:

    - No surface preparation required

    - Can be installed via helicopter in remote areas

    - On slopes steeper than 2.5:1, blanket installers may need to be roped and harnessed for safety

    - BFMs and MBFMs are at least $1,000 per acre cheaper to install.

- In most cases, the shear strength of blankets is not a factor when used on slopes, only when used in channels. BFMs and MBFMs are good alternatives to blankets in most situations where vegetation establishment is the goal.

Seeding and Seed Mixtures

- When installing seed via hydroseeding operations, only about 1/3 of the seed actually ends up in contact with the soil surface. This reduces the ability to establish a good stand of grass quickly. One way to overcome this is to increase seed quantities by up to 50 percent.

- Vegetation establishment can also be enhanced by dividing the hydromulch operation into two phases:

    - Phase 1 – Install all seed and fertilizer with 25 to 30 percent mulch and tackifier onto soil in the first lift;

    - Phase 2 – Install the rest of the mulch and tackifier over the first lift.

    Or, enhance vegetation by:

    - Installing the mulch, seed, fertilizer, and tackifier in one lift.

    - Spread or blow straw over the top of the hydromulch at a rate of about 800 to 1,000 pounds per acre.

    - Hold straw in place with a standard tackifier.

    Both of these approaches will increase cost moderately but will greatly improve and enhance vegetative establishment. The increased cost may be offset by the reduced need for:

    - Irrigation
    - Reapplication of mulch
    - Repair of failed slope surfaces.

    This technique works with standard hydromulch (1,500 pounds per acre minimum) and Bonded Fiber Matrix/Mechanically Bonded Fiber Matrix BFM/MBFMs (3,000 pounds per acre minimum).

- Seed installed as a temporary measure may be installed by hand if it will be covered by straw, mulch, or topsoil. Seed installed as a permanent measure may be installed by hand on small areas (usually less than 1 acre) that will be covered with mulch, topsoil, or erosion blankets.

- The seed mixes listed below include recommended mixes for both temporary and permanent seeding. These mixes, with the exception of the wet area seed mix, shall be applied at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used. Apply the wet area seed mix at a rate of 60 pounds per acre.

- Consult local suppliers or the Thurston County Conservation District for recommendations because the appropriate mix depends on a variety of factors, including location, exposure, soil type, slope, and expected foot traffic. Alternative seed mixes approved by the County may be used.

- Table II - 3.2 represents the standard mix for those areas where just a temporary vegetative cover is required.

Table II - 3.2 Temporary Erosion Control Seed Mix

	% Weight	% Purity	% Germination
Chewings or annual blue grass *Festuca rubra var. commutata* or *Poa anna*	40	98	90
Perennial rye *Lolium perenne*	50	98	90
Redtop or colonial bentgrass *Agrostis alba* or *Agrostis tenuis*	5	92	85
White dutch clover *Trifolium repens*	5	98	90

- Table II - 3.3 Provides just one recommended possibility for landscaping seed.

Table II - 3.3 Landscaping Seed Mix

	% Weight	% Purity	% Germination
Perennial rye blend *Lolium perenne*	70	98	90
Chewings and red fescue blend *Festuca rubra var. commutata* or Festuca *rubra*	30	98	90

- This turf seed mix in Table II - 3.4 is for dry situations where there is no need for much water. The advantage is that this mix requires very little maintenance.

Table II - 3.4 Low-Growing Turf Seed Mix

	% Weight	% Purity	% Germination
Dwarf tall fescue (several varieties) *Festuca arundinacea var.*	45	98	90
Dwarf perennial rye (Barclay) *Lolium perenne var. barclay*	30	98	90
Red fescue *Festuca rubra*	20	98	90

Colonial bentgrass *Agrostis tenuis*	5	98	90

- Table II - 3.5 presents a mix recommended for bioswales and other intermittently wet areas.

Table II - 3.5 Bioswale Seed Mix[a]

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	75-80	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	92	85
Redtop bentgrass *Agrostis alba* or *Agrostis gigantea*	5-10	90	80

[a] Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix

- The seed mix shown in Table II - 3.6 is a recommended low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Other mixes may be appropriate, depending on the soil type and hydrology of the area. Recent research suggests that bentgrass (*agrostis* sp.) should be emphasized in wet-area seed mixes. Apply this mixture at a rate of 60 pounds per acre.

Table II - 3.6 Wet Area Seed Mix

	% Weight	% Purity	% Germination
Tall or meadow fescue *Festuca arundinacea* or *Festuca elatior*	60-70	98	90
Seaside/Creeping bentgrass *Agrostis palustris*	10-15	98	85
Meadow foxtail *Alepocurus pratensis*	10-15	90	80
Alsike clover *Trifolium hybridum*	1-6	98	90
Redtop bentgrass *Agrostis alba*	1-6	92	85

[a] Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix

- The meadow seed mix in Table II - 3.7 is recommended for areas that will be maintained infrequently or not at all and where native plant colonization is desired. Likely applications include rural road and utility right-of-way. Seeding should take place in September or very early October in order to obtain adequate establishment prior to the winter months. The

appropriateness of clover in the mix may need to be considered, as this can be a fairly invasive species. If the soil is amended, the addition of clover may not be necessary.

Table II - 3.7 Meadow Seed Mix

	% Weight	% Purity	% Germination
Redtop or Oregon bentgrass *Agrostis alba* or *Agrostis oregonensis*	20	92	85
Red fescue *Festuca rubra*	70	98	90
White dutch clover *Trifolium repens*	10	98	90

Maintenance Standards

- Reseed any seeded areas that fail to establish at least 80 percent cover (100 percent cover for areas that receive sheet or concentrated flows).
- If reseeding is ineffective, an alternate method, such as sodding, mulching, or nets/blankets shall be used.
- If winter weather prevents adequate grass growth, time limits may be relaxed at the discretion of the County when sensitive areas would otherwise be protected.
- After adequate cover is achieved, any areas that experience erosion shall be reseeded and protected by mulch. If the erosion problem is drainage related, the problem shall be fixed, and the eroded area reseeded and protected by mulch.
- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

Products Approved as Equivalent

Products approved by Ecology as equivalent to meet the requirements of BMP C120 are acceptable for use in Thurston County. The approved products are available for review on Ecology's website at:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

BMP C121: Mulching

Purpose

To provide immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture and holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There is an enormous variety of mulches, but only the most common types are discussed in this section.

Conditions of Use

As a temporary cover measure, use mulch:

- On disturbed areas that require cover measures for less than 30 days.
- At all times for seeded areas, especially during the wet season and hot summer months.
- During the wet season on slopes steeper than 3H:1V with more than 10 feet of vertical relief.

Mulch may be applied at any time of the year and must be refreshed periodically.

For seeded areas mulch may be made up of 100 percent:

- cottonseed meal;
- fibers made from wood, recycled cellulose, hemp, kenaf;
- compost;
- or blends of these.

Tackifier shall be plant-based, such a guar or alpha plantago, or chemical-based such as polyacrylamide or polymers.

Generally, mulches come in 40-50 pound bags. Seed and fertilizer are added at time of application.

Recycled cellulose may contain polychlorinated biphenyl (PCBs). Ecology recommends that products should be evaluated for PCBs prior to use.

Refer to BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection for conditions of use. PAM shall not be directly applied to water or allowed to enter a water body.

Any mulch or tackifier product used shall be installed per manufacturer’s instructions.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table II - 3.8. Consult with the local supplier or the local conservation district for their recommendations. Increase the application rate until the ground is 95% covered (i.e. not visible under the mulch layer). Note: Thicknesses may be increased for disturbed areas in or near sensitive areas or other areas highly susceptible to erosion.

Mulch used within the ordinary high-water mark of surface waters should be selected to minimize potential flotation of organic matter. Composted organic materials have higher specific gravities (densities) than straw, wood, or chipped material. Consult with WDFW as part of the Hydraulic Project Approval for mulch mixes allowed, if applicable.

Where the option of “Compost” is selected, it should be a coarse compost that meets the following size gradations when tested in accordance with the U.S. Composting Council “Test Methods for the Examination of Compost and Composting” (TMECC) Test Method 02.02-B.

Coarse Compost

- Minimum Percent passing 3” sieve openings 100%
- Minimum Percent passing 1” sieve openings 90%
- Minimum Percent passing ¾” sieve openings 70%
- Minimum Percent passing ¼” sieve openings 40%

Maintenance Standards

- The thickness of the cover must be maintained.
- Any areas that experience erosion shall be re-mulched and/or protected with a net or blanket. If the erosion problem is drainage related, then the problem shall be fixed and the eroded area re-mulched.

Table II - 3.8 Mulch Standards and Guidelines

Mulch Material	Quality Standards	Application Rates	Remarks
Straw	Air-dried; free from undesirable seed and coarse material.	2 to 3 inches thick; 5 bales per 1,000 sf or 2 to 3 tons per acre	Cost-effective when applied with adequate thickness. Hand-application requires greater thickness than blown straw. Straw thickness may be reduced by half when used in conjunction with seeding. In windy areas, straw must be held in place by crimping, using a tackifier, or covering with netting. Blown straw always has to be held in place with a tackifier since light winds will blow it away. Straw, however, has several deficiencies to consider when selecting mulch materials. It often introduces and/or encourages the propagation of weed species and has no significant long-term benefits. Use straw only if mulches with long-term benefits are unavailable. It also shall not be used within the ordinary high-water elevation of surface waters (due to flotation).
Hydromulch	No growth inhibiting factors.	Approx. 25-30 lbs per 1,000 sf or 1,500-2,000 lbs per acre	Shall be applied with hydromulcher. Shall not be used without seed and tackifier unless the application rate is at least doubled. Fibers longer than about 3/4 to 1 inch clog hydromulch equipment. Keep fibers to less than 3/4 inch.
Composted Mulch and Compost	No visible water or dust during handling. Must be purchased from supplier with Solid Waste Handling Permit (unless exempt) and produced in accordance with WAC 173-350.	2-in thick min.; approx. 100 tons per acre (approx. 800 lbs per yard)	Increase thickness to 3 inches to improve effectiveness. Excellent mulch for protecting final grades until landscaping, because it can be directly seeded or tilled into soil as an amendment. Composted mulch has a coarser size gradation than compost. It is more stable and practical to use in wet areas and during rainy weather conditions. Do not use composted mulch near wetlands or near phosphorous impaired water bodies.
Chipped Site Vegetation	Average size shall be several inches. Gradations from fines to 6 inches in length for texture, variation, and interlocking properties.	2-in thick min.	A cost-effective way to dispose of debris from clearing and grubbing, and eliminates problems associated with burning. Should not be used on slopes above about 10 percent because of its tendency to be transported by runoff. Not recommended within 200 feet of surface waters. If seeding is expected shortly after mulch, the decomposition of the chipped vegetation may tie up nutrients important to grass establishment.

Mulch Material	Quality Standards	Application Rates	Remarks
Wood-based Mulch or Wood Straw	No visible water or dust during handling. Must be purchased from a supplier with a Solid Waste Handling Permit or one exempt from solid waste regulations.	2-in. thick min.; approx. 100 tons per acre (approx. 800 lbs. per cubic yard)	Often called “hog or hogged fuel.” The use of mulch ultimately improves the organic matter in the soil. Special caution is advised regarding the source and composition of wood-based mulches. Its preparation typically does not provide any weed seed control, so evidence of residual vegetation in its composition or known inclusion of weed plants or seeds should be monitored and prevented (or minimized).
Wood Strand Mulch	A blend of loose, long, thin wood pieces derived from native conifer or deciduous trees with high length-to-width ratio.	2-in. thick min.	Cost-effective protection when applied with adequate thickness. A minimum of 95-percent of the wood strand shall have lengths between 2 and 10 inches, with a width and thickness between 1/16 and 3/8-inches. The mulch shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life. Sawdust or wood shavings shall not be used as mulch. (WSDOT specification 9-14.4(4))

BMP C122: Nets and Blankets

Purpose

To prevent erosion and hold seed and mulch in place on steep slopes and in channels so that vegetation can become well established. Some nets and blankets can permanently reinforce turf to protect drainage ways during high flows. Nets (commonly called *matting*) are strands of material woven into an open but high-tensile strength net (for example, coconut fiber matting). Blankets are strands of material that are not tightly woven but form a layer of interlocking fibers, typically held together by a biodegradable or photodegradable netting (for example, excelsior or straw blankets). Blankets generally have lower tensile strength than nets but cover the ground more completely. Coir (coconut fiber) fabric comes as both nets and blankets.

Conditions of Use

Erosion control netting and blankets shall be made of natural plant fibers unaltered by synthetic materials.

Use erosion control nets and blankets:

- To aid permanent vegetated stabilization of slopes 2H:1V or greater and with more than 10 feet of vertical relief.
- For drainage ditches and swales (highly recommended). Using netting or blankets in drainage ditches and swales can protect bare soil from channelized runoff until vegetation is established. Nets and blankets can also capture a large amount of sediment due to their open, porous structure. Nets and blankets can permanently stabilize channels and may provide a cost-effective, environmentally preferable alternative to riprap.

Disadvantages of nets and blankets include:

- Surface preparation required
- On slopes steeper than 2.5:1, blanket installers may need to be roped and harnessed for safety
- They cost at least $4,000 to $6,000 per acre installed.

Advantages of nets and blankets include:

- Can be installed without mobilizing special equipment
- Can be installed by anyone with minimal training
- Can be installed in stages or phases as the project progresses

- Seed and fertilizer can be hand-placed by the installers as they progress down the slope

- Can be installed in any weather. There are numerous types of blankets that can be designed with various parameters in mind. Those parameters include fiber blend, mesh strength, longevity, biodegradability, cost, and availability.

Design and Installation Specifications

- See Figure II- 3.2 and Figure II - 3.3 for typical orientation and installation of blankets used in channels and as slope protection. Note: these are typical only; all nets and blankets must be installed using manufacturer's installation instructions.

- Installation is critical to the effectiveness of these products. If good ground contact is not achieved, runoff can concentrate under the product, resulting in significant erosion. Installation of nets and blankets on slopes:

    1. Complete final grade and track walk up and down the slope.

    2. Install hydromulch with seed and fertilizer.

    3. Dig a small trench, approximately 12 inches wide by 6 inches deep along the top of the slope.

    4. Install the leading edge of the net/blanket into the small trench and staple approximately every 18 inches. Staples are metal, "U" -shaped, and a minimum of 6 inches long. Longer staples are used in sandy soils. Biodegradable stakes are available.

    5. Roll the net/blanket slowly down the slope as installer walks backwards. The net/blanket rests against the installer's legs. Staples are installed as the blanket is unrolled. It is critical that the proper staple pattern is used for the net/blanket being installed. Do not allow the net/blanket to roll down the slope on its own as this stretches the net/blanket making it impossible to maintain soil contact. In addition, do not walk on the net/blanket after it is in place.

    6. If the net/blanket is not long enough to cover the entire slope length, the trailing edge of the upper blanket shall overlap the leading edge of the lower blanket and be stapled. On steeper slopes, install this overlap in a small trench, staple it, and cover it with soil.

    - A wide variety of products is available. Therefore, it is critical that the design engineer consults the manufacturer's information and that a site

visit takes place in order to ensure that the product specified is appropriate. Information is also available in WSDOT's *Standard Specifications for Road, Bridge, and Municipal* Construction Division 8-01 and Division 9-14 (WSDOT, 2016).

- Jute matting must be used in conjunction with mulch (BMP C121). Excelsior, woven straw blankets and coir (coconut fiber) blankets may be installed without mulch. There are many other types of erosion control nets and blankets on the market that may be appropriate in certain circumstances.

- In general, most nets require mulch in order to prevent erosion because of their open structure. Blankets typically do not require mulch because they normally provide complete protection of the surface.

- Extremely steep, unstable, wet, or rocky slopes are often appropriate locations for use of synthetic blankets, as are riverbanks, beaches and other high-energy environments. If synthetic blankets are used, hydromulch the soil first.

- 100 percent biodegradable blankets are available for use in sensitive areas. These organic blankets are usually held together with a paper or fiber mesh and stitching which can last up to a year.

- Most netting used with blankets is photodegradable, meaning they break down under sunlight (not UV stabilized). However, this process can take months or years even under bright sun. Once vegetation is established, sunlight does not reach the mesh. It is not uncommon to find non-degraded netting still in place several years after installation. This can be a problem if maintenance requires the use of mowers or ditch cleaning equipment. In addition, birds and small animals can become trapped in the netting.

Maintenance Standards

- Maintain good contact with the ground. Erosion must not occur beneath the net or blanket.

- Repair and staple any areas of the net or blanket that are damaged or not in close contact with the ground.

- Fix and protect eroded areas if erosion occurs due to poorly controlled drainage.

BMP C123: Plastic Covering

Purpose

To provide immediate, short-term erosion protection of slopes and disturbed areas.

Conditions of Use

Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below.

- Plastic is particularly useful for protecting cut and fill slopes and stockpiles, but the rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than 6 months) applications.
- Due to rapid runoff caused by plastic sheeting, this method shall not be used upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes.
- Plastic sheeting may result in increased runoff volumes and velocities, requiring onsite measures to counteract the increases. Creating a trough with wattles or other material can convey water away from these areas.
- To prevent undercutting, trench and backfill rolled plastic covering products.
- Plastic sheeting requires close monitoring and frequent maintenance to ensure proper performance. Water quality standards must be met at all times.
- While plastic is inexpensive to purchase, the cost of installation, maintenance, removal, and disposal add to the total costs of this BMP
- Whenever plastic is used to protect slopes, water collection measures must be installed at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to covey clean rainwater away from bare soil and disturbed areas. At no time is clean runoff from a plastic covered slope to be mixed with dirty runoff from a project.
- Other uses for plastic include:
    1. Temporary ditch liner
    2. Pond liner in temporary sediment pond
    3. Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored
    4. Emergency slope protection during heavy rains
    5. Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
    1. Run plastic up and down slope, not across slope
    2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet
    3. Minimum of 8-inch overlap at seams
    4. Tape all seams on long or wide slopes, or slopes subject to wind
    5. Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath
    6. Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and tie them together with twine and pound a wooden stake through each to hold them in place
    7. Inspect plastic for rips, tears, and open seams regularly and repair immediately. This prevents high velocity runoff from contacting bare soil which causes extreme erosion.
    8. Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.
- Plastic sheeting shall have a minimum thickness of 0.06 millimeters.
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff.

Maintenance Standards

- Torn sheets must be replaced and open seams repaired.
- Completely remove and replace if the plastic begins to deteriorate due to ultraviolet radiation.
- Completely remove the plastic when it is no longer needed.
- Dispose of old tires used to weight down plastic sheeting appropriately.

BMP C124: Sodding

Purpose

To establish permanent turf for immediate erosion protection and stabilize drainage ways where concentrated overland flow will occur.

Conditions of Use

Sodding may be used in the following areas:

- Disturbed areas that require short-term or long-term cover.
- Disturbed areas that require immediate vegetative cover.
- All waterways that require vegetative lining. Waterways may also be seeded rather than sodded and protected with a net or blanket.

Design and Installation Specifications

Sod shall be free of weeds, of uniform thickness (approximately 1 inch thick), and shall have a dense root mat for mechanical strength.

The following steps are recommended for sod installation:

- Shape and smooth the surface to final grade in accordance with the approved grading plan. The swale needs to be over excavated 4 to 6 inches below design elevation to allow room for placing soil amendment and sod.
- Amend 4 inches (minimum) of compost into the top 8 inches of the soil if the organic content of the soil is less than ten percent or the permeability is less than 0.6 inches per hour. See https://ecology.wa.gov/Waste-Toxics/Reducing-recycling-waste/Organic-materials/Managing-orgaincs-compostfor further information.
- Fertilize according to the supplier's recommendations.
- Work lime and fertilizer into the top 1 to 2 inches of the soil and smooth the surface.[2]
- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely into place. Square the ends of each strip to provide for a close, tight fit.

[2] Lime and fertilizer shall only be applied if necessary, as determined by a soil test on the amended soil.

Stagger joints at least 12 inches. Staple on slopes steeper than 3H:1V. Staple the upstream edge of each sod strip.

- Roll the sodded area and irrigate.
- When sodding is carried out in alternating strips or other patterns, seed the areas between the sod immediately after sodding.

Maintenance Standards

If the grass is unhealthy, the cause shall be determined, and appropriate action taken to reestablish a healthy groundcover. If it is impossible to establish a healthy groundcover due to frequent saturation, instability, or some other cause, the sod shall be removed, the area seeded with an appropriate mix, and protected with a net or blanket.

BMP C125: Topsoiling/Composting

Purpose

To provide a suitable growth medium for final site stabilization with vegetation.

While not a permanent cover practice, topsoiling and composting are an integral component of providing permanent cover in areas with an unsuitable soil surface for plant growth. Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but also serve as effective biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

Conditions of Use

- Areas to be permanently landscaped shall provide a healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetal health and vitality, improves hydrologic characteristics, and reduces the need for irrigation. This is required for most project and shall be completed in accordance with the requirements of BMP LID.02: Post –Construction Soil Quality and Depth (Volume V of DDECM).

- Leave native soils and the duff layer undisturbed as much as possible. Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. If an existing soil system is functioning properly it shall be preserved in its undisturbed and uncompacted condition.

- Areas that already have healthy topsoil, such as undisturbed areas, do not require soil amendments.

- Restore, to the maximum extent practicable, native soils disturbed during clearing and grading to a condition where moisture-holding capacity is equal to or better than the original site conditions. This criterion can be met by using on-site native topsoil, incorporating amendments into on-site soil, or importing blended topsoil.

- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels.

- Beware of where the topsoil comes from, or what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses.

- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Use commercially available mycorrhiza products when using offsite topsoil.

Design and Installation Specifications

Meet the following requirements for disturbed areas that will be developed as lawn or landscaped areas at the completed project site:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil shall have:
    - A minimum depth of 8-inches. Scarify subsoils below the topsoil layer at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible. Ripping or restructuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system.
    - A minimum organic content of 10 percent dry weight in planting beds, and 5 percent organic matter content in turf areas. Incorporate organic amendments to a minimum 8-inch depth except where tree roots or other natural features limit the depth of incorporation.
    - A pH between 6.0 and 8.0 or matching the pH of the undisturbed soil.
    - If blended topsoil is imported, then fines should be limited to 25 percent passing through a 200 sieve.
- Mulch planting beds with 2 inches of organic material.
- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, and clay loam). Avoid areas of natural groundwater recharge.
- Stripping shall be confined to the immediate construction area. A 4- to 6-inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping.
- Do not place topsoil while in frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding.
- In any areas requiring grading remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public

resources and critical areas. Stockpiled topsoil is to be reapplied to other portions of the site where feasible.

- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used.
- Stockpiling of topsoil shall occur in the following manner:
    - Side slopes of the stockpile shall not exceed 2H:1V.
    - Between October 1 and April 30:
        - An interceptor dike with gravel outlet and silt fence shall surround all topsoil stockpiles.
        - Within 2 days complete erosion control seeding, or cover stockpiles with clear plastic, or other mulching materials.
    - Between May 1 and September 30:
        - An interceptor dike with gravel outlet and silt fence shall be installed if the stockpile will remain in place for a longer period of time than active construction grading.
        - Within 7 days complete erosion control seeding, or cover stockpiles with clear plastic, or other mulching materials.
- When native topsoil is to be stockpiled and reused the following apply to ensure the mycorrhizal, bacterial, earthworms, and other beneficial organisms will not be destroyed:
    - Re-install topsoil within 4 to 6 weeks.
    - Do not allow the saturation of topsoil with water.
    - Do not use plastic covering.

Maintenance Standards

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded.
- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant and mulch soil after installation.

- Leave plant debris or its equivalent on the soil surface to replenish organic matter.

- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection

Purpose

Polyacrylamide (PAM) is a soil binding agent used on construction sites to prevent soil erosion.

Applying PAM to bare soil in advance of rain significantly reduces erosion and controls sediment in two ways. First, PAM increases the soil's available pore volume, thus increasing infiltration through flocculation and reducing the quantity of stormwater runoff. Second, it increases flocculation of suspended particles and aids in their deposition, thus reducing stormwater runoff turbidity and improving water quality.

Conditions of Use

PAM shall only be applied with prior acceptance by the County and shall not be directly applied to water or allowed to enter a water body. Some PAMs are more toxic and carcinogenic than others. Only the most environmentally safe PAM products should be used, as noted in the following paragraph.

The specific PAM copolymer formulation must be anionic. **Cationic PAM shall not be used in any application because of known aquatic toxicity problems**. Only the highest drinking water grade PAM, certified for compliance with ANSI/NSF Standard 60 for drinking water treatment, will be used for soil applications. Recent media attention and high interest in PAM has resulted in some entrepreneurial exploitation of the term "polymer." All PAM are polymers, but not all polymers are PAM, and not all PAM products comply with ANSI/NSF Standard 60. PAM use shall be reviewed and approved by the County. The Washington State Department of Transportation (WSDOT) has listed approved PAM products on their web page.

In areas that drain to a sediment pond, PAM can be applied to bare soil in the following locations and under the following conditions:

- During rough grading operations
- In staging areas
- Balanced cut and fill earthwork
- Haul roads prior to placement of crushed rock surfacing
- Compacted soil road base
- Stockpiles
- After final grade and before paving or final seeding and planting
- Pit sites

- Sites having a winter shut down. In the case of winter shut down, or where soil will remain unworked for several months, use PAM together with mulch.

Design and Installation Specifications

PAM may be applied in dissolved form with water, or it may be applied in dry, granular or powdered form. The preferred application method is the dissolved form.

PAM is to be applied at a maximum rate of 2/3 pound PAM per 1,000 gallons water (80 mg/L) per 1 acre of bare soil. Table II - 3.9 can be used to determine the PAM and water application rate for a disturbed soil area. Higher concentrations of PAM **do not** provide any additional effectiveness.

Table II - 3.9 PAM and Water Application Rates

Disturbed Area (ac)	PAM (lbs.)	Water (gal)
0.50	0.33	500
1.00	0.66	1,000
1.50	1.00	1,500
2.00	1.32	2,000
2.50	1.65	2,500
3.00	2.00	3,000
3.50	2.33	3,500
4.00	2.65	4,000
4.50	3.00	4,500
5.00	3.33	5,000

The Preferred Method:

- Pre-measure the area where PAM is to be applied and calculate the amount of product and water necessary to provide coverage at the specified application rate (2/3 pound PAM/1,000 gallons/acre).

- PAM has high solubility in water, but dissolves very slowly. Dissolve pre-measured dry granular PAM with a known quantity of clean water in a bucket several hours or overnight. Mechanical mixing will help dissolve the PAM. Always add PAM to water - not water to PAM.

- Pre-fill the water truck about 1/8 full with water. The water does not have to be potable, but it must have relatively low turbidity – in the range of 20 NTU or less.

- Add PAM /Water mixture to the truck
- Completely fill the water truck to specified volume.
- Spray PAM/Water mixture onto dry soil until the soil surface is uniformly and completely wetted.

An Alternate Method:

PAM may also be applied as a powder at the rate of 5 lbs. per acre. This must be applied on a day that is dry. For areas less than 5 to 10 acres, a hand-held "organ grinder" fertilizer spreader set to the smallest setting will work. Tractor-mounted spreaders will work for larger areas.

The following shall be used for application of powdered PAM:

- PAM shall be used in conjunction with other BMPs and not in place of other BMPs.
- Do not use PAM on a slope that flows directly into a stream or wetland. The stormwater runoff shall pass through a sediment control BMP prior to discharging to surface waters.
- Do not add PAM to water discharging from site.
- When the total drainage area is greater than or equal to 5 acres, PAM treated areas shall drain to a sediment pond.
- Areas less than 5 acres shall drain to sediment control BMPs, such as a minimum of three check dams per acre. The total number of check dams used shall be maximized to achieve the greatest amount of settlement of sediment prior to discharging from the site. Each check dam shall be spaced evenly in the drainage channel through which stormwater flows are discharged offsite.
- On all sites, the use of silt fence shall be maximized to limit the discharges of sediment from the site.
- All areas not being actively worked shall be covered and protected from rainfall. PAM shall not be the only cover BMP used.
- PAM can be applied to wet soil, but dry soil is preferred due to less sediment loss.
- PAM will work when applied to saturated soil but is not as effective as applications to dry or damp soil.

- Keep the granular PAM supply out of the sun. Granular PAM loses its effectiveness in three months after exposure to sunlight and air.

- Proper application and re-application plans are necessary to ensure total effectiveness of PAM usage.

- PAM, combined with water, is very slippery and can be a safety hazard. Care must be taken to prevent spills of PAM powder onto paved surfaces. During an application of PAM, prevent over-spray from reaching pavement as pavement will become slippery. If PAM powder gets on skin or clothing, wipe it off with a rough towel rather than washing with water-this only makes cleanup messier and take longer.

- Some PAMs are more toxic and carcinogenic than others. Only the most environmentally safe PAM products shall be used.

- PAM designated for these uses should be “water soluble” or “linear” or “non-crosslinked”. Cross-linked or water absorbent PAM, polymerized in highly acidic (pH<2) conditions, are used to maintain soil moisture content.

- The PAM anionic charge density may vary from 2 to 30 percent; a value of 18 percent is typical. Studies conducted by the United States Department of Agriculture (USDA)/ARS demonstrated that soil stabilization was optimized by using very high molecular weight (12 to 15 mg/mole), highly anionic (>20 percent hydrolysis) PAM.

- PAM tackifiers are available and being used in place of guar and alpha plantago. Typically, PAM tackifiers should be used at a rate of no more than 0.5 to 1 lb. per 1,000 gallons of water in a hydromulch machine. Some tackifier product instructions say to use at a rate of 3 to 5 lbs. per acre, which can be too much. In addition, pump problems can occur at higher rates due to increased viscosity.

Maintenance Standards

- PAM may be reapplied on actively worked areas after a 48-hour period.

- Reapplication is not required unless PAM treated soil is disturbed or unless turbidity levels show the need for an additional application. If PAM treated soil is left undisturbed a reapplication may be necessary after 2 months. More PAM applications may be required for steep slopes, silty and clayey soils (USDA Classification Type "C" and "D" soils), long grades, and high precipitation areas. When PAM is applied first to bare soil and then covered with straw, a reapplication may not be necessary for several months.

- Loss of sediment and PAM may be a basis for penalties per RCW 90.48.080.

BMP C130: Surface Roughening

Purpose

To aid in the establishment of vegetative cover, reduce runoff velocity, increase infiltration, and provide for sediment trapping through the provision of a rough soil surface. Horizontal depressions are created by operating a tiller or other suitable equipment on the contour or by leaving slopes in a roughened condition by not fine grading them.

Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding.

Conditions for Use

- All slopes steeper than 3:1 and greater than 5 vertical feet require surface roughening to a depth of 2 to 4 inches prior to seeding.
- Areas that will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.
- Slopes with a stable rock face do not require roughening.
- Slopes where mowing is planned should not be excessively roughened.

Design and Installation Specifications

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, contour furrows, and tracking. See Figure II - 3.2 for tracking and contour furrows. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

- Disturbed areas that will not require mowing may be stair-step graded, grooved, or left rough after filling.
- Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each “step” catches material that 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. Stair steps must be on contour or gullies will form on the slope.
- Areas that will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.

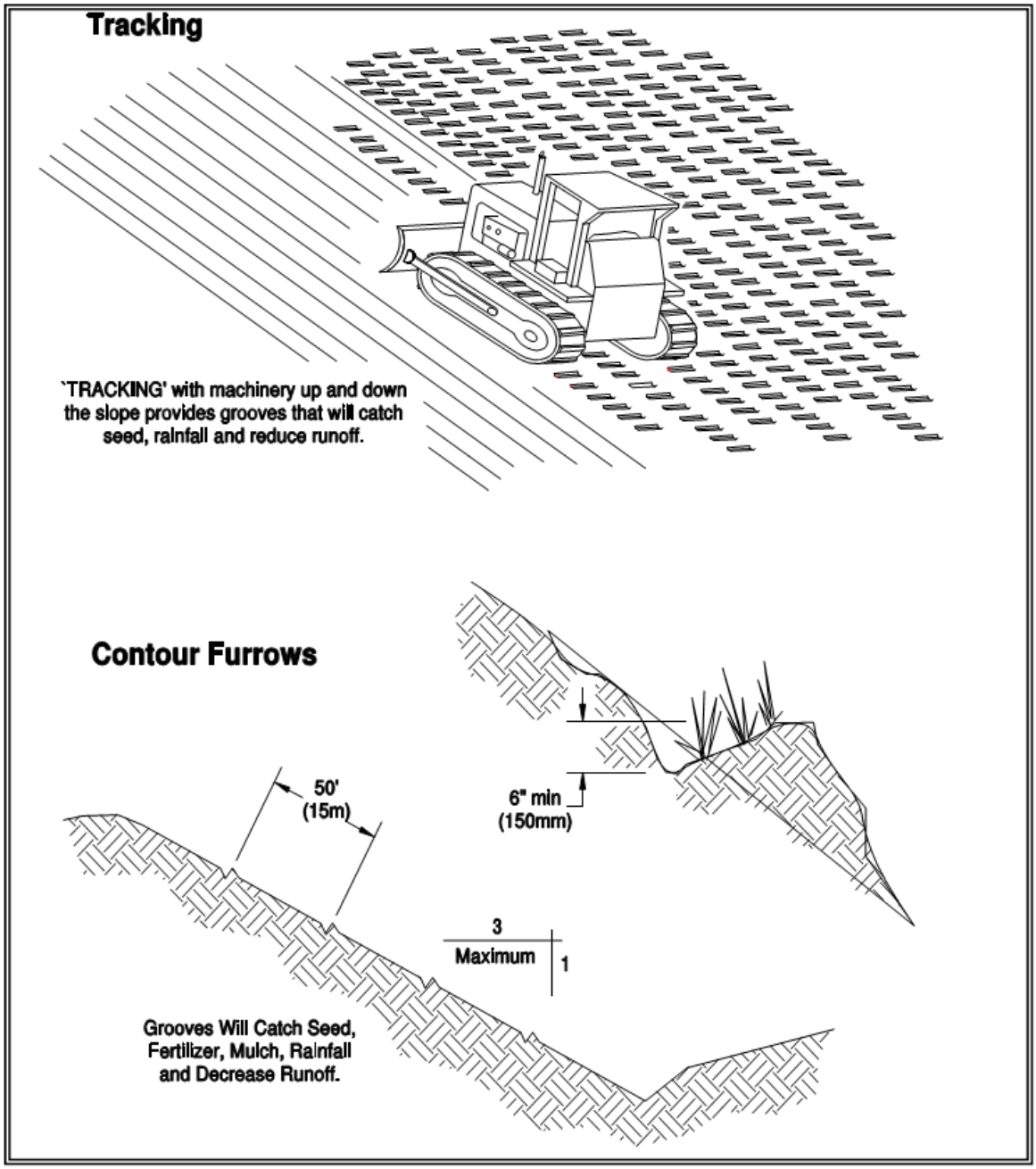


Figure II - 3.2 Surface Roughening by Tracking and Contour Furrows

- Graded areas with slopes greater than 3:1 but less than 2:1 shall 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, leaving a pattern of cleat imprints parallel to slope contours.

- Tracking is done by operating equipment up and down the slope to leave horizontal depressions in the soil.

Maintenance Standards

- Areas that are surfaced roughened should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, re-roughen and re-seed immediately.

BMP C131: Gradient Terraces

Purpose

To reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a non-erosive velocity.

Conditions of Use

Gradient terraces normally are limited to denuded land having a water erosion problem. They should not be constructed on deep sands or on soils that are too stony, steep, or shallow to permit practical and economical installation and maintenance. Gradient terraces may be used only where suitable outlets are or will be made available. See Figure II - 3.3 for gradient terraces.

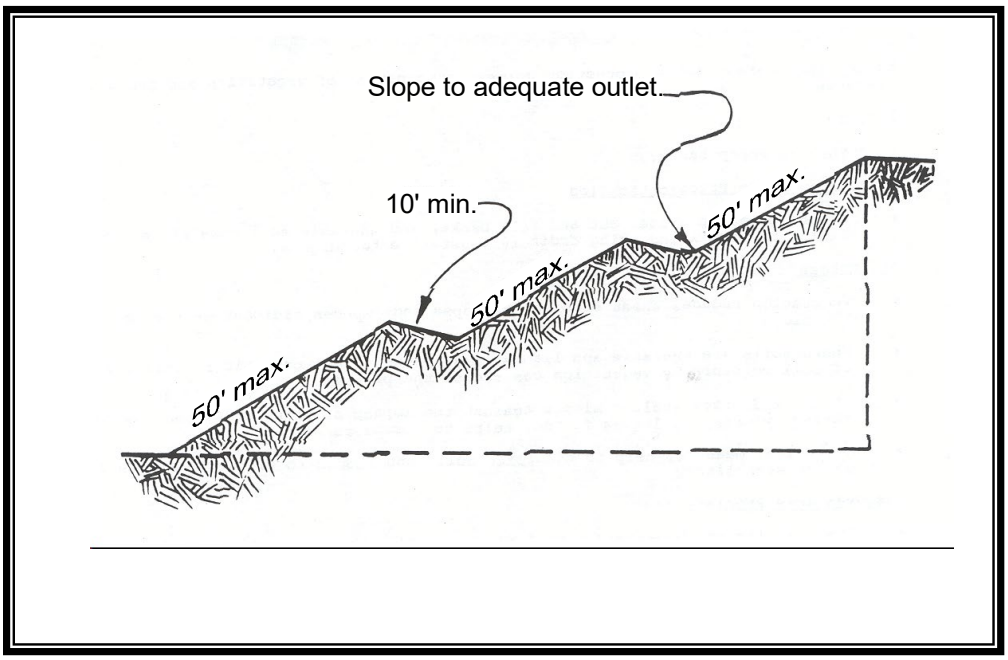


Figure II - 3.3 Gradient Terraces

Design and Installation Specifications

- Determine the maximum spacing of gradient terraces using the following formula:

$$VI = (0.8)s + y$$

Where:
VI = vertical interval in feet
S = land rise per 100 feet, expressed in feet
y = a soil and cover variable with values from 1.0 to 4.0

Values of “y” are influenced by soil erodibility and cover practices. The lower values are applicable to erosive soils where little to no residue is left on the surface. The higher value is applicable only to erosion-resistant soils where a large amount of residue (1-1/2 tons of straw/acre equivalent) is on the surface.

- The minimum constructed cross-section shall meet the design dimensions.
- The top of the constructed ridge shall not be lower at any point than the design elevation plus the specified overfill for settlement. The opening at the outlet end of the terrace shall have a cross-section equal to that specified for the terrace channel.
- Channel grades may be either uniform or variable with a maximum grade of 0.6 feet per 100 feet length (0.6%). For short distances, terrace grades may be increased to improve alignment. The channel velocity shall not exceed that which is non-erosive for the soil type with the planned treatment.
- All gradient terraces shall have adequate outlets. Such an outlet may be a grassed waterway, vegetated area, or tile outlet. In all cases the outlet must convey runoff from the terrace or terrace system to a point where the outflow will not cause damage. Use vegetative cover in the outlet channel.
- The design elevation of the water surface of the terrace shall not be lower than the design elevation of the water surface in the outlet at their junction, when both are operating at design flow.
- Vertical spacing determined by the above methods may be increased as much as 0.5 feet or 10 percent, whichever is greater, to provide better alignment or location, to avoid obstacles, to adjust for equipment size, or to reach a satisfactory outlet. The drainage area above the terrace shall not exceed the area that would be drained by a terrace with normal spacing.
- The terrace shall have enough capacity to handle the peak runoff expected from a 2-year, 24-hour design storm without overtopping.
- The terrace cross-section should be proportioned to fit the land slope. The ridge height should include a reasonable settlement factor. The ridge shall have a minimum top width of 3 feet at the design height. The minimum cross-sectional area of the terrace channel shall be 8 square feet for land slopes of 5 percent or less, 7 square feet for slopes from 5 to 8 percent, and 6 square feet for slopes steeper than 8 percent. The terrace can be constructed wide enough to be maintained using a small cat.

Maintenance Standards

Performance maintenance as needed. Terraces should be inspected regularly; at least once a year, and after large storm events.

BMP C140: Dust Control

Purpose

To prevent wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

Dust control must be used in areas (including roadways) subject to surface and air movement of dust, where on-site and off-site impacts to roadways, drainage ways or surface waters are likely.

Design and Installation Specifications

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock.
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition, if stable. Maintain the original ground cover as long as practical.
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources.
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, see Stabilized Construction Entrance (BMP C105).
- Irrigation water can be used for dust control. Install irrigation systems as a first step on sites where dust control is a concern.
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Oil based products are prohibited from use as a dust suppressant. The County may approve other dust palliatives such as calcium chloride or PAM.
- PAM (BMP C126) added to water at a rate of 0.5 lbs. per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to the increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind. Adding PAM may actually reduce the quantity of water needed for dust control. PAM has also shown to be relatively affordable and thus an extremely cost-effective dust control method.

- Techniques that can be used for unpaved roads and lots include:
    - Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots.
    - Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials.
    - Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent.
    - Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction.
    - Encourage the use of alternate, paved routes, if available.
    - Restrict roadway use by tracked vehicles and heavy trucks to prevent damage to road surface and base.
    - Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments.
    - Pave unpaved permanent roads and other trafficked areas.
    - Use vacuum street sweepers.
    - Remove mud and other dirt promptly so it does not dry and then turn into dust.
    - Limit dust-causing work on windy days.
- Contact the Olympic Region Clean Air Agency (ORCAA) for guidance and training on other dust control measures. Compliance with the ORCAA constitutes compliance with this BMP.

Maintenance Standards

Respray area as necessary to keep dust to a minimum.

BMP C150: Materials on Hand

Purpose

Quantities of erosion prevention and sediment control materials can be kept on the project site at all times for regular maintenance and emergency situations such as unexpected heavy summer rains. Having these materials on-site reduces the time needed to implement BMPs when inspections indicate that existing BMPs are not meeting the Construction SWPPP requirements. In addition, contractors can save money by buying some materials in bulk and storing them at their office or yard.

Conditions of Use

- Construction projects of any size or type can benefit from having materials on hand. A small commercial development project could have a roll of plastic and some gravel available for immediate protection of bare soil and temporary berm construction. A large earthwork project, such as highway construction, might have several tons of straw, several rolls of plastic, flexible pipe, sandbags, geotextile fabric, and steel “T” posts.

- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A large contractor or developer could keep a stockpile of materials that are available to be used on several projects.

- If storage space at the project site is at a premium, the contractor could maintain the materials at their office or yard. The office or yard must be less than an hour from the project site.

Design and Installation Specifications

Depending on project type, size, complexity, and length, materials and quantities will vary. A good minimum that will cover numerous situations includes:

Table II - 3.10 Materials on Hand

Material	Measure	Quantity
Clear Plastic, 6 mil	100 foot roll	1-2
Drainpipe, 6- or 8-inch diameter	25 foot section	4-6
Sandbags, filled	each	25-50
Straw Bales for mulching,	approx. 50# each	10-20
Quarry Spalls	ton	2-4
Washed Gravel	cubic yard	2-4
Geotextile Fabric	100 foot roll	1-2
Catch Basin Inserts	each	2-4
Steel “T” Posts	each	12-24

Silt fence material	Lineal feet	200
Straw Wattles	Lineal feet	100

Maintenance Standards

- All materials with the exception of the quarry spalls, steel “T” posts, and gravel should be kept covered and out of both sun and rain.
- Re-stock materials used as needed.

BMP C151: Concrete Handling

Purpose

Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate concrete, concrete process water, and concrete slurry from entering waters of the State.

Conditions of Use

Any time concrete is used; these management practices shall be utilized, since concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water.

Concrete construction projects include, but are not limited to, the following:

- Curbs
- Sidewalks
- Roads
- Bridges
- Foundations
- Floors
- Runways

Disposal options for concrete, in order of preference are:

1. Off-site disposal locations
2. Concrete wash-out areas (see BMP C154: Concrete Washout Area)
3. De minimis washout to formed areas awaiting concrete

Design and Installation Specifications

- Washout concrete truck drums at an approved off-site location or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground (including formed areas awaiting concrete), or into storm drains, open ditches, streets, or streams. Refer to BMP C154 for information on concrete washout areas.

  - Unused concrete remaining in the truck and pump shall be returned to the originating batch plant for recycling, as feasible. Do not dump excess concrete on site, except in designated concrete washout areas as allowed in BMP C154.

- Small concrete handling equipment (e.g., hand tools screeds, shovels, rakes, floats, trowels, and wheelbarrows) shall be washed into designated concrete washout areas or into formed areas awaiting concrete pour.

- At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.

- Equipment that cannot be easily moved, such as concrete paving machines, shall only be washed in areas that do not directly drain to natural or constructed stormwater conveyances or potential infiltration areas.

- Do not allow washwater from areas, such as concrete aggregate driveways, to drain directly (without detention or treatment) to natural or constructed stormwater conveyances.

- When no designated concrete washout areas (or formed areas, allowed as described above) are available, contain washwater and leftover product in a lined container. Lining shall be a minimum of 10-mil polyethylene sheeting and shall be free of holes, tears, or other defects that compromise the impermeability of the material. Dispose of contained concrete and concrete washwater (process water) in a manner that does not violate groundwater or surface water quality standards.

- Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.

- Refer to BMPs C252: Treating and Disposing of High pH Water for pH adjustment requirements.

- Refer to the Construction Stormwater General Permit (CSWGP) for pH monitoring requirements if the project involves one of the following activities:

  - Significant concrete work (as defined in the CSWGP).

  - The use of soils amended with (but not limited to) Portland cement-treated base, cement kiln dust or fly ash.

  - Discharging stormwater to segments of water bodies on the 303(d) list (Category 5) for high pH.

Maintenance Standards

Check containers for holes in the liner daily during concrete pours and repaired the same day.

BMP C152: Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting or surfacing operations generate slurry and process water that contains fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. Concrete spillage or concrete discharge to surface waters of the State is prohibited. Use this BMP to minimize and eliminate process water and slurry from entering waters of the State.

Conditions of Use

Utilize these management practices anytime sawcutting and surfacing operations take place. Sawcutting and surfacing operations include, but are not limited to, the following:

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

Design and Installation Specifications

- Vacuum slurry and cuttings during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance including stormwater systems. This may require temporarily blocking catch basins.
- Dispose collected slurry and cuttings in a manner that does not violate groundwater or surface water quality standards.
- Do not allow process water that is generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems and dispose it in a manner that does not violate groundwater or surface water quality standards.
- Handle and dispose cleaning waste material and demolition debris in a manner that does not cause contamination of water. If the area is swept

with a pick-up sweeper, haul the material out of the area to an appropriate disposal site.

Maintenance Standards

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the state. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and/or vacuum trucks.

BMP C153: Material Delivery, Storage and Containment

Purpose

To prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or water courses from material delivery and storage by minimizing on-site hazardous materials storage, storing materials in a designated area, and installing secondary containment.

Conditions of Use

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Petroleum products such as fuel, oil and grease
- Soil stabilizers and binders (e.g., Polyacrylamide)
- Fertilizers, pesticides and herbicides
- Detergents
- Asphalt and concrete compounds
- Hazardous chemicals such as acids, lime, adhesives, paints, solvents and curing compounds
- Any other material that may be detrimental if released to the environment

Design and Installation Specifications

To minimize risk, do the following:

- Locate temporary storage area away from vehicular traffic, near the construction entrance(s), and away from waterways or storm drains.
- Safety Data Sheets (SDS) should be supplied for all stored materials. Chemicals should be kept in their original labeled containers.
- Minimize on-site hazardous material storage.
- Handle hazardous materials as infrequently as possible.
- During the wet weather season (October 1 – April 30), store materials in a covered area when possible.
- Store materials in secondary containments such as an earthen dike, a horse trough, or even a children’s wading pool for non-reactive materials

such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.

- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.

- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.

Material Storage Areas and Secondary Containment Practices:

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 shall be stored in approved containers and drums and shall not be overfilled. Containers and drums shall be stored in temporary secondary containment facilities.

- Temporary secondary containment facilities shall provide for a spill containment volume able to contain precipitation from a 25-year, 24-hour storm event, plus 10 percent of the total enclosed container volume of all containers, or 110 percent of the capacity of the largest container within its boundary, whichever is greater.

- Secondary containment facilities shall be impervious to the materials stored therein for a minimum contact time of 72 hours.

- Secondary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as hazardous waste unless testing determines them to be non-hazardous.

- Provide sufficient separation between stored containers to allow for spill cleanup and emergency response access.

- During the wet weather season (October 1 – April 30), each secondary containment facility shall be covered during non-working days, prior to and during rain events.

- Keep material storage areas clean, organized and equipped with an ample supply of appropriate spill clean-up material (spill kit).

- The spill kit should include, at a minimum:

    - 1-Water Resistant Nylon Bag

- 3-Oil Absorbent Socks 3” x 4’
- 2-Oil Absorbent Socks 3” x 10’
- 12-Oil Absorbent Pads 17” x 19”
- 1-Pair Splash Resistant Goggles
- 3-Pair Nitrile Gloves
- 10-Disposable Bags with Ties
- Instructions.

Maintenance Standards

- Secondary containment facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills shall be collected and placed into drums. These liquids shall be handled as hazardous waste unless testing determines them to be non-hazardous.

- Re-stock spill kit materials as needed.

BMP C154: Concrete Washout Area

Purpose

To prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout off-site or performing on-site washout in a designated area to prevent pollutants from entering surface waters or groundwater.

Conditions of Use

Concrete washout area best management practices are implemented on construction projects where:

- Concrete is used as a construction material
- It is not possible to dispose of all concrete wastewater and washout off-site (ready mix plant, etc.).
- Concrete truck drums are washed on-site.

Note that auxiliary concrete truck components (e.g. chutes and hoses) and small concrete handling equipment (e.g. hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrows) may be washed into formed areas awaiting concrete pour. At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.

Design and Installation Specifications

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Perform washout of concrete truck drums at an approved off-site location or in designated concrete washout areas only.
- Do not wash out concrete onto non-formed areas, or into storm drains, open ditches, streets, or streams.
- Wash equipment difficult to move, such as concrete paving machines, in areas that do not directly drain to natural or constructed stormwater conveyance or potential infiltration areas.
- Do not allow excess concrete to be dumped on-site, except in designated concrete washout areas as allowed above.
- Concrete washout areas may be prefabricated concrete washout containers, or self-installed structures (above-grade or below-grade).

- Prefabricated containers are most resistant to damage and protect against spills and leaks. Companies may offer delivery service and provide regular maintenance and disposal of solid and liquid waste.
- If self-installed concrete washout areas are used, below-grade structures are preferred over above-grade structures because they are less prone to spills and leaks.
- Self-installed above-grade structures should only be used if excavation is not practical.
- Construct and maintain concrete washout areas in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

Education

- Discuss the concrete management techniques described in this BMP with the ready-mix concrete supplier before any deliveries are made.
- Educate employees and subcontractors on the concrete waste management techniques described in this BMP.
- Arrange for contractor's superintendent or Certified Erosion and Sediment Control Lead (CESCL) to oversee and enforce concrete waste management procedures.
- A sign shall be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.

Contracts

Incorporate requirements for concrete waste management into concrete supplier and subcontractor agreements.

Location and Placement

- Locate concrete washout areas at least 50 feet from sensitive areas such as storm drains, open ditches, water bodies, or wetlands.
- Allow convenient access to the concrete washout area for concrete trucks, preferably near the area where the concrete is being poured.
- If trucks need to leave a paved area to access the concrete washout area, prevent track-out with a pad of rock or quarry). These areas should be far

enough away from other construction traffic to reduce the likelihood of accidental damage and spills.

- The number of concrete washout areas you install should depend on the expected demand for storage capacity.

- On large sites with extensive concrete work, concrete washout areas should be placed in multiple locations for ease of use by concrete truck drivers.

Concrete Truck Washout Procedures

- Perform washout of concrete truck drums in designated concrete washout areas only.

- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated concrete washout areas or properly disposed of off-site.

Concrete Washout Area Installation

- Concrete washout areas should be constructed as shown on the details below, with a recommended minimum length and width of 10 feet, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.

- Plastic lining material shall be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

- Lath and flagging should be commercial type.

- Liner seams shall be installed in accordance with manufacturers' recommendations.

- Soil base shall be prepared free of rocks or other debris that may cause tears or holes in the plastic lining material.

Maintenance Standards

Inspection and Maintenance

- Inspect and verify that concrete washout areas are in place prior to the commencement of concrete work. Once concrete wastes are washed into the designated washout area and allowed to harden, the concrete should be broken up, removed, and disposed of per applicable solid waste regulations. Dispose of hardened concrete on a regular basis.

- During periods of concrete work, inspect daily to verify continued performance.
    - Check overall condition and performance.
    - Check remaining capacity (% full).
    - If using self-installed washout facilities, verify plastic liners are intact and sidewalls are not damaged.
    - If using prefabricated containers, check for leaks.
- Concrete washout areas shall be maintained to provide adequate holding capacity with a minimum freeboard of 12 inches.
- Concrete washout areas must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.
- If the concrete washout area is nearing capacity, vacuum and dispose of the waste material in an approved manner.
    - Do not discharge liquid or slurry to waterways, storm drains, or directly onto the ground.
    - Do not use sanitary sewer without local sewer service provider approval.
    - Place a secure, non-collapsing, non-water collecting cover over the concrete washout facility prior to predicted wet weather to prevent accumulation and overflow of precipitation.
    - Remove and dispose of hardened concrete and return the structure to a functional condition. Concrete may be reused on-site or hauled away for disposal or recycling.
- When you remove materials from a self-installed concrete washout area, build a new structure; or, if the previous structure is still intact, inspect for signs of weakening or damage, and make any necessary repairs. Re-line the structure with new plastic after each cleaning.

Removal of Concrete Washout Areas

- When concrete washout areas are no longer required for the work, the hardened concrete, slurries and liquids shall be removed and properly disposed of.

- Materials used to construct temporary concrete washout areas shall be removed from the site of the work and disposed of or recycled.

- Holes, depressions or other ground disturbance caused by the removal of the concrete washout areas shall be backfilled, repaired, and stabilized to prevent erosion.

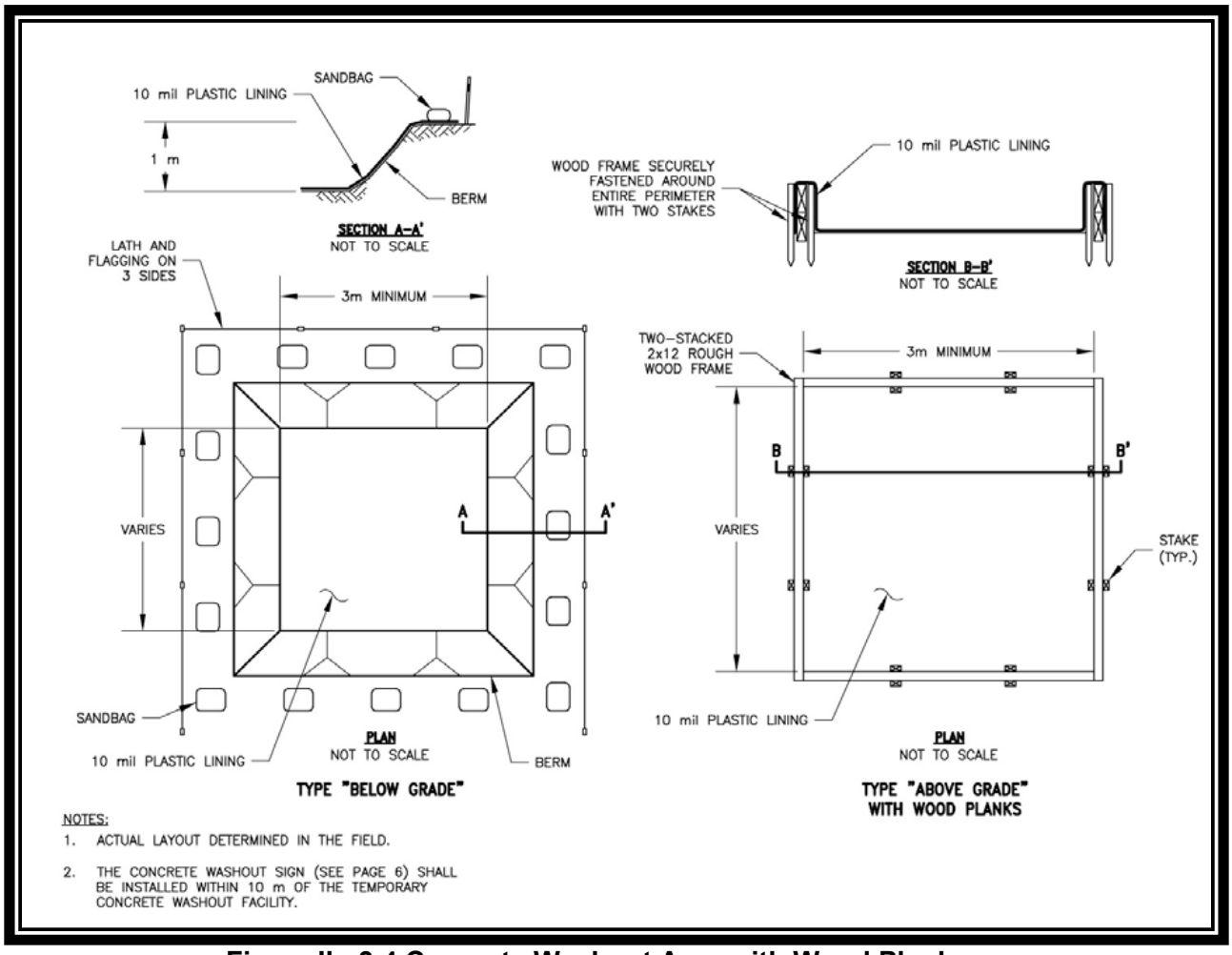


Figure II - 3.4 Concrete Washout Area with Wood Planks

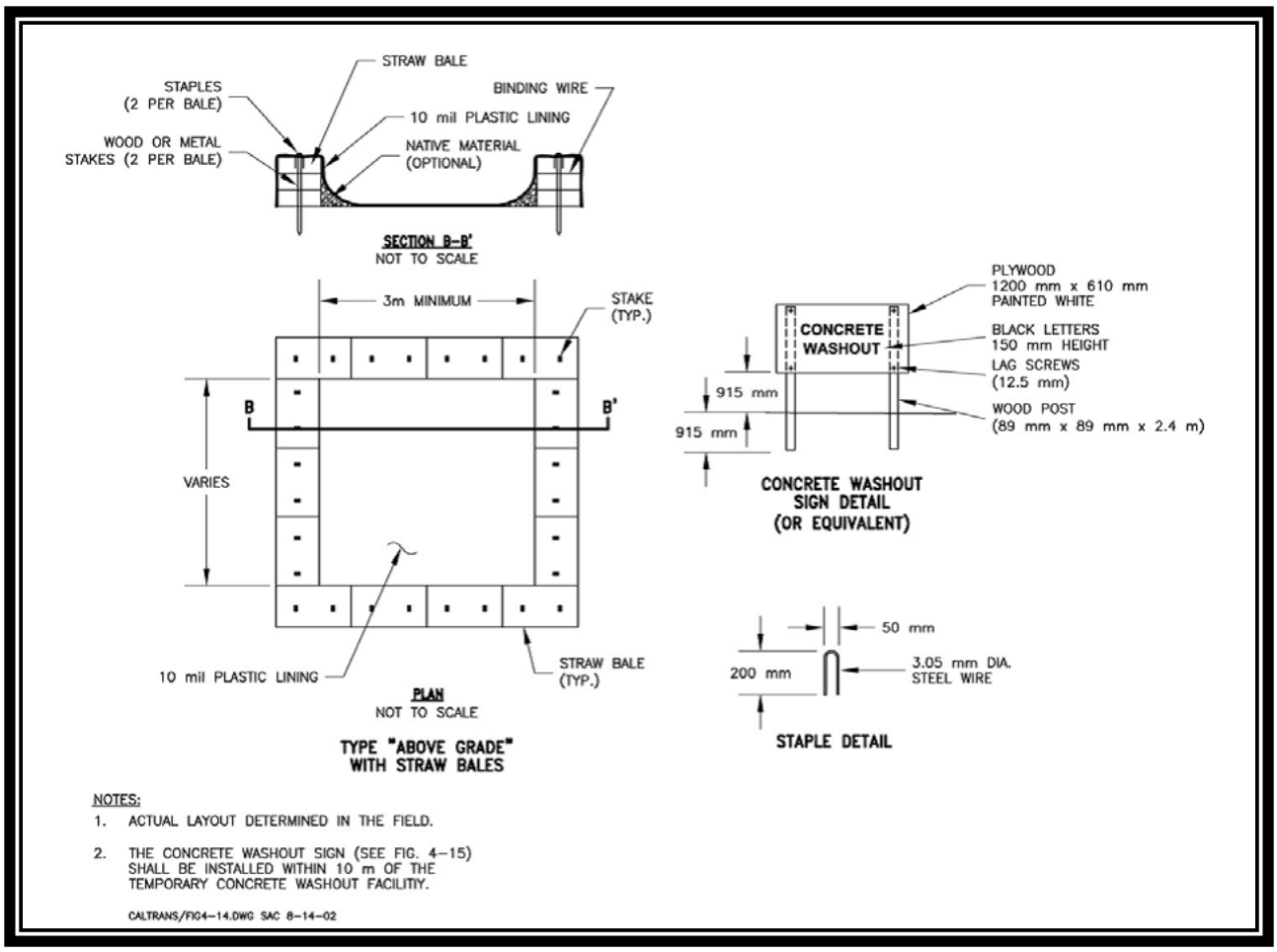


Figure II - 3.5 Concrete Washout Area with Straw Bales

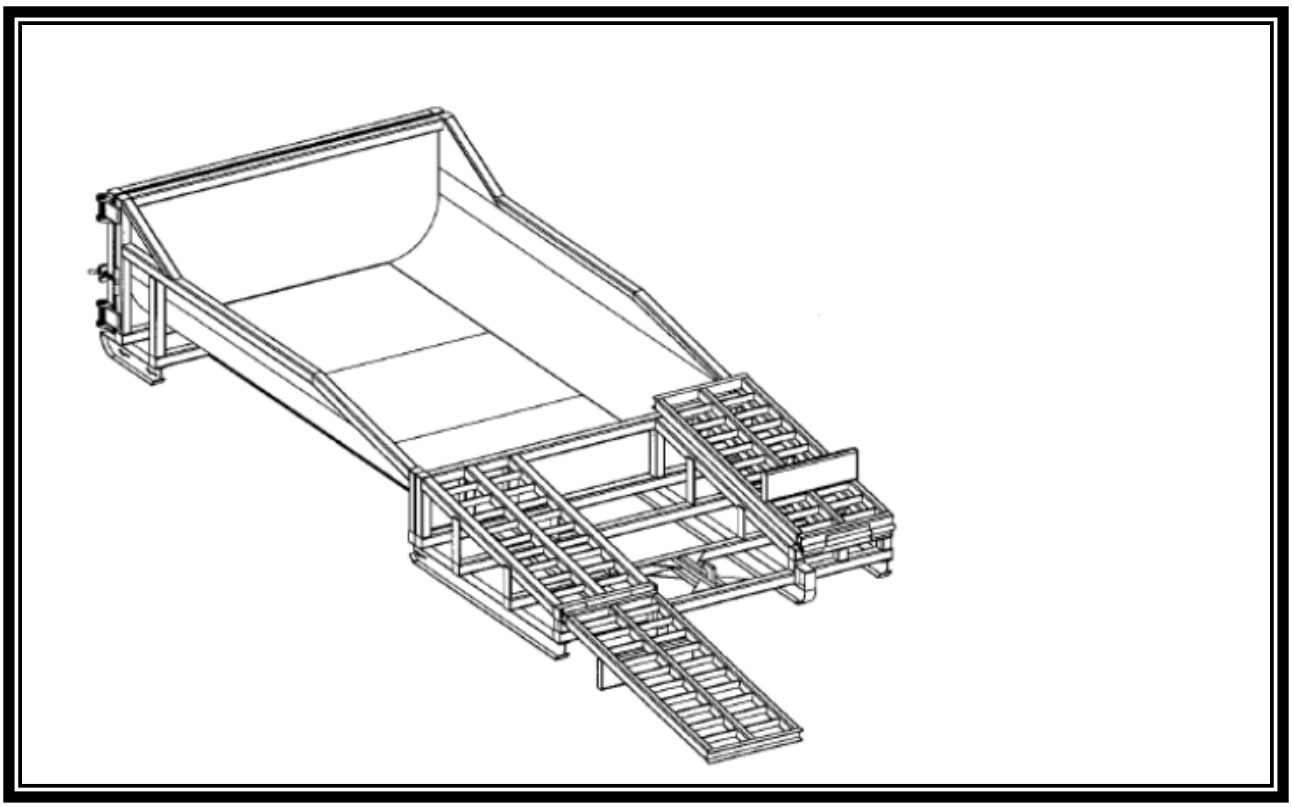


Figure II - 3.6 Prefabricated Concrete Washout Container w/Ramp

BMP C160: Certified Erosion and Sediment Control Lead

Purpose

To ensure compliance with all local, state, and federal erosion and sediment control and water quality requirements by designating at least one person as the responsible representative in charge of erosion and sediment control (ESC), and water quality protection. The designated person shall be the Certified Erosion and Sediment Control Lead (CESCL).

Conditions of Use

A CESCL shall be made available on projects disturbing ground 1 acre or larger and that discharge stormwater to surface waters of the state. Sites less than one acre may have a person without CESCL certification conduct inspections; sampling is not required on sites that disturb less than an acre.

The CESCL shall:

- Have a current certificate proving attendance in an erosion and sediment control training course that meets the minimum ESC training and certification requirements established by Ecology (see Ecology's 2012 Stormwater Management Manual for Western Washington for details).

  Ecology will maintain a list of ESC training and certification providers at: https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Certified-erosion-sediment-control

OR

- Be a Certified Professional in Erosion and Sediment Control (CPESC); for additional information go to: http://www.envirocertintl.org/cpesc/

Specifications

- CESCL certification shall remain valid for 3 years.
- The CESCL shall have authority to act on behalf of the contractor or project proponent and shall be available, or on call, 24 hours per day throughout the period of construction.
- The Construction SWPPP shall include the name, telephone number, fax number, and address of the designated CESCL.
- A CESCL may provide inspection and compliance services for multiple construction projects in the same geographic region but must be on site whenever earthwork activities are occurring that could generate release of turbid water.

- Duties and responsibilities of the CESCL shall include, but are not limited to the following:
    - Maintaining permit file on site at all times which includes the Construction SWPPP and any associated permits and plans.
    - Directing BMP installation, inspection, maintenance, modification, and removal.
    - Updating all project drawings and the Construction SWPPP with changes made.
    - Completing any sampling requirements including reporting results using electronic Discharge Monitoring Reports (WebDMR). Keeping daily logs, and inspection reports. Inspection reports shall include:
        - Inspection date/time.
        - Weather information; general conditions during inspection and approximate amount of precipitation since the last inspection.
        - A summary or list of all BMPs implemented, including observations of all erosion/sediment control structures or practices. The following shall be noted:
            1. Locations of BMPs inspected
            2. Locations of BMPs that need maintenance
            3. Locations of BMPs that failed to operate as designed or intended
            4. Locations of where additional or different BMPs are required.
    - Visual monitoring results, including a description of discharged stormwater. The presence of suspended sediment, turbid water, discoloration, and oil sheen shall be noted, as applicable.
    - Any water quality monitoring performed during inspection.
    - General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.
- Facilitate, participate in, and take corrective actions resulting from inspections performed by outside agencies or the owner.

BMP C162: Scheduling

Purpose

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

Conditions of Use

The construction sequence schedule is an orderly listing of all major land-disturbing activities together with the necessary erosion and sedimentation control measures planned for the project. This type of schedule guides the contractor on work to be done before other work is started so that serious erosion and sedimentation problems can be avoided.

Following a specified work schedule that coordinates the timing of land-disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of surface ground cover leaves a site vulnerable to accelerated erosion. Construction procedures that limit land clearing, provide timely installation of erosion and sedimentation controls, and restore protective cover quickly can significantly reduce the erosion potential of a site.

Design Considerations

- Avoid construction during rainy periods.
- Schedule projects to disturb only small portions of the site at any one time.
- Complete grading as soon as possible.
- Immediately stabilize the disturbed portion before grading the next portion.
- Practice staged seeding in order to revegetate cut and fill slopes as the work progresses.

3.2 Runoff Conveyance and Treatment BMPs

This section contains the standards and specifications for Runoff Conveyance and Treatment BMPS. Table II - 3.11, below, shows the relationship of the BMPs in Section 3.2 to the Construction Stormwater Pollution Prevention Plan (SWPPP) Elements described in Section 2.3.3.

Table II - 3.11 Runoff Conveyance and Treatment BMPs by SWPPP Element

BMP or Element Name	Element #3 Control Flow Rates	Element #4 Install Sediment Controls	Element #6 Protect Slopes	Element #7 Protect Drain Inlets	Element #8 Stabilize Channels and Outlets	Element #9 Control Pollutants	Element #10 Control De-Watering	Element #13 Protect LID BMPs
BMP C200: Interceptor Dike and Swale			✓					✓
BMP C201: Grass-Lined Channels			✓					✓
BMP C202: Riprap Channel Lining					✓			
BMP C203: Water Bars	✓		✓				✓	
BMP C204: Pipe Slope Drains			✓					
BMP C205: Subsurface Drains			✓					
BMP C206: Level Spreader			✓				✓	
BMP C207: Check Dams	✓		✓		✓			✓
BMP C208: Triangular Silt Dike (Geotextile-Encased Check Dam)			✓					✓
BMP C209: Outlet Protection	✓				✓			
BMP C220: Storm Drain Inlet Protection				✓				
BMP C231: Brush Barrier		✓						✓
BMP C232: Gravel Filter Berm		✓						
BMP C233: Silt Fence		✓						✓
BMP C234: Vegetated Strip		✓						✓
BMP C235: Wattles	✓	✓						
BMP C236: Vegetative Filtration							✓	
BMP C240: Sediment Trap	✓	✓						
BMP C241: Temporary Sediment Pond	✓	✓						
BMP C250: Construction Stormwater Chemical Treatment		✓				✓		
BMP C251: Construction Stormwater Filtration		✓				✓		
BMP C252: Treating and Disposing of High pH Water						✓		

BMP C200: Interceptor Dike and Swale

Purpose

Provide a ridge of compacted soil or a swale at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike or swale to intercept runoff from undisturbed areas before it enters exposed soils to prevent the clean runoff from becoming sediment laden or to intercept runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area and sediment-laden runoff from leaving the construction site.

Conditions of Use

Use an interceptor dike or swale where runoff from an exposed site or disturbed slope must be conveyed to an erosion control BMP which can safely convey the stormwater:

- Locate upslope of a construction site to prevent runoff from entering the disturbed area.
- When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope.
- Locate downslope to collect runoff from a disturbed area and direct it to a sediment BMP.

Design and Installation Specifications

- Dike and/or swale and channel must be stabilized with temporary or permanent vegetation or other channel protection during construction.
- Channel requires a positive grade for drainage; steeper grades require channel protection and check dams.
- Review construction for areas where overtopping may occur.
- Can be used at top of new fill before vegetation is established.
- May be used as a permanent diversion channel to carry the runoff.
- Contributing area for an individual dike or swale should be 1 acre or less.
- Design the dike and/or swale to contain flows calculated by one of the following methods:
    - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A,

10-year, 24-hour frequency storm for the worst-case land cover condition.

OR

- Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step for the worst-case land cover condition. For conveyance systems that will also serve on a permanent basis see design standards in Volume III, Chapter 3.

Worst-case land cover conditions (i.e., producing the most runoff) should be used for analysis (in most cases, this would be the land cover conditions just prior to final landscaping).

Interceptor dikes shall meet the following criteria:

-Top Width: 2 feet minimum

-Height: 1.5 feet minimum on berm

-Side Slope: 2:1 or flatter

-Grade: Depends on topography, however, dike system minimum is 0.5% and maximum is 1%

-Compaction: Minimum of 90 percent ASTM D698 standard proctor.

Horizontal Spacing of Interceptor Dikes:

Table II - 3.12 Horizontal Spacing of Interceptor Dikes

Average Slope	Slope Percent	Flow Path Length
20H:1V or less	3-5%	300 feet
(10 to 20) H:1V	5-10%	200 feet
(4 to 10) H:1V	10-25%	100 feet
(2 to 4) H:1V	25-50%	50 feet

Stabilization depends on velocity and reach:

-Slopes <5%: Seed and mulch applied within 5 days of dike construction (*see BMP C121, Mulching*).

-Slopes 5 to 40%: Dependent on runoff velocities and dike materials. Stabilization shall be done immediately using either sod or riprap or other measures to avoid erosion.

- The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility.

- Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing.

Interceptor swales shall meet the following criteria:

-Bottom Width:	2 feet minimum; the cross-section bottom shall be level
-Depth:	1-foot minimum
-Side Slope:	2H:1V or flatter
-Grade:	Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment pond)
-Stabilization:	Seed as per BMP C120, Temporary and Permanent Seeding, or BMP C202, Riprap Channel Lining, 12 inches thick of riprap pressed into the bank and extending at least 8 inches vertical from the bottom.

Maintenance Standards

- Inspect diversion dikes and interceptor swales once a week and after every rainfall. Immediately remove sediment from the flow area.

- Damage caused by construction traffic or other activity must be repaired before the end of each working day.

- Check outlets and make timely repairs as needed to avoid gully formation. When the area below the temporary diversion dike is permanently stabilized, remove the dike and fill and stabilize the channel to blend with the natural surface.

BMP C201: Grass-Lined Channels

Purpose

To provide a channel with a vegetative lining for conveyance of runoff. See Figure II - 3.7 for typical grass-lined channels.

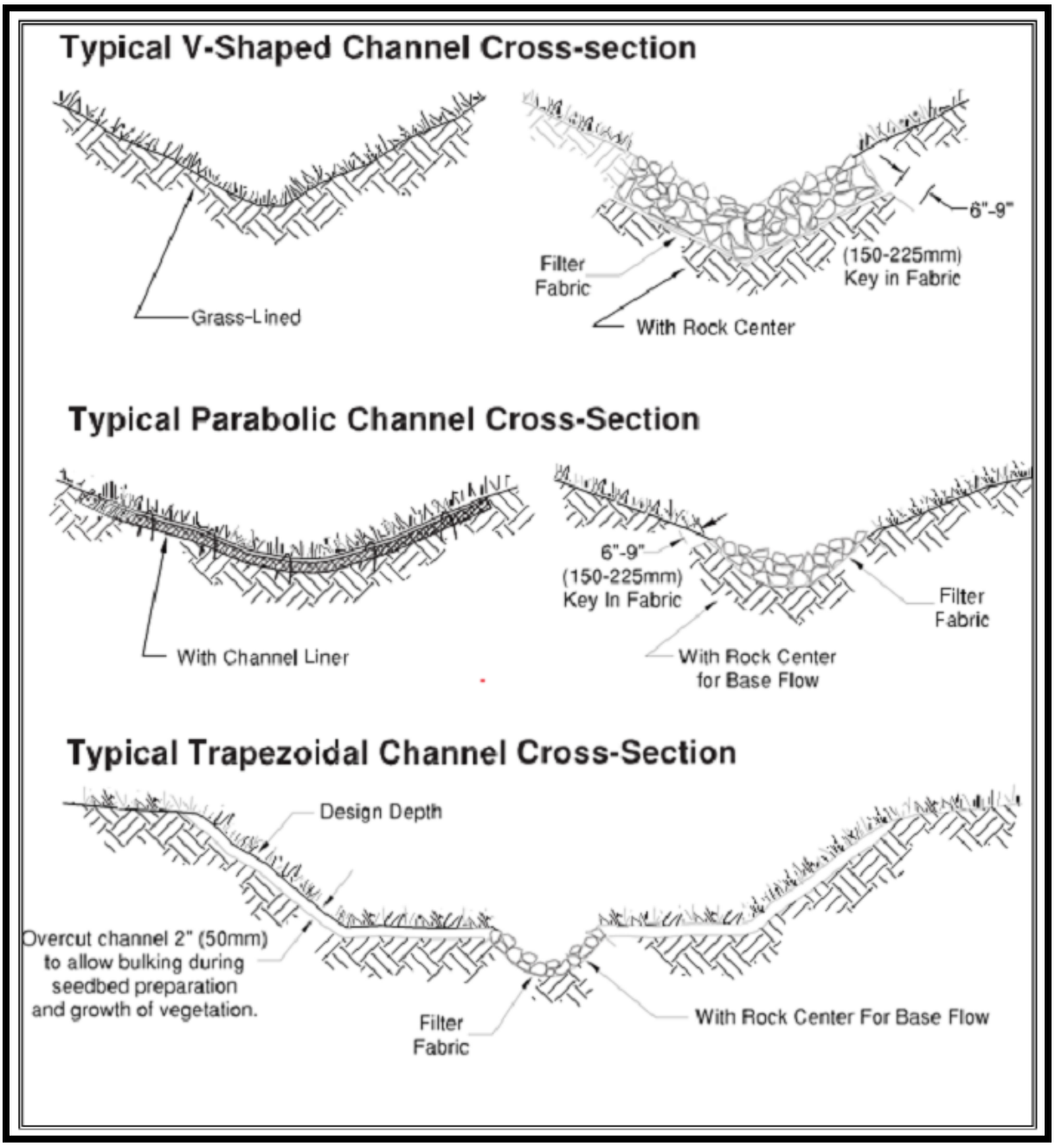


Figure II - 3.7 Typical Grass-Lined Channels

Conditions of Use

This practice applies to construction sites where concentrated runoff needs to be contained to prevent erosion or flooding.

- Use this BMP when a vegetative lining can provide sufficient stability for the channel cross-section and at lower velocities of water (normally dependent on grade). This means that the channel slopes are generally less than 5 percent and space is available for a relatively large cross-section.

- Typical uses include roadside ditches, channels at property boundaries, outlets for diversions, and other channels and drainage ditches in low areas.

- Install channels to be vegetated before major earthwork and hydroseed with a bonded fiber matrix (BFM). The vegetation should be well established (i.e., 75 percent cover) before water is allowed to flow in the ditch. With channels that will have high flows, install erosion control blankets over the hydroseed. (See WSDOT Standard Plan I-60.20-01) If vegetation cannot be established from seed before water is allowed in the ditch, install sod in the bottom of the ditch in lieu of hydromulch and blankets.

Design and Installation Specifications

- Locate the channel where it can conform to the topography and other features such as roads.

- Locate them to use natural drainage systems to the greatest extent possible.

- Avoid sharp changes in alignment or bends and changes in grade.

- Do not reshape the landscape to fit the drainage channel.

- The maximum design velocity shall be based on soil conditions, type of vegetation, and method of revegetation, but at no times shall velocity exceed 5 feet/second. The channel shall not be overtopped by the peak volumetric flow rate calculated by one of the following methods:

    - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the worst-case land cover condition.

    OR

- Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step for the worst-case land cover condition.

Worst-case land cover conditions (i.e., producing the most runoff) should be used for analysis (in most cases, this would be the land cover conditions just prior to final landscaping).

- Where the grass-lined channel will also function as a permanent stormwater conveyance facility the channel must meet the conveyance requirements defined in Volume III, Chapter 3.

- An established grass or vegetated lining is required before the channel can be used to convey stormwater, unless stabilized with nets or blankets.

- If design velocity of a channel to be vegetated by seeding exceeds 2 ft/sec, a temporary channel liner is required. Geotextile or special mulch protection such as fiberglass roving or straw and netting should be used to provide stability until the vegetation is fully established. See Figure II - 3.8.

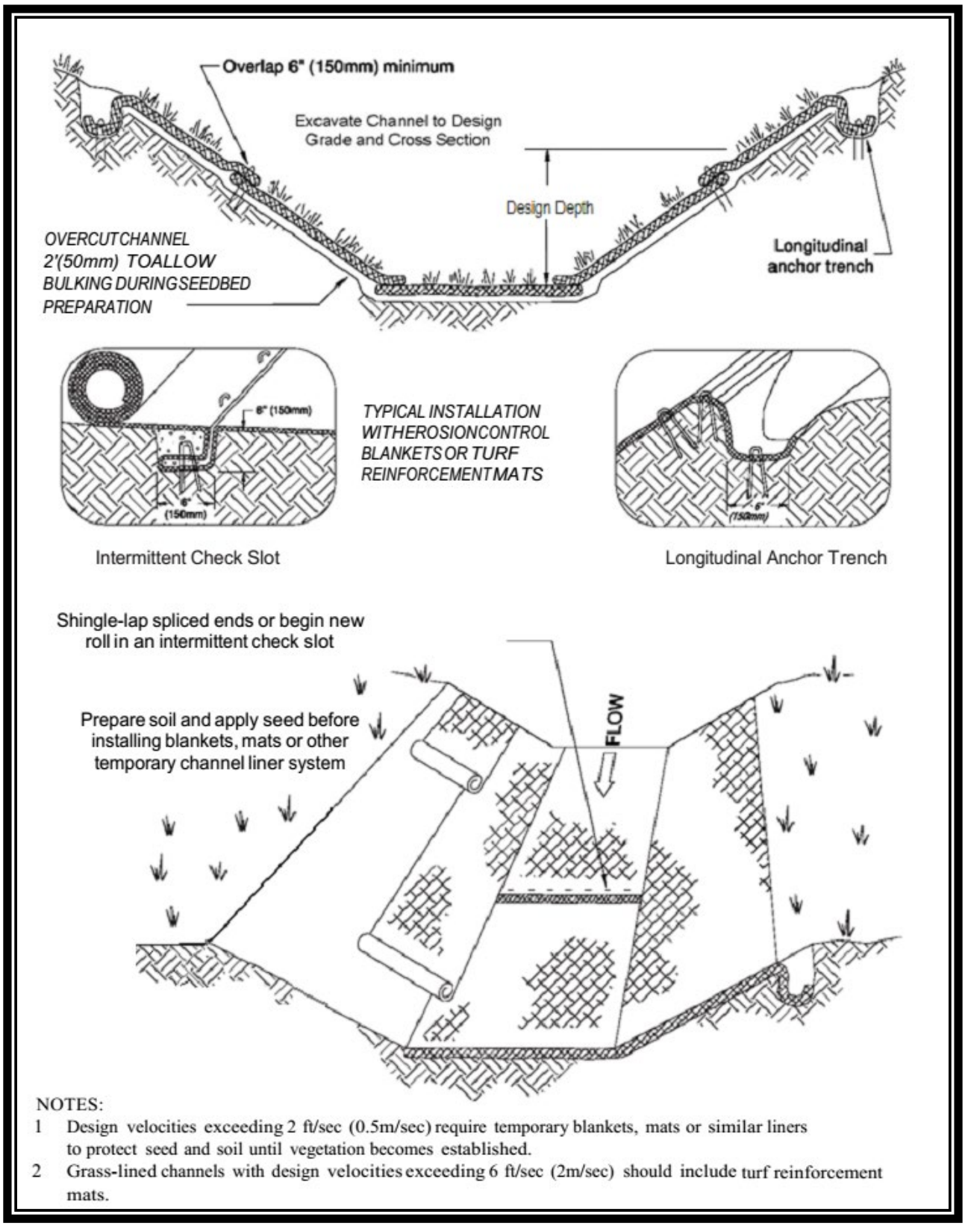


Figure II - 3.8 Temporary Channel Liners

- Remove temporary check dams when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. Seed and mulch the area beneath the check dams immediately after dam removal.

- If vegetation is established by sodding, the permissible velocity for established vegetation may be used and no temporary liner is needed.

- Do not subject grass-lined channel to sedimentation from disturbed areas. Use sediment-trapping BMPs upstream of the channel.

- V-shaped grass channels generally apply where the quantity of water is small, such as in short reaches along roadsides. The V-shaped cross-section is least desirable because it is difficult to stabilize the bottom where velocities may be high.

- Trapezoidal grass channels are used where runoff volumes are large and slope is low so that velocities are non-erosive to vegetated linings. (Note: it is difficult to construct small parabolic shaped channels.)

- Subsurface drainage, or riprap channel bottoms, may be necessary on sites that are subject to prolonged wet conditions due to long duration flows or a high water table.

- Provide outlet protection at culvert ends and at channel intersections.

- Grass channels, at a minimum, shall carry peak runoff for temporary construction drainage facilities from the 10-year, 24-hour storm without eroding. Where flood hazard exists, increase the capacity according to the potential damage.

- Grassed channel side slopes generally are constructed 3H:1V or flatter to aid in the establishment of vegetation and for maintenance.

- Construct channels a minimum of 0.2 foot larger around the periphery to allow for soil bulking during seedbed preparations and sod buildup.

Maintenance Standards

- During the establishment period, check grass-lined channels after every rainfall.

- After grass is established, periodically check the channel; check it after every heavy rainfall event. Make repairs immediately.

- It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes.

- Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel.

BMP C202: Riprap Channel Lining

Purpose

To protect channels by providing a channel liner using riprap.

Conditions of Use

- Use this BMP when natural soils or vegetated stabilized soils in a channel are not adequate to prevent channel erosion.
- Use this BMP when a permanent ditch or pipe system is to be installed and a temporary measure is needed.
- An alternative to riprap channel lining is BMP C122: Nets and Blankets.
- The Federal Highway Administration recommends not using geotextile liners whenever the slope exceeds 10 percent, or the shear stress exceeds 8 lbs./ft^2.

Design and Installation Specifications

- Since riprap is typically used where erosion potential is high, construction must be sequenced so that the riprap is put in place with the minimum possible delay.
- Disturb areas awaiting riprap only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate.
- The designer, after determining the riprap size that will be stable under the flow conditions, shall consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size. The possibility of drainage structure damage by others shall be considered in selecting a riprap size, especially if there is nearby water or a gully in which to toss the stones.
- Stone for riprap shall consist of field stone or quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended. See Section 9-13 of WSDOT's *Standard Specifications for Road, Bridge, and Municipal Construction* (WSDOT, 2016).

- Place a lining of engineering filter fabric (geotextile) between the riprap and the underlying soil surface to prevent soil movement into or through the riprap. Key the geotextile in at the top of the bank.

- Do not use filter fabric on slopes greater than 1-1/2H:1V as slippage may occur. It should be used in conjunction with a layer of coarse aggregate (granular filter blanket) when the riprap to be placed is 12 inches and larger.

Maintenance Standards

Replace riprap as needed.

BMP C203: Water Bars

Purpose

To divert stormwater runoff from the road surface, wheel tracks, or a shallow road ditch by constructing a small ditch or ridge of material diagonally across a road or right-of-way. See Figure II - 3.9

Conditions of Use

- Clearing right-of-way and construction of access for power lines, pipelines, and other similar installations often require long narrow rights-of-way over sloping terrain. Disturbance and compaction promotes gully formation in these cleared strips by increasing the volume and velocity of runoff. Gully formation may be especially severe in tire tracks and ruts. To prevent gullying, runoff can often be diverted across the width of the right-of-way to undisturbed areas by using small predesigned diversions.

- Give special consideration to each individual outlet area, as well as to the cumulative effect of added diversions. Use gravel to stabilize the diversion where significant vehicular traffic is anticipated.

Design and Installation Specifications

- Height: 8-inch minimum measured from the channel bottom to the ridge top.

- Side slope of channel: 2H:1V maximum; 3H:1V or flatter when vehicles will cross.

- Base width of ridge: 6-inch minimum.

- Locate them to use natural drainage systems and to discharge into well vegetated stable areas.

- Guideline for Spacing:

Table II - 3.13 Water Bar Spacing

Slope %	Spacing (ft)
< 5	125
5 - 10	100
10 - 20	75
20 - 35	50
> 35	Use rock lined ditch

- Grade of water bar and angle: Select angle that results in ditch slope less than 2 percent.
- Install as soon as the clearing and grading is complete. Reconstruct when construction is complete on a section when utilities are being installed.
- Compact the ridge when installed.
- Stabilize, seed and mulch the portions that are not subject to traffic. Gravel the areas crossed by vehicles.

Maintenance Standards

- Periodically inspect right-of-way diversions for wear and after every heavy rainfall for erosion damage.
- Immediately remove sediment from the flow area and repair the dike.
- Check outlet areas and make timely repairs as needed.
- When permanent road drainage is established and the area above the temporary right-of-way diversion is permanently stabilized, remove the dikes and fill the channel to blend with the natural ground, and appropriately stabilize the disturbed area.

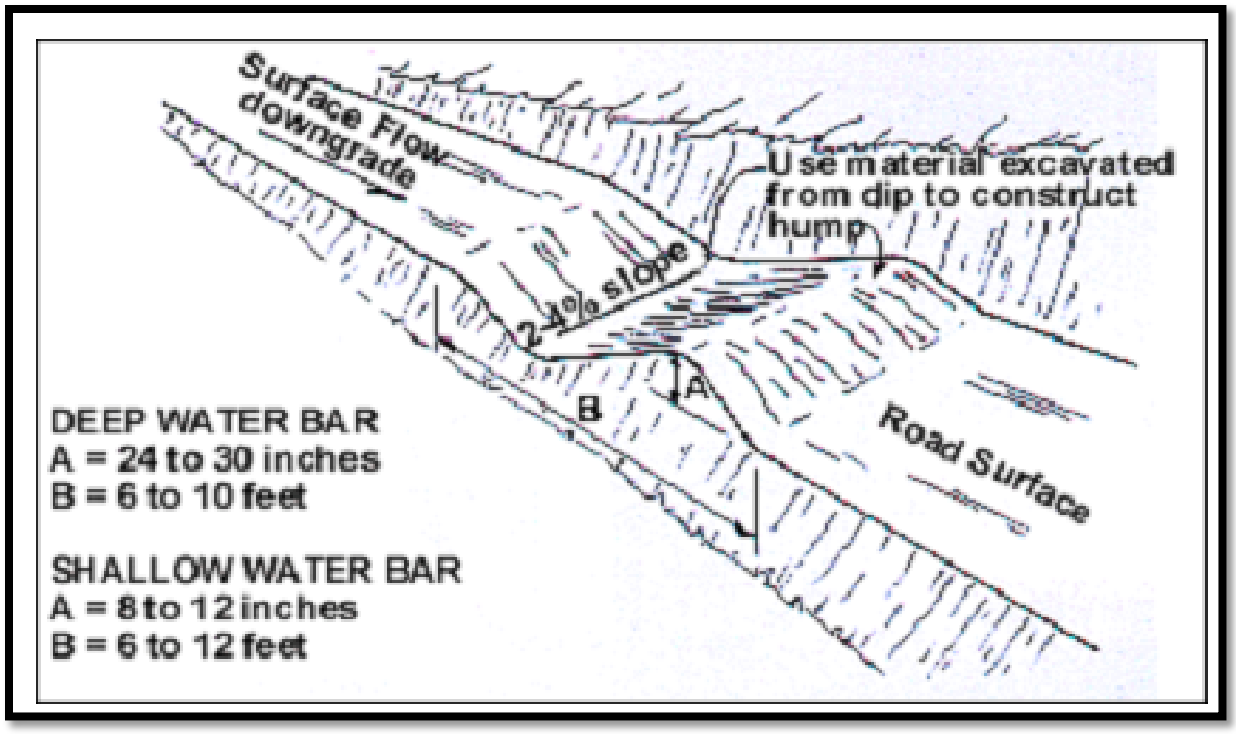


Figure II - 3.9 Water Bar
(Figure courtesy of SWMMWW)

BMP C204: Pipe Slope Drains

Purpose

To use a pipe to convey stormwater when diverting water away from (or over) bare soil to prevent gullies, channel erosion, and saturation of slide-prone soils.

Conditions of Use

Use pipe slope drains when a temporary or permanent stormwater conveyance is needed to move the water down a steep slope to avoid erosion (Figure II - 3.10).

On highway projects, use pipe slope drains at bridge ends to collect runoff and pipe it to the base of the fill slopes along bridge approaches. These can be designed into a project and included as bid items. Another use on road projects is to collect runoff from pavement and pipe it away from side slopes. These are useful because there is generally a time lag between having the first lift of asphalt installed and the curbs, gutters, and permanent drainage installed. Used in conjunction with sandbags, or other temporary diversion devices, these will prevent massive amounts of sediment from leaving a project.

Water can be collected, channeled with sandbags, Triangular Silt Dikes, berms, or other material, and piped to temporary sediment ponds.

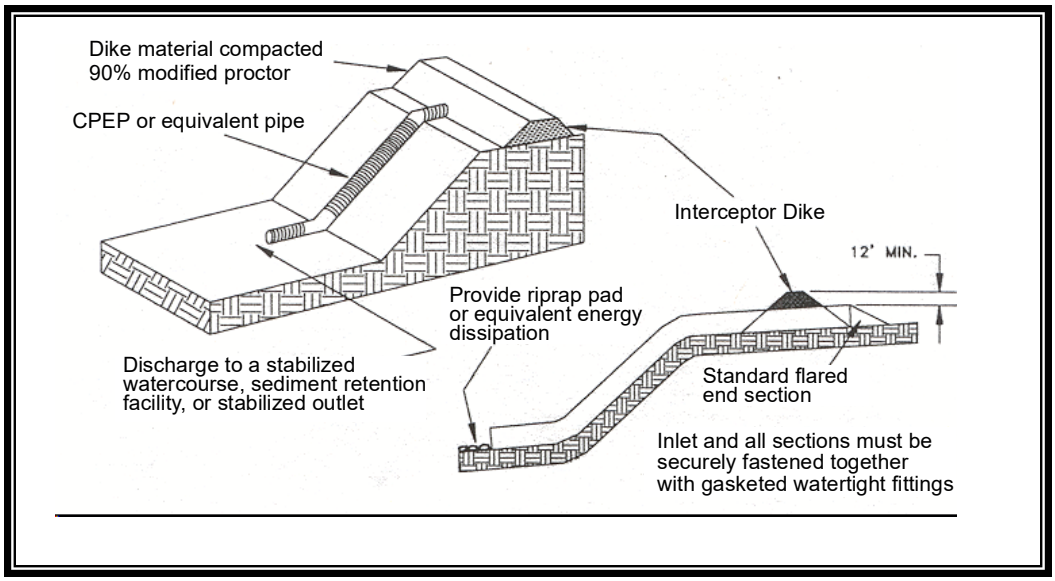


Figure II - 3.10 Pipe Slope Drain

Pipe slope drains can be:

- Connected to new catch basins and used temporarily until all permanent piping is installed;
- Used to drain water collected from aquifers exposed on cut slopes and take it to the base of the slope;
- Used to collect clean runoff from plastic sheeting and direct it away from exposed soil;
- Installed in conjunction with silt fence to drain collected water to a controlled area;
- Used to divert small seasonal streams away from construction. They have been used successfully on culvert replacement and extension jobs. Large flex pipe can be used on larger streams during culvert removal, repair, or replacement; and,
- Connected to existing down spouts and roof drains and used to divert water away from work areas during building renovation, demolition, and construction projects.

There are now several commercially available collectors that are attached to the pipe inlet and help prevent erosion at the inlet.

Design and Installation Specifications

- Size the pipe to convey the flow. The capacity for temporary drains shall be sufficient to handle flows calculated by one of the following methods:

    - Single Event Hydrograph Method: The peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the worst-case land cover condition.

      OR

    - Continuous Simulation Method: The 10-year peak flow rate, as determined by an approved continuous runoff model with a 15-minute time step for the worst-case land cover condition.

Worst-case land cover conditions (i.e., producing the most runoff) should be used for analysis (in most cases, this would be the land cover conditions just prior to final landscaping).

See Volume III, Chapter 3 for sizing requirements for permanent pipe slope drains.

- Use care in clearing vegetated slopes for installation.
- Re-establish cover immediately on areas disturbed by installation.
- Use temporary drains on new cut or fill slopes.
- Use BMP C200: Interceptor Dike and Swale to collect water at the top of the slope.
- Ensure that the entrance area is stable and large enough to direct flow into the pipe.
- Dike material shall be compacted to 90 percent modified proctor to prevent piping of water through the berm. The entrance area is a common failure location.
- The entrance shall 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 shall be at least 3 percent. Sandbags may also be used at pipe entrances as a temporary measure.
- The soil around and under the pipe and entrance section shall be thoroughly compacted to prevent undercutting.

- The flared inlet section shall be securely connected to the slope drain and have watertight connecting bands.

- Slope drain sections shall be securely fastened together, fused or have gasketed watertight fittings, and shall be securely anchored into the soil.

- Install thrust blocks anytime 90 degree bends are used. Depending on size of pipe and flow, these can be constructed with sandbags, straw bales staked in place, “t” posts and wire, or ecology blocks.

- Pipe needs to be secured along its full length to prevent movement. This can be done with steel “t” posts and wire. A post is installed on each side of the pipe and the pipe is wired to them. Do this approximately every 10 to 20 feet of pipe length, depending on the size of the pipe and quantity of water to be diverted.

- BMP C200: Interceptor Dike and Swales shall be used to direct runoff into a slope drain. The height of the dike shall 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 (see BMP C209 Outlet Protection, for the appropriate outlet material).

- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.

- Materials specifications for any permanent piped system are listed in Volume III, Section 3.7.3 and shall be acceptable to the County.

Maintenance Standards

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

- The inlet should be free of undercutting, and no water should be going around the point of entry. If there are problems, reinforce the headwall with compacted earth or sandbags.

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

- For permanent installations, inspect pipe periodically for vandalism and physical distress such as slides and wind-throw.

- Normally the pipe slope is so steep that clogging is not a problem with smooth wall pipe, however, debris may become lodged in the pipe. Remove debris immediately.

BMP C205: Subsurface Drains

Purpose

To intercept, collect, and convey groundwater to a satisfactory outlet, using a perforated pipe or conduit below the ground surface. Subsurface drains are also known as "French drains". The perforated pipe provides a dewatering mechanism to drain excessively wet soils, provide a stable base for construction, improve stability of structures with shallow foundations, and to reduce hydrostatic pressure to improve slope stability.

Conditions of Use

Use subsurface drains when you must remove excessive water from the soil. The soil permeability, depth to water table and impervious layers are all factors which may govern the use of subsurface drains.

Design and Installation Specifications

- **Relief drains** are used either to lower the water table in large, relatively flat areas, improve the growth of vegetation, or to remove surface water.
    - They are installed along a slope and drain in the direction of the slope.
    - They can be installed in a grid pattern, a herringbone pattern, or a random pattern.
- **Interceptor drains** are used to remove excess groundwater from a slope, stabilize steep slopes, and lower the water table immediately below a slope to prevent the soil from becoming saturated.
    - They are installed perpendicular to a slope and drain to the side of the slope.
    - They usually consist of a single pipe or series of single pipes instead of a patterned layout.
- **Depth and spacing of interceptor drains** – The depth of an interceptor drain is determined primarily by the depth to which the water table is to be lowered or the depth to a confining layer. For practical reasons, the maximum depth is usually limited to 6 feet, with a minimum cover of 2 feet to protect the conduit.
    - The soil should have depth and sufficient permeability to permit installation of an effective drainage system at a depth of 2 to 6 feet.

- This standard does not apply to subsurface drains for building foundations or deep excavations.

- **Size of drain** – Size subsurface drains to carry the required capacity without pressure flow. Minimum diameter for a subsurface drain is 4 inches.

  - The quantity and quality of discharge needs to be accounted for in the receiving stream (additional detention may be required).

  - The minimum velocity required to prevent silting is 1.4 ft./sec. The line shall be graded to achieve this velocity at a minimum. The maximum allowable velocity using a sand-gravel filter or envelope is 9 ft/sec.

  - Filter material and fabric shall be used around all drains for proper bedding and filtration of fine materials. Envelopes and filters shall surround the drain to a minimum of 3-inch thickness.

  - The capacity of an interceptor drain is determined by calculating the maximum rate of groundwater flow to be intercepted. Therefore, it is good practice to make complete subsurface investigations, including hydraulic conductivity of the soil, before designing a subsurface drainage system.

  - The trench shall be constructed on a continuous grade with no reverse grades or low spots.

  - Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.

  - Backfilling shall be done immediately after placement of the pipe. No sections of pipe shall remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drain pipe is not displaced or damaged.

  - Do not install permanent drains near trees to avoid the tree roots that tend to clog the line. Use solid pipe with watertight connections where it is necessary to pass a subsurface drainage system through a stand of trees.

- **Outlet** – Ensure that the outlet of a drain empties into a channel or other watercourse above the normal water level.

  - Secure an animal guard to the outlet end of the pipe to keep out rodents.

  - Use outlet pipe of corrugated metal, cast iron, or heavy-duty plastic without perforations and at least 10 feet long. Do not use an envelope

or filter material around the outlet pipe and bury at least two-thirds of the pipe length.

- When outlet velocities exceed those allowable for the receiving stream, outlet protection must be provided.
- The outlet of the subsurface drain shall empty into a sediment trapping BMP through a catch basin. If free of sediment, it can then empty into a receiving channel, swale, or stable vegetated area adequately protected from erosion and undermining.
- An adequate outlet for the drainage system must be available either by gravity or by pumping.

Maintenance Standards

- Check subsurface drains periodically to ensure that they are free-flowing and not clogged with sediment or roots.
- Keep the outlet clean and free of debris.
- Keep the surface inlets open and free of sediment and other debris.
- Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees as a last resort. Plan drain placement to minimize this problem.
- Where drains are crossed by heavy vehicles use steel plate or boards to prevent the lines from being crushed. After work is complete the line shall be checked to ensure that it was not crushed.

BMP C206: Level Spreader

Purpose

To provide a temporary outlet for dikes and diversions, and to convert concentrated runoff to sheet flow prior to releasing it to stabilized areas.

Conditions of Use

- Use a level spreader when a concentrated flow of water needs to be dispersed over a large area with existing stable vegetation.
- Items to consider are:
    1. What is the risk of erosion or damage if the flow may become concentrated?
    2. Is an easement required if discharged to adjoining property?
- Use only where the slopes are gentle, the water volume is relatively low, and the soil will adsorb most of the low flow events.

Design and Installation Specifications

- Use above undisturbed areas that are stabilized by existing vegetation.
- Do not allow any low points in the level spreader. If the level spreader has any low points, flow will concentrate, create channels and may cause erosion.
- Discharge area below the outlet must be uniform with a slope of less than 5H:1V.
- Ensure the outlet is level in a stable, undisturbed soil profile (not on fill).
- The runoff shall not re-concentrate on site after release from the level spreader unless intercepted by another downstream measure.
- The grade of the channel for the last 20 feet of the dike or interceptor entering the level spreader shall be less than or equal to 1 percent. The grade of the level spreader shall be 0 percent to ensure uniform spreading of storm runoff.
- Place a 6-inch high gravel berm across the level lip consisting of washed crushed rock, 2- to 4-inch or 3/4-inch to 1½-inch size.
- The spreader length shall be determined by estimating the peak volumetric flow rate using a 10-minute time step from a Type 1A, 10-year,

24-hour design storm. The length of the spreader shall be a minimum of 15 feet for 0.1 cfs and shall increase by 10 feet for each 0.1 cfs thereafter to a maximum of 0.5 cfs per spreader. Use multiple spreaders for higher flows.

- The width of the approach to the spreader should be at least 6 feet.
- The depth of the spreader as measured from the lip shall be at least 6 inches and it should be uniform across the entire length.
- Level spreaders shall be setback 100 feet minimum from the property line unless there is an easement for flow, or the flow is directed to a natural drainage course.
- Level spreaders, when installed every so often in grassy swales, keep the flows from concentrating. Materials that can be used include sandbags, lumber, plastic lumber, logs, concrete, and pipe. To function properly, the material needs to be installed level and on contour. Figure II - 3.10 and Figure II - 3.11 provide a cross-section and a detail of a level spreader. A capped perforated pipe can also be used as a spreader.

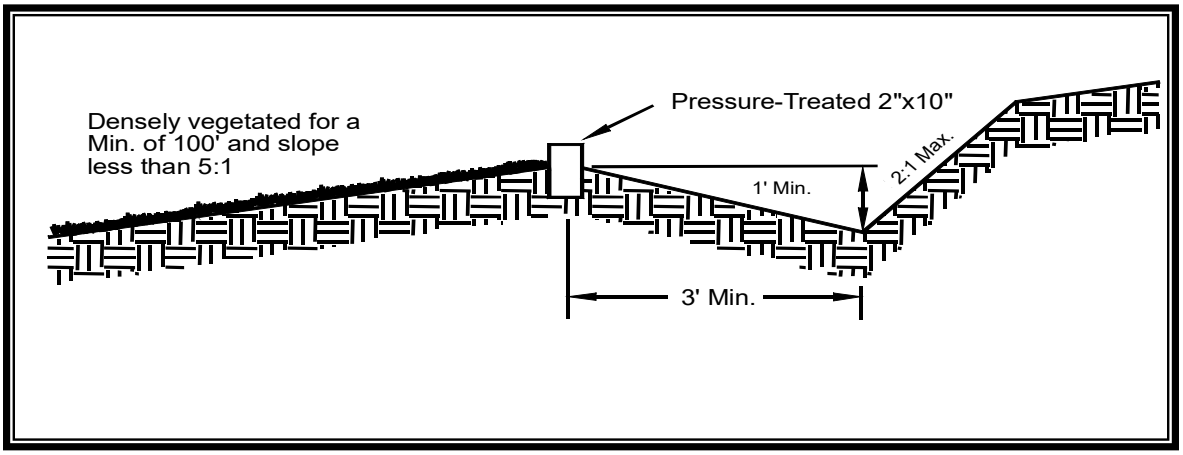


Figure II - 3.11 Cross-Section of Level Spreader

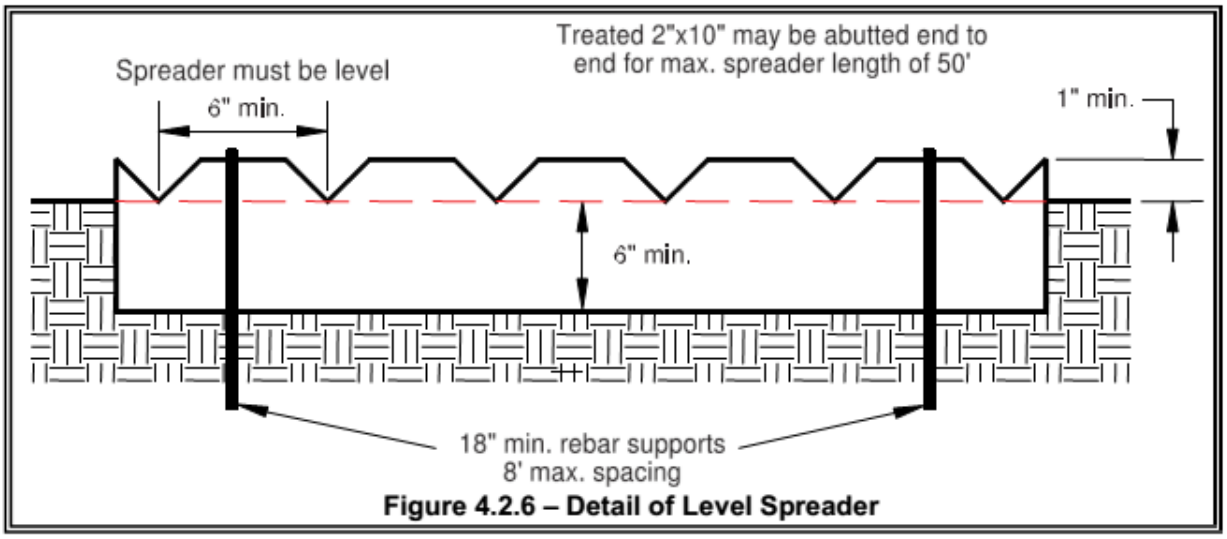


Figure II - 3.12 Detail of Level Spreader

Maintenance Standards

- Inspect the spreader during and after runoff events to ensure that it is functioning correctly.
- The contractor should avoid the placement of any material on the level spreader and should prevent construction traffic from crossing over the level spreader.
- If the level spreader is damaged by construction traffic, it shall be immediately repaired.

BMP C207: Check Dams

Purpose

Construction of check dams across a swale or ditch are used to reduce the velocity of concentrated flow and dissipate energy at the check dam.

Conditions of Use

- Use check dams where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, and velocity checks are required.
- Check dams may not be placed in streams unless approved by the State Department of Fish and Wildlife. Check dams may not be placed in wetlands without approval from Thurston County and/or another applicable permitting agency.
- Do not place check dams below the expected backwater from any salmonid bearing water between October 1 and May 31 to ensure that there is no loss of high flow refuge habitat for overwintering juvenile salmonids and emergent salmonid fry.

Design and Installation Specifications

- Whatever material is used, the dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom.

- Before installing check dams impound and bypass upstream water flow away from the work area. Options for bypassing include pumps, siphons, or temporary channels.

- Check dams in association with sumps work more effectively at slowing flow and retaining sediment than just a check dam alone. Provide a deep sump immediately upstream of the check dam.

- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to prevent further sediment from leaving the site.

- Construct rock check dams with appropriately sized rock. Place the rock by hand or by mechanical means (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges. The rock used must be large enough to stay in place given the expected design flow through the channel.

- Check dams may also be constructed of either rock or pea-gravel filled bags. Numerous new products are also available for this purpose. They tend to be re-usable, quick and easy to install, effective, and cost efficient.

- Place check dams perpendicular to the flow of water.

- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

- Keep the maximum height at 2 feet at the center of the dam.

- Keep the center of the check dam at least 12 inches lower than the outer edges at natural ground elevation.

- Keep the side slopes of the check dam at 2:1 or flatter.

- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the dam.

- Use filter fabric foundation under a rock or sandbag check dam. If a blanket ditch liner is used, this is not necessary. A piece of organic or synthetic blanket cut to fit will also work for this purpose.

- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale – unless the slope of the swale is

greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

- Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones. Figure II - 3.13 depicts a typical rock check dam.

Maintenance Standards

- Check dams shall be monitored for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the sump depth.

- Anticipate submergence and deposition above the check dam and erosion from high flows around the edges of the dam.

- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel.

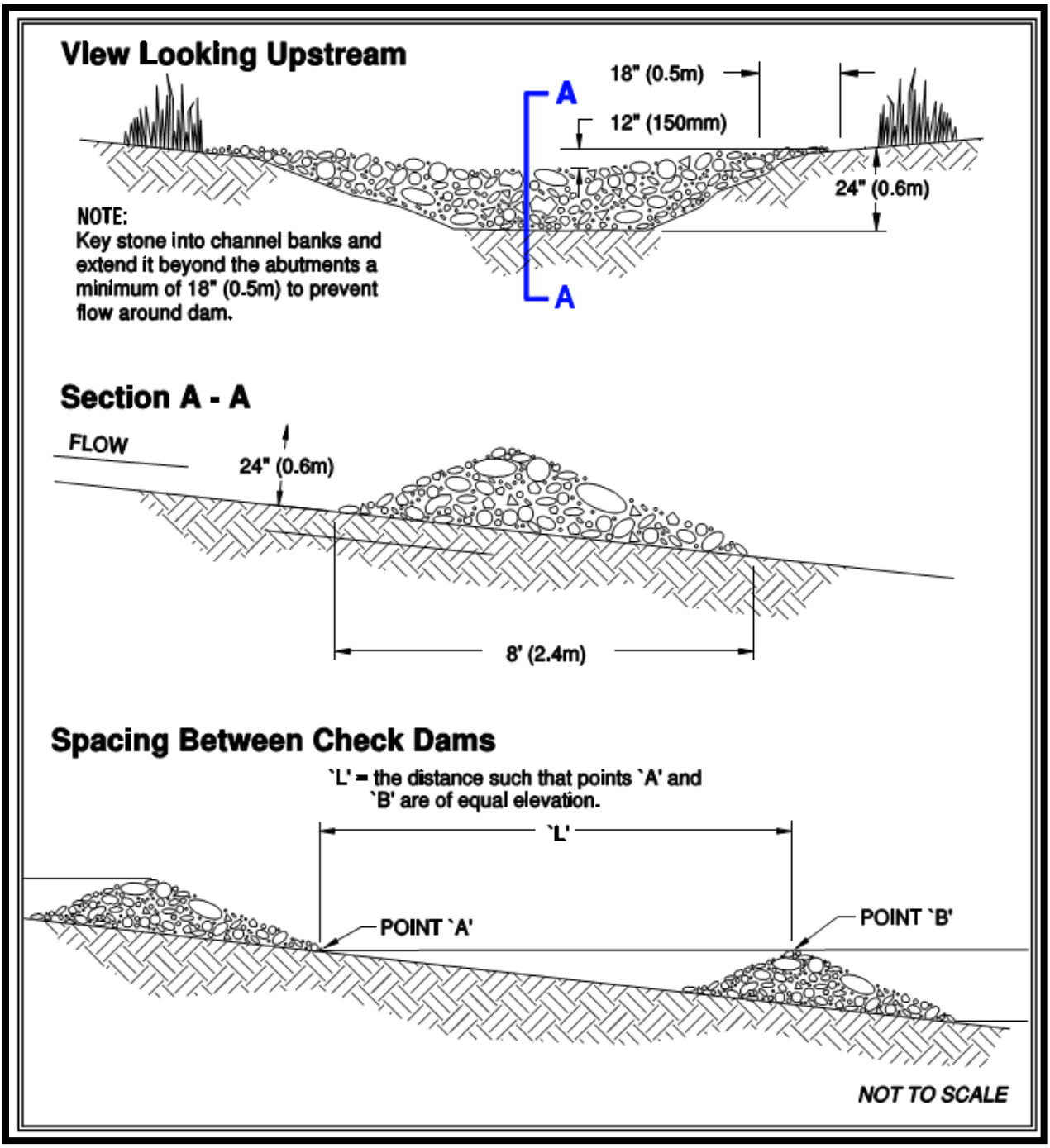


Figure II - 3.13 Check Dams

BMP C208: Triangular Silt Dike (Geotextile-Encased Check Dam)

Purpose

Triangular silt dikes (TSDs) may be used as check dams, for perimeter protection, for temporary soil stockpile protection, for drop inlet protection, or as a temporary interceptor dike.

Conditions of Use

- TSDs may be used on soil or pavement with adhesive or staples.
- TSDs have been used to build temporary:
    1. BMP C241: Temporary Sediment Pond
    2. BMP C200: Interceptor Dike and Swale;
    3. BMP C154: Concrete Washout Area;
    4. Curbing; and
    5. Berms.

Design and Installation Specifications

- TSDs are typically made of urethane foam sewn into a woven geosynthetic fabric.
- TSDs are triangular, 10 inches to 14 inches high in the center, with a 20-inch to 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 allows attachment of additional sections as needed.

- 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 shall be No. 11 gauge wire and shall be 200 mm to 300 mm (8 in to 12 in) in length.
- When multiple units are installed, the sleeve of fabric at the end of the unit shall overlap the abutting unit and be stapled.
- When used as check dams:
    - TSDs should be located and installed as soon as construction will allow.
    - TSDs should be placed perpendicular to the flow of water.
    - The leading edge of the TSD must be secured with rocks, sandbags, or a small key slot and staples.
    - In the case of grass-lined ditches and swales, check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal.

Maintenance Standards

- Inspect TSDs for performance and sediment accumulation during and after each runoff producing rainfall. Sediment shall be removed when it reaches one half the height of the dam.
- Anticipate submergence and deposition above the triangular silt dam and erosion from high flows around the edges of the TSD. Immediately repair any damage or any undercutting of the dam.

BMP C209: Outlet Protection

Purpose

To prevent scour at conveyance outlets and minimize the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

Conditions of Use

Outlet protection is required at the outlets of all ponds, pipes, ditches, or other conveyances that discharge to a natural or man-made drainage feature such as a stream, wetland, lake, or ditch.

Design and Installation Specifications

- The receiving channel at the outlet of a pipe shall be protected from erosion by lining a minimum of 6 feet downstream and extending up the channel sides a minimum of 1 foot above the maximum tailwater elevation or 1 foot above the crown, whichever is higher. For large pipes (more than 18 inches in diameter), the outlet protection lining of the channel is lengthened to four times the diameter of the outlet pipe.

- Standard wingwalls, and tapered outlets and paved channels should also be considered when appropriate for permanent culvert outlet protection. (See WSDOT Hydraulic Manual, available through WSDOT Engineering Publications, or on-line.)

- BMP C122: Nets and Blankets or BMP 202: Riprap Channel Lining provide suitable options for lining materials.

- With low flows, BMP C201: Grass-Lined Channels can be effective.

- The following guidelines shall be used for riprap outlet protection:

    1. If the discharge velocity at the outlet is less than 5 fps (pipe slope less than 1 percent), use 2-inch to 8-inch riprap. Minimum thickness is 1 foot.

    2. For 5 to 10 fps discharge velocity at the outlet (pipe slope less than 3 percent), use 24-inch to 4-foot riprap. Minimum thickness is 2 feet.

    3. For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), an engineered energy dissipater shall be used.

    4. Filter fabric or erosion control blankets shall always be used under riprap to prevent scour and channel erosion.

- New pipe outfalls can provide an opportunity for low-cost fish habitat improvements. For example, an alcove of low-velocity water can be created by constructing the pipe outfall and associated energy dissipater back from the stream edge and digging a channel, over-widened to the upstream side, from the outfall. Overwintering juvenile and migrating adult salmonids may use the alcove as shelter during high flows. Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. This work may require a HPA from WDFW. See Volume III for more information on outfall system design.

Maintenance Standards

- Inspect and repair as needed.

- Add rock as needed to maintain the intended function.

- Clean energy dissipater if sediment builds up.

BMP C220: Storm Drain Inlet Protection

Purpose

Inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of a disturbed area.

Conditions of Use

Use this BMP where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area. Provide protection for all storm drain inlets downslope and within 500 feet of a disturbed or construction area, unless the runoff that enters the catch basin will be conveyed to a sediment trapping BMP. Inlet protection may be used anywhere to protect the drainage system. It is likely that the drainage system will still require cleaning.

Also consider inlet protection for lawn and yard drains on new home construction. These small and numerous drains coupled with lack of gutters in new home construction can add significant amounts of sediment into the roof drain system. If possible delay installing lawn and yard drains until just before landscaping or cap these drains to prevent sediment from entering the system until completion of landscaping. Provide 18-inches of sod around each finished lawn and yard drain.

Table II - 3.14 lists several options for inlet protection. All of the methods for storm drain inlet protection are prone to plugging and require a high frequency of maintenance. Limit contributing drainage areas for an individual inlet to 1 acre or less. If possible, provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

For projects where the final lift of asphalt or concrete will not be completed for a period of time, an asphalt taper shall be constructed around the storm drain inlet frame. Where

weepholes are required, the pipe shall be placed in the center of the catch basin filter and extended beyond the taper.

Table II - 3.14 Storm Drain Inlet Protection

Type of Inlet Protection	Emergency Overflow	Applicable for Paved/Earthen Surfaces	Conditions of Use
Drop Inlet Protection			
Excavated drop inlet protection	Yes, temporary flooding will occur	Earthen	Applicable for heavy flows. Easy to maintain. Large Area Requirement: 30' X 30'/acre.
Block and gravel drop inlet protection	Yes	Paved or Earthen	Applicable for heavy concentrated flows. Will not pond.
Gravel and wire drop inlet protection	No		Applicable for heavy concentrated flows. Will pond. Can withstand traffic.
Catch basin filters	Yes	Paved or Earthen	Frequent maintenance required.
Curb Inlet Protection			
Curb inlet protection with a wooden weir	Small capacity overflow	Paved	Used for sturdy, more compact installation.
Block and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap			18 month expected life.

Design and Installation Specifications

Excavated Drop Inlet Protection – An excavated impoundment around the storm drain inlet. Sediment settles out of the stormwater prior to entering the storm drain. Design and installation specifications for excavated drop inlet protection include:

- Provide a depth 1 to 2 feet as measured from the crest of the inlet structure.
- Slope sides of excavation no steeper than 2H:1V.
- Minimum volume of excavation 35 cubic yards.
- Shape the excavation to fit site, with longest dimension oriented toward the longest inflow area.
- Install provisions for draining to prevent standing water problems.
- Clear the area of all debris.
- Grade the approach to the inlet uniformly.

- Drill weep holes into the side of the inlet.
- Protect weep holes with screen wire and washed aggregate.
- Seal weep holes when removing structure and stabilizing area.
- It may be necessary to build a temporary dike to the down slope side of the structure to prevent bypass flow.

Block and Gravel Filter – A barrier formed around the storm drain inlet with standard concrete blocks and gravel. See Figure II - 3.14. Design and installation specifications for block gravel filters include:

- Provide a height of 1 to 2 feet above inlet.
- Recess the first row of blocks 2-inches into the ground for stability.
- Support subsequent courses by placing a 2x4 through the block opening.
- Do not use mortar
- Lay some blocks in the bottom row on their side for dewatering the pool.
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings.
- Place gravel just below the top of blocks on slopes of 2H:1V or flatter.
- An alternative design is a gravel berm surrounding the inlet, as follows:
  - Provide a slope of 3H:1V on the upstream side of the berm.
  - Provide a slope of 2H:1V on the downstream side of the berm.
  - Provide a 1-foot wide level stone area between the gravel berm and the inlet.
  - Use stones 3 inches in diameter or larger on the upstream slope of the berm.
  - Use gravel ½ - to ¾-inch at a minimum thickness of 1-foot on the downstream slope of the berm.

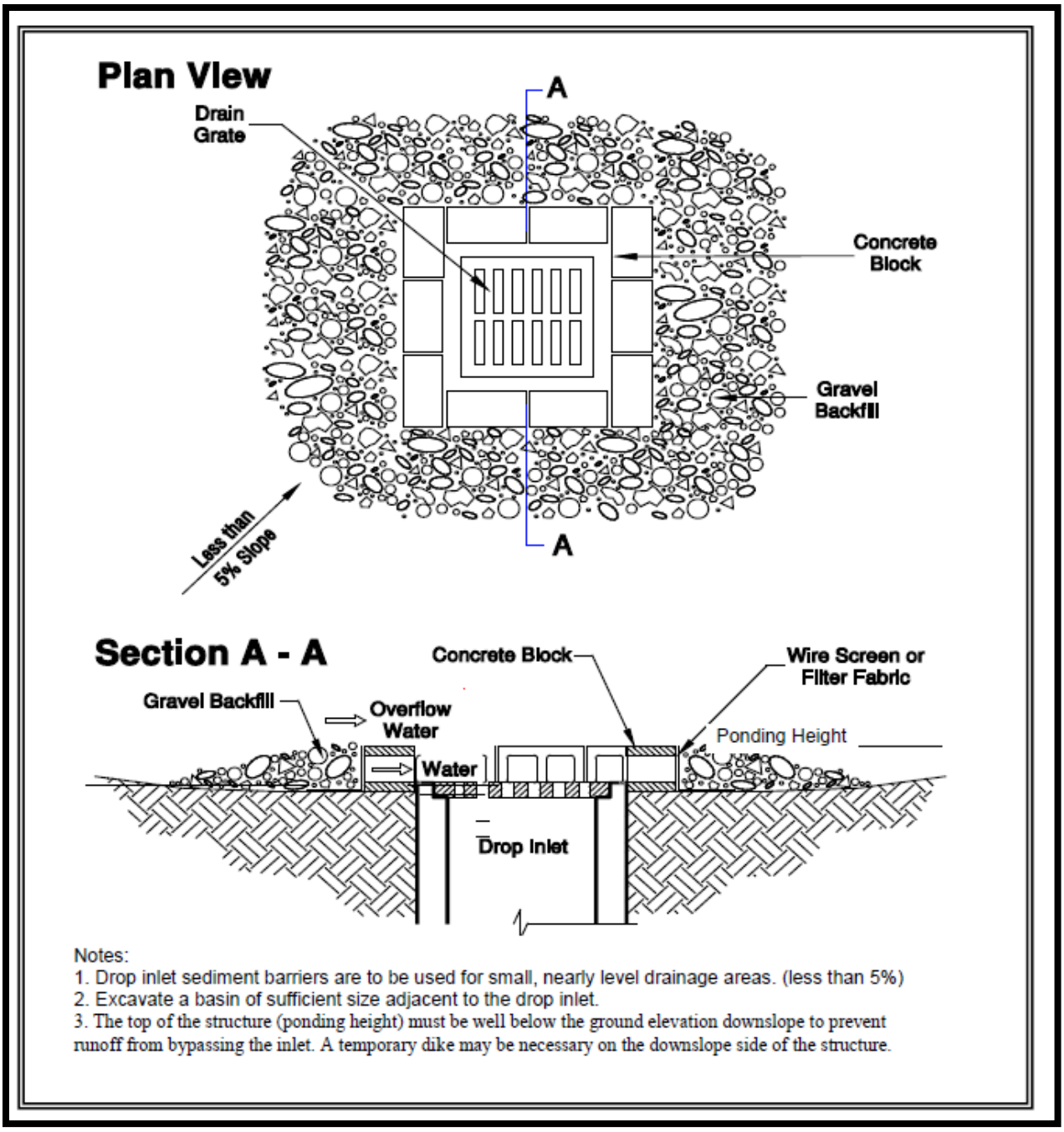


Figure II - 3.14 Block and Gravel Filter

Gravel and Wire Mesh Filter- A gravel barrier placed over the top of the inlet. This method does not provide an overflow. Design and installation specifications for gravel and wire mesh filters include:

- Use a hardware cloth or comparable wire mesh with ½-inch openings.
    - Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure.

  - Overlap the strips if more than one strip of mesh is necessary.

- Place coarse aggregate over the wire mesh.

  - Provide at least a 12-inch depth of coarse aggregate over the entire inlet opening and extend at least 18-inches on all sides.

Catch Basin Filters – Use inserts designed by manufacturers for construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. To reduce maintenance requirements, combine a catch basin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way. Design and installation specifications for catch basin filters include:

- Provides 5 cubic feet of storage.
- Requires dewatering provisions.
- Provides a high-flow bypass that will not clog under normal use at a construction site.
- Insert the catch basin filter in the catch basin just below the grating.

Curb Inlet Protection with Wooden Weir – Barrier formed around a curb inlet with a wooden frame and gravel. Design and installation specifications for curb inlet protection with wooden weirs include:

- Use wire mesh with 1/2-inch openings.
- Use extra strength filter cloth.
- Construct a frame.
- Attach the wire and filter fabric to the frame.
- Pile coarse washed aggregate against wire/fabric.
- Place weight on frame anchors.
- See Figure II - 3.15

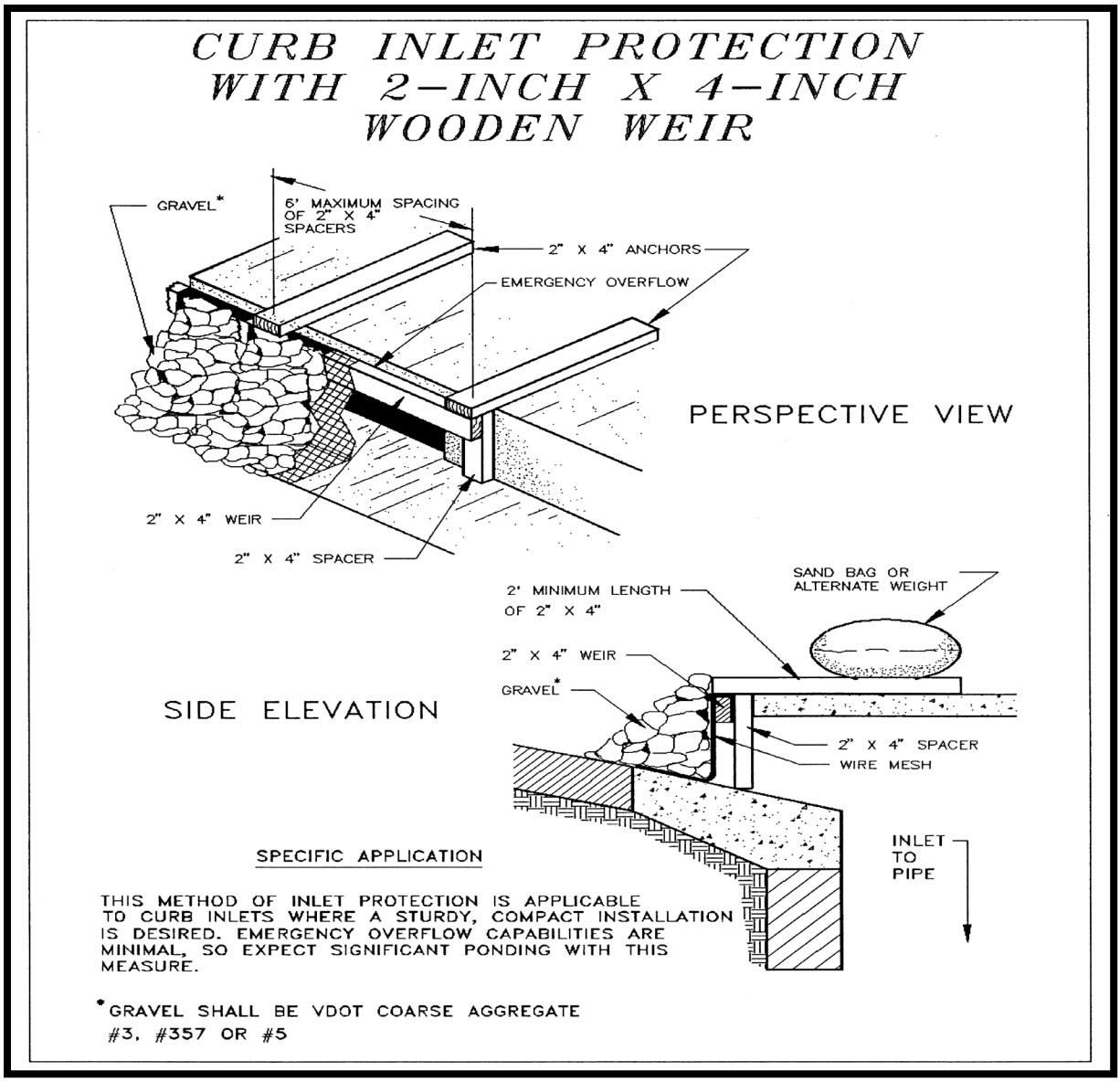


Figure II - 3.15 Curb Inlet with Wooden Weir
(Figure courtesy of Maryland Standards and Specifications for Soil Erosion and Sediment Control)

Block and Gravel Curb Inlet Protection – Barrier formed around a curb inlet with concrete blocks and gravel. See Figure II - 3.16. Design and installation specifications for block and gravel curb inlet protection include:

- Use wire mesh with ½-inch openings.
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks.
- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks.

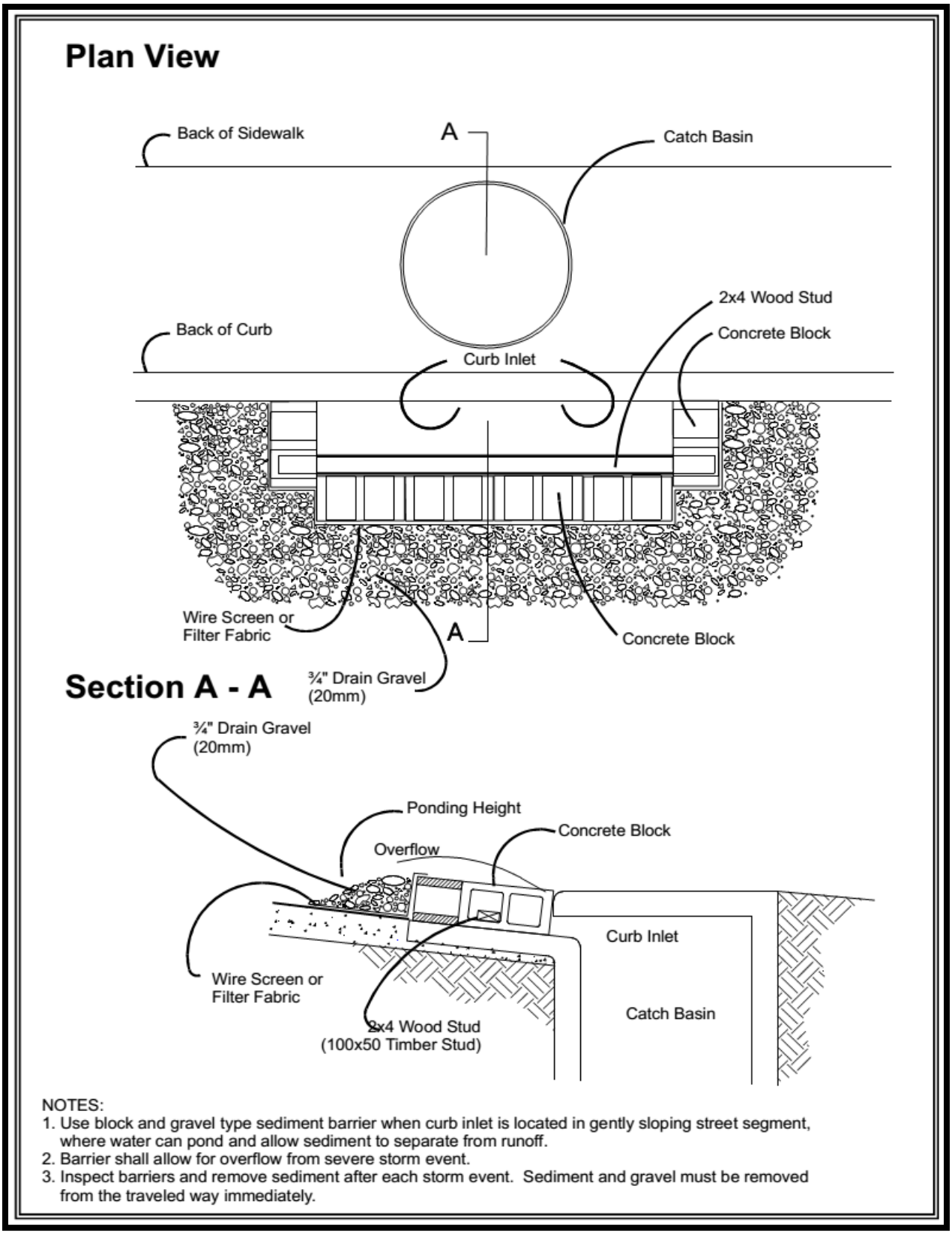
- Place blocks on their sides across the front of the inlet and abutting the spacer blocks.
- Place wire mesh over the outside vertical face.
- Pile coarse aggregate against the wire to the top of the barrier.

Curb and Gutter Sediment Barrier – Sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape. See Figure II - 3.17. Design and installation specifications for curb and gutter sediment barrier include:

- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet.
- Construct a horseshoe shaped sedimentation trap on the upstream side of the berm. Size the sediment trap to sediment trap standards for protecting a culvert inlet.

Maintenance Standards

- Inspect all forms of inlet protection frequently, especially after storm events. If the insert becomes clogged, it should be cleaned or replaced.
- For systems using stone filters: If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate.



NOTES:
1. Use block and gravel type sediment barrier when curb inlet is located in gently sloping street segment, where water can pond and allow sediment to separate from runoff.
2. Barrier shall allow for overflow from severe storm event.
3. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Figure II - 3.16 Block and Gravel Curb Inlet Protection

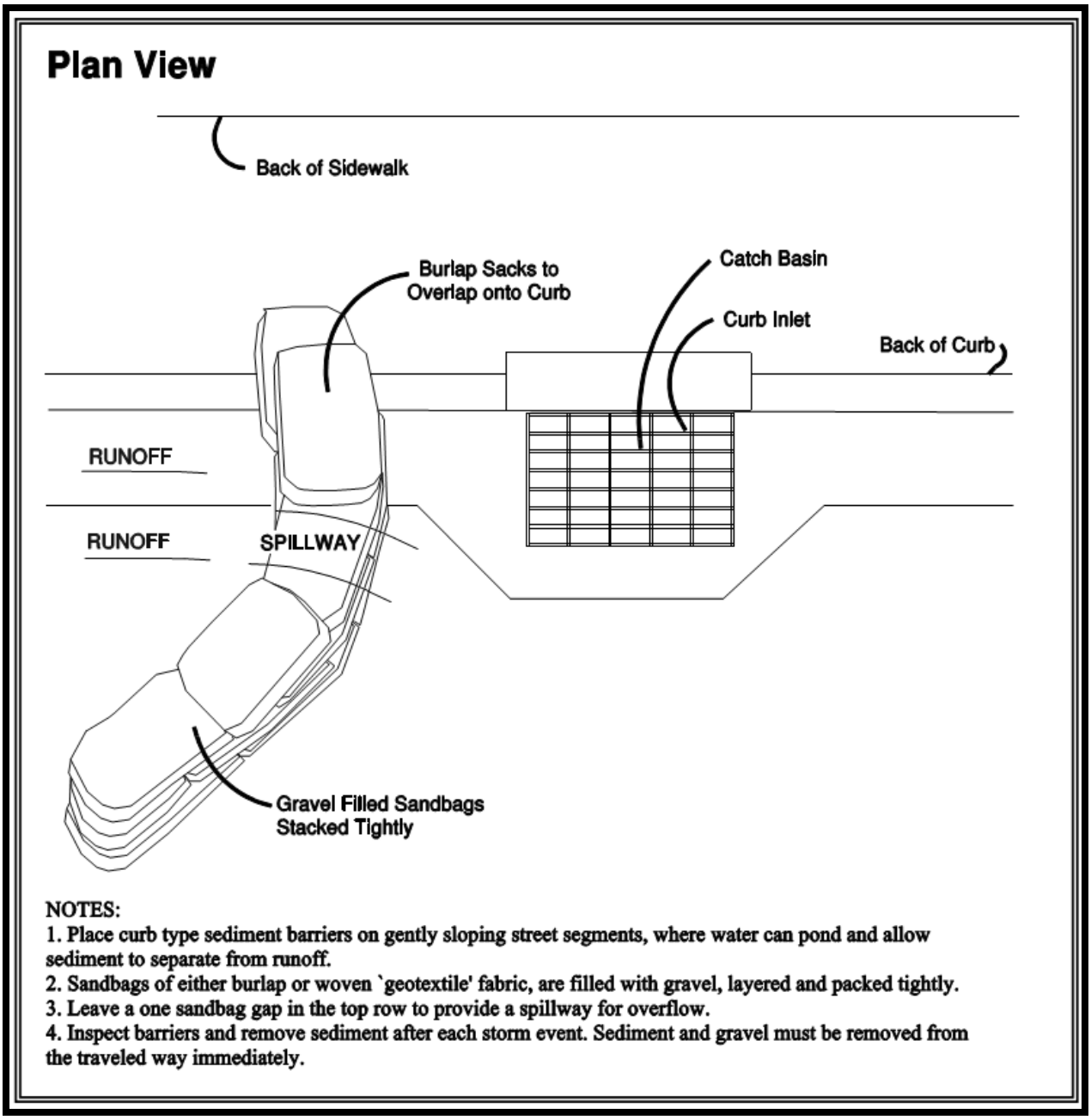


Figure II - 3.17 Curb and Gutter Barrier

BMP C231: Brush Barrier

Purpose

To reduce the transport of course sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

- Brush barriers may be used downslope of all disturbed area of less than one-quarter acre.
- Brush barriers are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a brush barrier, rather than a sediment pond, is when the area draining to the barrier is small.
- Brush barriers should only be installed on contours.

Design and Installation Specifications

- Height: 2 feet (minimum) to 5 feet (maximum).
- Width: 5 feet at base (minimum) to 15 feet (maximum)
- Filter fabric (geotextile) may be anchored over the brush berm to enhance the filtration ability of the barrier. Ten-ounce burlap is an adequate alternative to filter fabric.
- Chipped site vegetation, composted mulch, or wood-based mulch (hog fuel) can be used to construct brush barriers.
- A 100 percent biodegradable installation can be constructed using 10-ounce burlap held in place by wooden stakes. Figure II - 3.18 depicts a typical brush barrier.

Maintenance Standards

- There shall be no signs of erosion or concentrated runoff under or around the barrier. If concentrated flows are bypassing the barrier, it must be expanded or augmented by toed-in filter fabric.
- The dimensions of the barrier must be maintained.

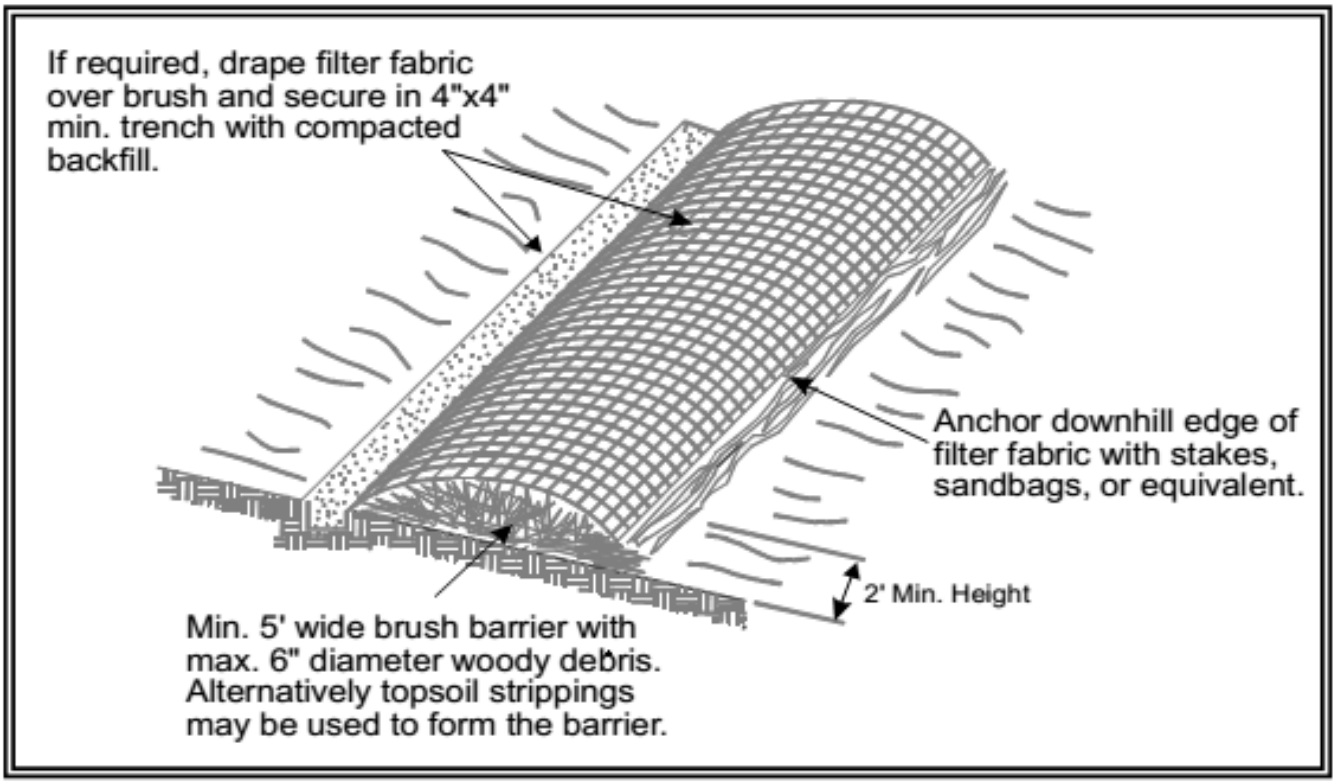


Figure II - 3.18 Brush Barrier

BMP C232: Gravel Filter Berm

Purpose

To retain sediment by filtering runoff through a berm of gravel or crushed rock.

Conditions of Use

- Use a gravel filter berm where temporary measures are needed to retain sediment from construction sites.
- Do not place gravel filter berms in traffic areas; gravel filter berms are not intended to be driven over.
- Place gravel filter berms perpendicular to the flow of runoff, such that the runoff will filter through the berm prior to leaving the site.

Design and Installation Specifications

- Berm material shall be ¾ to 3 inches in size, washed well-graded gravel or crushed rock with less than 5 percent fines (% passing the 200 sieve). Do not use crushed concrete.
- Spacing of berms:
    - Every 300 feet on slopes less than 5 percent.
    - Every 200 feet on slopes between 5 percent and 10 percent.
    - Every 100 feet on slopes greater than 10 percent.
- Berm dimensions:
    - 1 foot high with 3H:1V side slopes
    - 8 linear feet per 1 cfs runoff based on the 10-year, 24-hour design storm.

Maintenance Standards

- Regular inspection is required.
- Sediment shall be removed, and filter material replaced as needed.

BMP C233: Silt Fence

Purpose

To reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure II - 3.19 for details on silt fence construction.

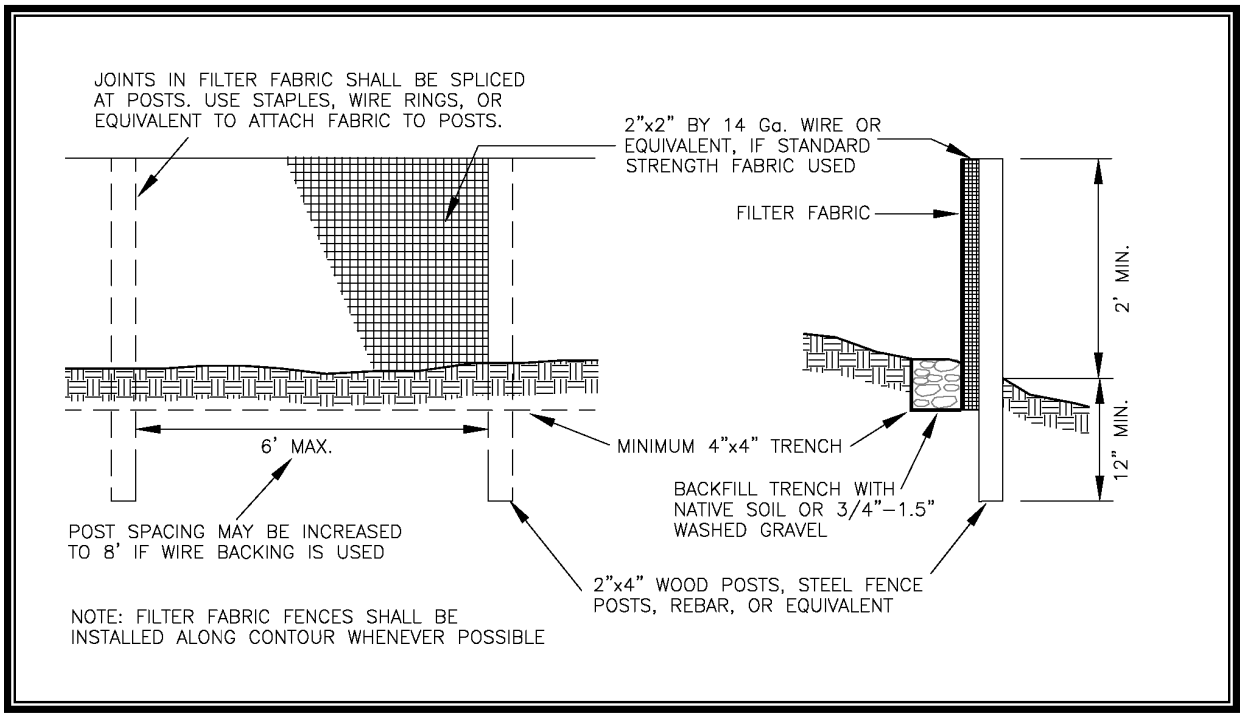


Figure II - 3.19 Silt Fence

Conditions of Use

- Silt fence may be used downslope of all disturbed areas.
- Silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.
- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Convey any concentrated flows through the drainage system to a sediment pond.
- Silt fences should not be constructed in streams or use in V-shaped ditches. They are not an adequate method of silt control for anything deeper than sheet or overland flow.

Design and Installation Specifications

- Use in combination with other construction stormwater BMPs.

- Maximum slope steepness (perpendicular to the silt fence line) 1H:1V.
- Maximum sheet or overland flow path length to the silt fence of 100 feet.
- Do not allow flows greater than 0.5 cfs.
- The geotextile used for filter fabric shall meet the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in Table II - 3.15):

Table II - 3.15 Geotextile Standards

Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for slit film wovens (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve).
Water Permittivity (ASTM D4491)	0.02 sec^{-1} minimum
Grab Tensile Strength (ASTM D4632)	180 lbs. Minimum for extra strength fabric. 100 lbs minimum for standard strength fabric.
Grab Tensile Strength (ASTM D4632)	30% maximum
Ultraviolet Resistance (ASTM D4355)	70% minimum

- Support standard strength fabrics with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the fabric. Silt fence materials are available that have synthetic mesh backing attached.
- Silt fence material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F. to 120°F.
- 100 percent biodegradable silt fence is available that is strong, long lasting, and can be left in place after the project is completed.
- Include the following Standard Notes for silt fence on construction plans and specifications. Refer to Figure II - 3.19 for standard silt fence details.

    1. The contractor shall install and maintain temporary silt fences at the locations shown in the Plans.
    2. Silt fences shall be constructed in the areas of clearing, grading, or drainage prior to starting those activities.

3. The silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to pass through the fence.

4. The minimum height of the top of silt fence shall be 2 feet and the maximum height shall be 2-1/2 feet above the original ground surface.

5. The geotextile shall be sewn together at the point of manufacture, or at an approved location as determined by the Engineer, to form geotextile lengths as required. All sewn seams shall be located at a support post. Alternatively, two sections of silt fence can be overlapped, provided the Contractor can demonstrate, to the satisfaction of the Engineer, that the overlap is long enough and that the adjacent fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.

6. The geotextile shall be attached on the up-slope side of the posts and support system with staples, wire, or in accordance with the manufacturer's recommendations. The geotextile shall be attached to the posts in a manner that reduces the potential for geotextile tearing at the staples, wire, or other connection device.

7. Silt fence back-up support for the geotextile in the form of a wire or plastic mesh is dependent on the properties of the geotextile selected for use. If wire or plastic back-up mesh is used, the mesh shall be fastened securely to the up-slope side of the posts with the geotextile being up-slope of the mesh back-up support.

8. Mesh support, if used, shall consist of steel wire with a maximum mesh spacing of 2-inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 lbs. grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the filter fabric it supports.

9. The geotextile at the bottom of the fence shall be buried in a trench to a minimum depth of 4 inches below the ground surface. The trench shall be backfilled, and the soil tamped in place over the buried portion of the geotextile, such that no flow can pass beneath the fence and scouring cannot occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the trench a minimum of 3 inches.

10. Drive or place the fence posts a minimum of 18 inches into the ground. A minimum depth of 12 inches is allowed if topsoil or other

soft subgrade soil is not present and a minimum depth of 18 inches cannot be reached. Fence post depths shall be increased by 6 inches if the fence is located on slopes of 3H:1V or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.

11. Silt fences shall be located on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.

12. If the fence must cross contours, with the exception of the ends of the fence, check dams placed perpendicular to the back of the fence shall be used to minimize concentrated flow and erosion along the back of the fence. The slope of the fence line where contours must be crossed shall not be steeper than 3:1.

    - The check dams shall be approximately 1 foot deep at the back of the fence. It shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence.

    - The l check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. The gravel check dams shall be located every 10 feet along the fence where the fence must cross contours.

13. Wood, steel or equivalent posts shall be used. The spacing of the support posts shall be a maximum of 6-feet. Posts shall consist of either:

    - Wood posts with minimum dimensions of 2 inches by 2 inches and 3 feet minimum length. Wood posts shall be free of defects such as knots, splits, or gouges.

    - No. 6 rebar or larger.

    - ASTM A 120 steel pipe with a minimum diameter of 1 inch.

    - U, T, L, or C shape steel posts with a minimum weight of 1.35 lbs./ft.

    - Other steel posts having equivalent strength and bending resistance to the post sizes listed above.

- Silt fence installation using the slicing method specification details follow. Refer to Figure II – 3.20 for slicing method details.

    1. The base of both end posts must be at least 2 to 4 inches above the top of the silt fence fabric on the middle posts for ditch checks to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.

    2. Install posts 3 to 4 feet apart in critical retention areas and 6 to 7 feet apart in standard applications.

    3. Install posts 24 inches deep on the downstream side of the silt fence, and as close as possible to the fabric, enabling posts to support the fabric from upstream water pressure.

    4. Install posts with the nipples facing away from the silt fence fabric.

    5. Attach the filter fabric to each post with three ties, all spaced within the top 8 inches of the fabric. Attach each tie diagonally 45 degrees through the fabric, with each puncture at least 1 inch vertically apart. In addition, position each tie to hang on a post nipple when tightening to prevent sagging.

    6. Wrap approximately 6 inches of fabric around the end posts and secure with three ties.

    7. No more than 24 inches of a 36-inch fabric is allowed above ground level.

    8. Compact the soil immediately next to the silt fence fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of four trips. The installation should be checked and corrected for any deviation before compaction. Use a flat-bladed shovel to tuck fabric deeper into the ground if necessary.

Maintenance Standards

- Any damage shall be repaired immediately.

- If concentrated flows are evident uphill of the fence, they must be intercepted and conveyed to a sediment trapping BMP.

- It is important to check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence and remove the trapped sediment.

- Sediment deposits shall either be removed when the deposit reaches approximately one-third the height of the silt fence, or a second silt fence shall be installed.

- If the filter fabric (geotextile) has deteriorated due to ultraviolet breakdown, it shall be replaced.

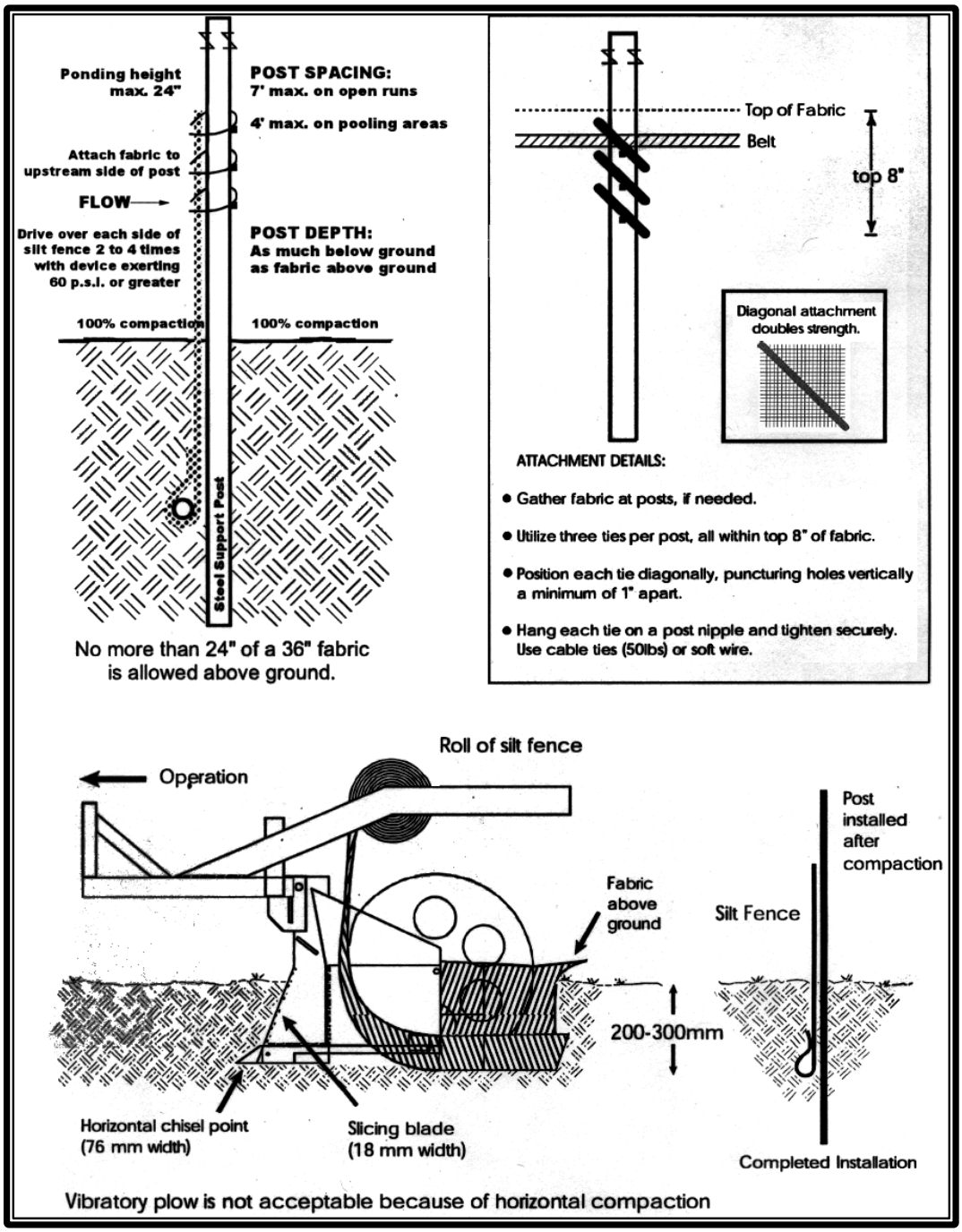


Figure II – 3.20 Silt Fence Installation by Slicing Method

BMP C234: Vegetated Strip

Purpose

To reduce the transport of coarse sediment from a construction site by providing a physical barrier to sediment and reducing the runoff velocities of overland flow.

Conditions of Use

- Vegetated strips may be used downslope of all disturbed areas.
- Vegetated strips are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to BMP C241: Temporary Sediment Pond. The only circumstance in which overland flow can be treated solely by a vegetated strip, rather than by a sediment trapping BMP, is when the criteria shown in Table II - 3.16 are met.

Table II - 3.16 Vegetated Strips

Average Slope of Contributing Area	Slope Percent	Contributing Flow Path Length
1.5H:1V or flatter	67% or flatter	100 feet
2H:1V or flatter	50% or flatter	115 feet
4H:1V or flatter	25% or flatter	150 feet
6H:1V or flatter	16.7% or flatter	200 feet
10H:1V or flatter	10% or flatter	250 feet

Design and Installation Specifications

- The vegetated strip shall consist of a continuous strip of dense vegetation with topsoil and have a minimum 25-foot long flow path. Grass-covered, landscaped areas are generally not adequate because the volume of sediment overwhelms the grass. Ideally, vegetated strips shall consist of undisturbed native growth with a well-developed soil that allows for infiltration of runoff.
- The slope within the vegetated strip shall not exceed 4H:1V.
- The uphill boundary of the vegetated strip shall be delineated with clearing limits.

Maintenance Standards

- Any areas damaged by erosion or construction activity shall be seeded immediately and protected by mulch.

- If more than 5 feet of the original vegetated strip width has had vegetation removed or is being eroded, sod must be installed.

- If there are indications that concentrated flows are traveling across the vegetated strip, stormwater runoff controls must be installed to reduce the flows entering the vegetated strip, or additional perimeter protection must be installed.

BMP C235: Wattles

Purpose

To reduce the velocity and spread the flow of rill and sheet runoff, and to capture and retain sediment.

Wattles are temporary erosion and sediment control barriers consisting of straw, compost, or other material that is wrapped in netting made of natural plant fiber or similar encasing material.

Conditions of Use

- Wattles shall consist of cylinders of plant material such as weed-free straw, coir, wood chips, excelsior, or wood fiber or shavings encased with netting made of natural plant fibers unaltered by synthetic materials.
- Use Wattles:
    1. In disturbed areas that require immediate erosion protection.
    2. On exposed soils during the period of short construction delays, or over winter months.
    3. On slopes requiring stabilization until permanent vegetation can be established.
- The material used dictates the effectiveness period of the wattle. Wattles are typically effective for one to two wet seasons.

- If conditions are appropriate, wattles can be staked to the ground using willow cuttings for added revegetation.
- Prevent rilling beneath wattles by properly entrenching and abutting wattles together to prevent water from passing between them.

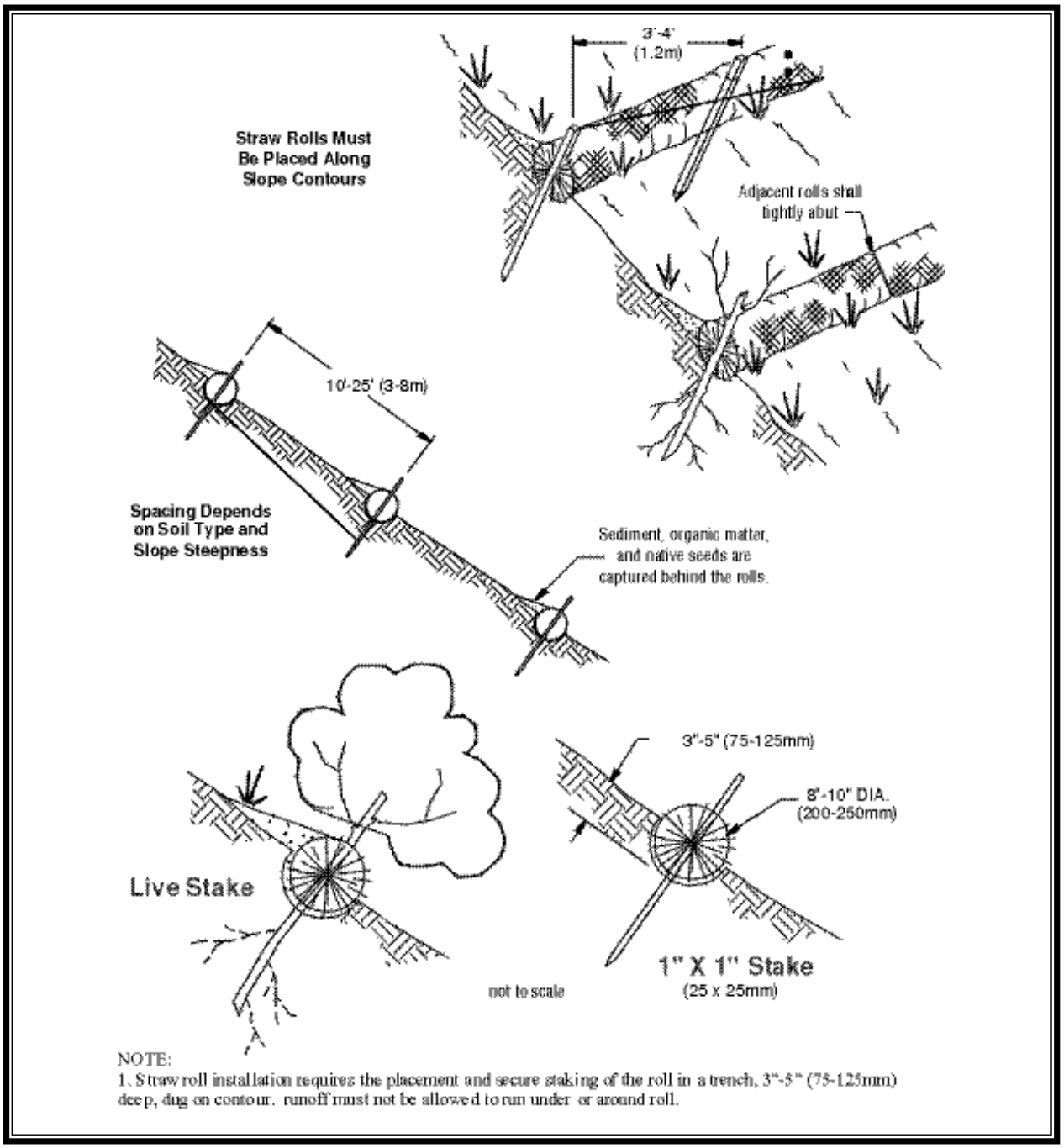


Figure II - 3.21 Straw Wattles

Design Criteria

- See Figure II - 3.23 for typical construction details. WSDOT Standard Plan I-30.30-00 also provides information on Wattles (http://www.wsdot.wa.gov/Design/Standards/Plans.htm#SectionI)
- Wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length.
- Install wattles perpendicular to the flow direction and parallel to the slope contour.
- Place wattles in narrow trenches, staked along the contour of disturbed or newly constructed slopes (on contour) to a depth of 3 to 5 inches on clay soils and soils with gradual slopes. On loose soils, steep slopes, and areas with high rainfall, the trenches should be dug to a depth of 5 to 7 inches, or 1/2 to 2/3 of the thickness of the wattle.
- Start building trenches and installing wattles from the base of the slope and work up. Spread excavated material evenly along the uphill slope and compact using hand tamping or other methods.
- Construct trenches at intervals of 10 to 25-feet depending on the steepness of the slope, soil type, and rainfall. The steeper the slope the closer together the trenches need to be. See Table II – 3.17 for spacing information.
- Install the wattles snugly into the trenches and abut tightly end to end. Do not overlap the ends.
- Install stakes at each end of the wattle, and at 4-foot centers along entire length of wattle.
- If required, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil.
- Wooden stakes shall be approximately 3/4 x 3/4 x 24 inches. Willow cuttings or 3/8-inch rebar can also be used for stakes.
- Stakes should be driven through the middle of the wattle, leaving 2 to 3-inches of the stake protruding above the wattle.

Table II – 3.17 Wattle Spacing Table

8” Diameter Wattle Spacing Table	
Slope	Maximum Spacing
1H:1V	10’-0”
2H:1V	20’-0”
3H:1V	30’-0”
4H:1V	40’-0”

Maintenance Standards

- Wattles may require maintenance to ensure they are in contact with soil and thoroughly entrenched, especially after significant rainfall on steep sandy soils.
- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted, or water has scoured beneath the wattles.

BMP C236: Vegetative Filtration

Purpose

To improve turbidity levels of stormwater discharges by filtering through existing vegetation where undisturbed forest floor duff layer or established lawn with thatch layer are present or to infiltrate dewatering wastewater from foundations, vaults, and trenches as long as runoff does not occur. Vegetative Filtration may be used in conjunction with BMP C241, *Temporary Sediment Ponds,* BMP C206, *Level Spreader* and a pumping system with surface intake.

Conditions of Use

- For every five acres of disturbed soil use one acre of grass field, farm pasture, or wooded area. Reduce or increase this area depending on project size, groundwater table height, and other site conditions. See Table II - 3.18 for flow path length requirements based on vegetative filtration area.
- Wetlands shall not be used for vegetative filtration.
- Do not use this BMP in areas with a high groundwater table, or in areas that will have a high seasonal groundwater table during the use of this BMP.
- This BMP may be less effective on soils that prevent the infiltration of water, such as hard till.
- Using other effective source control measures throughout a construction site will prevent the generation of additional highly turbid water and may reduce the time period or area needed for this BMP.
- Stop distributing water into the vegetated area if standing water or erosion results.
- On large projects that phase the clearing of the site, areas retained with native vegetation may be used as a temporary vegetative filtration area.

Design Criteria

- Find land adjacent to the project that has a vegetated field, preferably a farm field, or wooded area.
- If the project site does not contain enough vegetated field area, consider obtaining permission from adjacent landowners (especially for farm fields).
- Install a pump and downstream distribution manifold depending on the project size. Generally, the main distribution line should reach 100 to 200-

feet long (many large projects, or projects on tight soil, will require systems that reach several thousand feet long with numerous branch lines off of the main distribution line).

- The manifold should have several valves, allowing for control over the distribution area in the field.
- Install several branches of 4" schedule 20 polyvinyl chloride (PVC), swaged-fit common septic tight-lined sewer line, or 6" fire hose, which can convey the turbid water out to various sections of the field. See Figure II – 3.22.
- Determine the branch length based on the field area geography and number of branches. Typically, branches stretch from 200-feet to several thousand feet. Always lay branches on contour with the slope.
- On uneven ground, sprinklers perform well. Space sprinkler heads so the spray patterns do not overlap.
- On relatively even surfaces, a level spreader using 4-inch perforated pipe may be used as an alternative option to the sprinkler head setup. Install drainpipe at the highest point on the field and at various lower elevations to ensure full coverage of the filtration area. Pipe should be placed with the holes up to allow for a gentle weeping of stormwater evenly out all holes. Leveling the pipe by staking and using sandbags may be required.
- To prevent the over saturation of the field area, rotate the use of branches or spray heads. Do this as needed based on monitoring the spray field.

Table II - 3.18 Flow Path Guidelines for Vegetative Filtration

Average Slope of Vegetated Area	Average Area % Slope	Estimated Flow Path Length (ft)
1.5H:1V	67%	250
2H:1V	50%	200
4H:1V	25%	150
6H:1V	16.7%	115
10H:1V	10%	100

Maintenance Standards

- Monitor the spray field on a daily basis to ensure that over saturation of any portion of the field doesn't occur at any time. The presence of standing puddles of water or creation of concentrated flows visually signify that over saturation of the field has occurred.

- Monitor the vegetated spray field all the way down to the nearest surface water, or farthest spray area, to ensure that the water has not caused overland or concentrated flows and has not created erosion around the spray nozzle(s).

- Do not exceed water quality standards for turbidity.

- A separate inspection log shall be developed, maintained and kept with the existing site logbook to aid the operator conducting inspections. This separate “Field Filtration Logbook” can also aid the facility in demonstrating compliance with permit conditions.

- Inspect the spray nozzles daily, at a minimum, for leaks and plugging from sediment particles.

- If erosion, concentrated flows, or over saturation of the field occurs, rotate the use of branches or spray heads or move the branches to a new field location.

- Check all branches and the manifold for unintended leaks.

Figure II – 3.22 Manifold and Branches in wooded, vegetated spray field

3.2.2 BMP C240: Sediment Trap

Purpose

A sediment trap is a small temporary ponding area with a gravel outlet used to collect and store sediment from sites during construction. Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.

Conditions of Use

- Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or trap or other appropriate sediment removal best management practice.
- Non-engineered sediment traps may be used on-site prior to an engineered sediment trap or sediment pond to provide additional sediment removal capacity.
- Sediment traps are intended for use on sites where the tributary drainage area is less than 3 acres, with no unusual drainage features, and a projected build-out time of 6 months or less.
- The sediment trap is a temporary measure (with a design life of approximately 6 months) and shall be maintained until the site area is permanently protected against erosion by vegetation and/or structures.
- Sediment traps are only effective in removing sediment down to about the medium silt size fraction. Runoff with sediment of finer grades (fine silt and clay) will pass through untreated, emphasizing the need to control erosion to the maximum extent first.
- All projects that are constructing permanent Flow Control BMPs, or Runoff Treatment BMPs that use ponding for treatment, should use the rough-graded or final-graded permanent BMP footprint for the temporary sediment traps. This includes combined facilities and infiltration facilities. If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to no more than of 2 feet above final grade. Final grading of the infiltration facility shall occur only when all contributing drainage areas are fully stabilized.
- When permanent BMP footprints are used as temporary sediment traps, the surface area requirement of a sediment trap must be met. If the surface area requirement of the sediment trap is larger than the surface area of the permanent BMP, then the sediment trap shall be enlarged beyond the permanent BMP footprint to comply with the surface area requirement.

- A floating pond skimmer may be used for the sediment trap outlet.

Design and Installation Specifications

- See Figure II - 3.23 and Figure II - 3.24 for details.

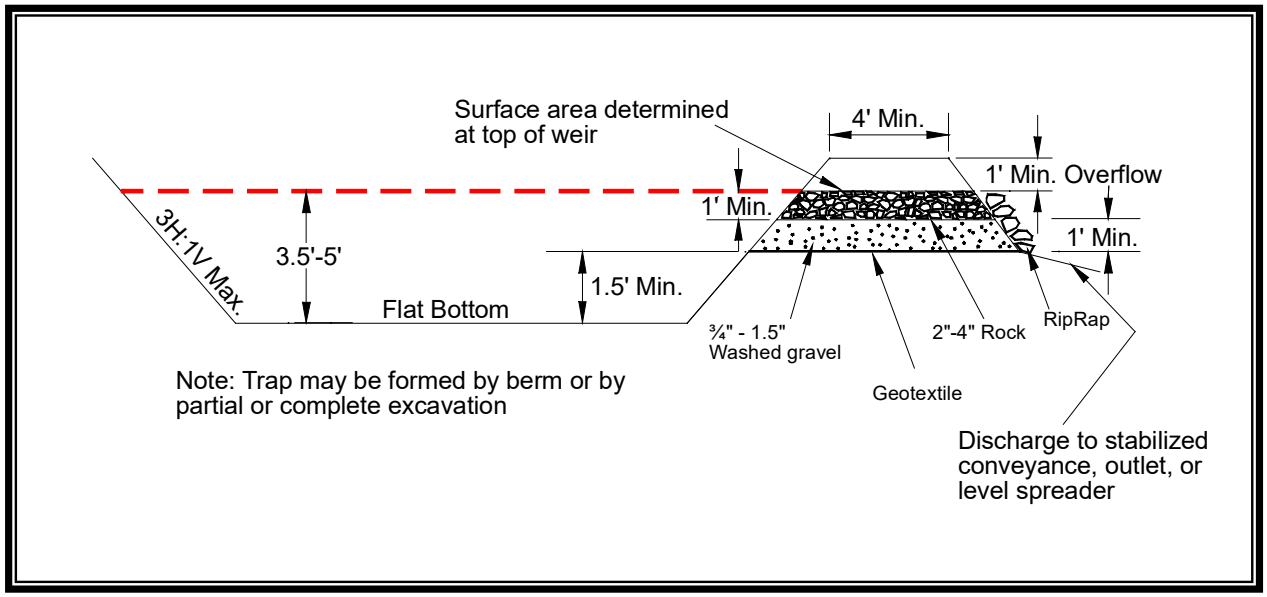


Figure II - 3.23 Cross Section of Sediment Trap

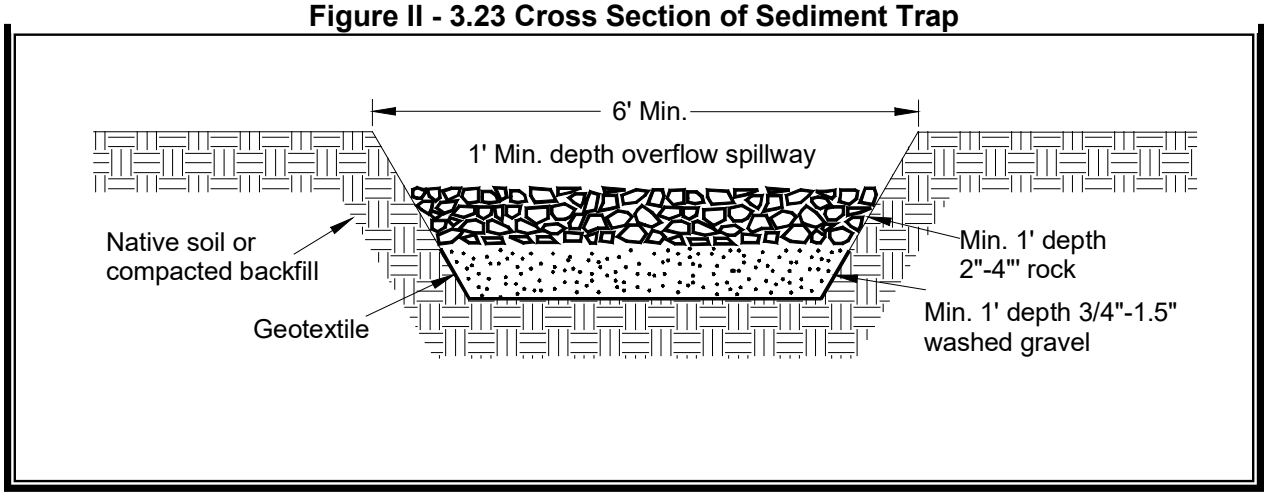


Figure II - 3.24 Sediment Trap Outlet

- To determine the sediment trap geometry, first calculate the design surface area (*SA*) of the trap, measured at the invert of the weir. Use the following equation:

$$SA = FS(Q_2/V_S)$$

Where:

Q_2 =

  - Option 1 – Single Event Hydrograph Method:

Q_2 = Peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 2-year, 24-hour frequency storm for the developed condition. The 10-year peak volumetric flow rate shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection.

- Option 2 – For construction sites that are less than 1 acre, the Rational Method may be used to determine Q_2.

V_S = The settling velocity of the soil particle of interest. The 0.02 mm (medium silt) particle with an assumed density of 2.65 g/cm^3 has been selected as the particle of interest and has a settling velocity (V_s) of 0.00096 ft/sec.

FS A safety factor of 2 to account for non-ideal settling.

Therefore, the equation for computing surface area becomes:

$$SA = 2 \times Q_2/0.00096$$

OR

2,080 square feet per cfs of inflow

Note: Even if permanent facilities are used, they must still have a surface area that is at least as large as that derived from the above formula. If they do not, the pond must be enlarged.

- Sediment trap depth shall be 3.5 feet minimum from the bottom of the trap to the top of the overflow weir.
- To aid in determining sediment depth, all sediment traps shall have a staff gauge with a prominent labeled mark for each 1-foot interval above the bottom of the trap.
- Sediment traps may not be feasible on utility projects due to the limited workspace or the short-term nature of the work. Portable tanks may be used in place of sediment traps for utility projects.

Maintenance Standards

- Sediment shall be removed from the trap when it reaches 1 foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

BMP C241: Temporary Sediment Pond

Purpose

To remove sediment from runoff originating from disturbed areas of the project site.

Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they may reduce turbidity only slightly.

Conditions of Use

- Sediment ponds must be installed only on sites 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.
- Sediment ponds are attractive to children and can be very dangerous. If fencing of the pond is planned, the type of fence and its location shall be shown on the ESC plan.
- Structures having a maximum storage capacity at the top of the dam of 10 acre-ft (435,600 ft3) or more, or have an embankment of more than 6 feet, are subject to the Washington Dam Safety Regulations (Chapter 173-175 WAC).
- Projects that are construction permanent Flow Control BMPs or Runoff Treatment BMPs that use ponding for treatment may use the rough-graded or final-graded permanent BMP footprint for the temporary sediment pond. When permanent BMP footprints are used as temporary sediment ponds, the surface area requirement of the temporary sediment pond must be met. If the surface area requirement of the sediment pond is larger than the surface area of the permanent BMP, then the sediment pond shall be enlarged beyond the permanent BMP footprint to comply with the surface area requirement.
- The permanent control structure must be temporarily replaced with a control structure that only allows water to leave the pond from the surface or by pumping. Alternatively, the permanent control structure may be used if it is temporarily modified by plugging any outlet holes below the riser. The permanent control structure must be installed after the site is fully stabilized.
- A sediment pond shall be used where the contributing drainage area is 3 acres or more. Ponds must be used in conjunction with erosion control practices to reduce the amount of sediment flowing into the basin.

Design and Installation Specifications

- See Figure II - 3.25, Figure II - 3.26 Sediment Pond Cross-Section, and Figure II - 3.27 for details.

- Use of permanent infiltration facilities for temporary sediment ponds during construction tends to clog the soils and reduce their capacity to infiltrate. If permanent infiltration BMP footprints are to be used, the sides and bottom of the temporary sediment pond must only be rough excavated to no more than 2 feet above final grade of the permanent infiltration BMP. Final grading of the permanent infiltration BMP shall occur only when all contributing drainage areas are fully stabilized. Any proposed permanent pretreatment BMP should be fully constructed and used with the temporary sediment pond to help prevent clogging of the soils.

- The **pond shall be divided** into two roughly equal volume cells by a permeable divider that will reduce turbulence while allowing movement of water between cells.

- The divider shall be at least one-half the height of the riser and a minimum of 1 foot below the top of the riser. Wire-backed, 2- to 3-foot high, extra strength filter fabric supported by treated 4"x4"s can be used as a divider. Alternatively, staked straw bales wrapped with filter fabric (geotextile) may be used.

- If the pond is more than 6 feet deep, a different mechanism must be proposed. A riprap embankment is one acceptable method of separation for deeper ponds. Other designs that satisfy the intent of this provision are allowed as long as the divider is permeable, structurally sound, and designed to prevent erosion under or around the barrier.

- If an **embankment** of more than 6 feet is proposed, the pond must comply with the criteria contained in Volume V regarding dam safety for detention BMPs.

- The most common structural failure of sedimentation ponds is caused by piping. Piping refers to two phenomena: (1) water seeping through fine-grained soil, eroding the soil grain by grain and forming pipes or tunnels; and (2) water under pressure flowing upward through a granular soil with a head of sufficient magnitude to cause soil grains to lose contact and capability for support.

  The most critical construction practices to prevent piping are:

  - Tight connections between the riser and the outlet pipe, and other pipe connections.

- Adequate anchoring of the riser.
- Proper soil compaction of the embankment and riser footing.
- Proper construction of anti-seep devices.

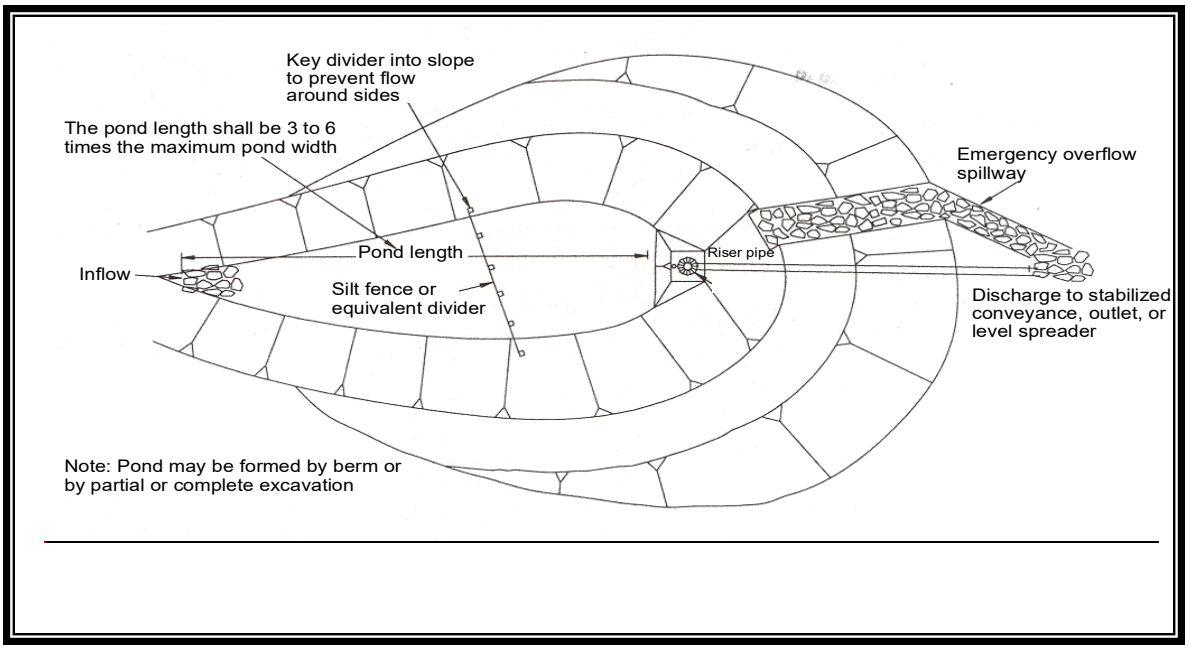


Figure II - 3.25 Sediment Pond Plan View

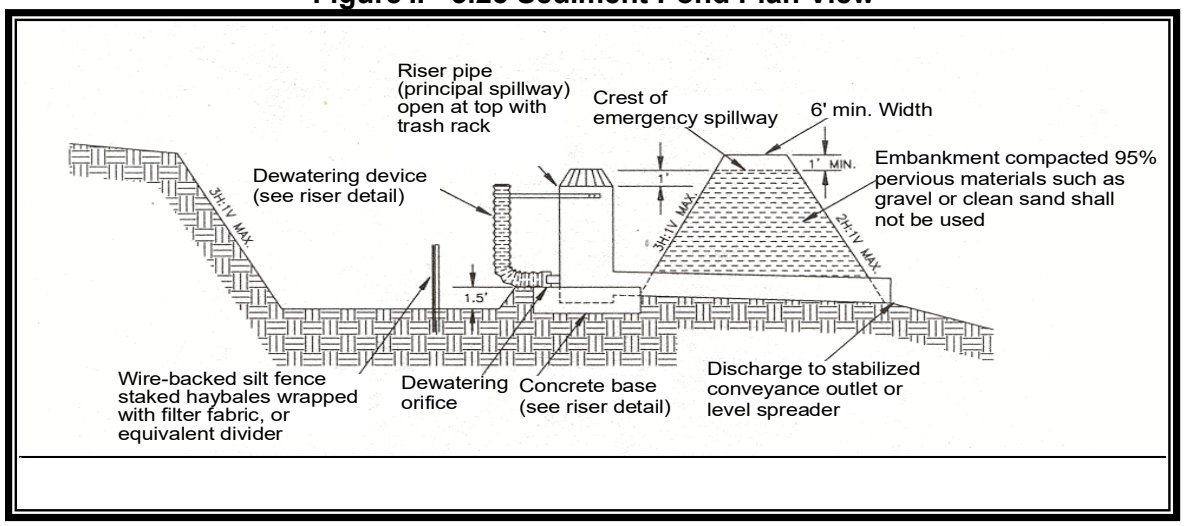


Figure II - 3.26 Sediment Pond Cross-Section

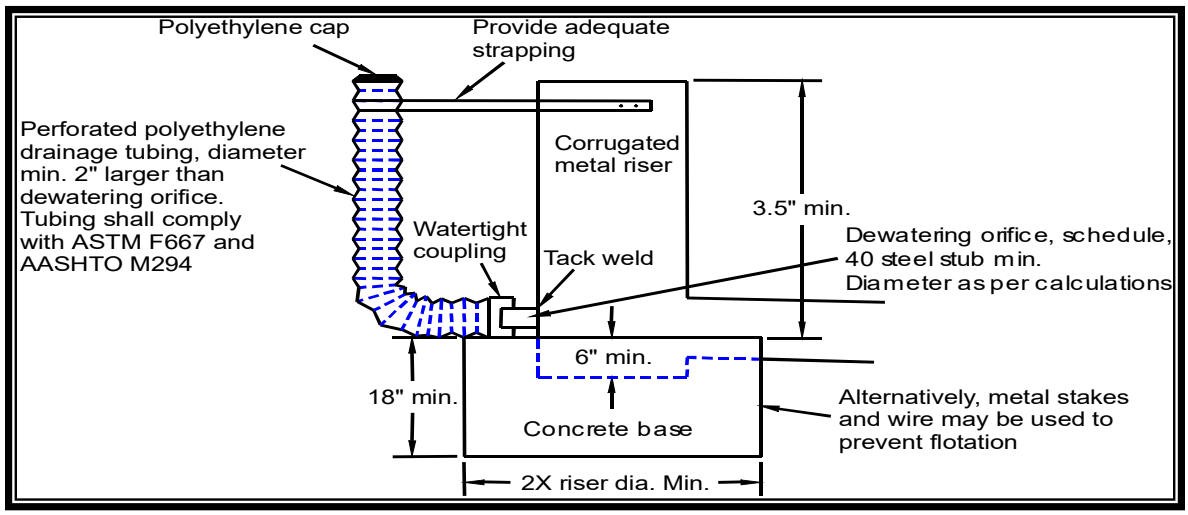


Figure II - 3.27 Sediment Pond Riser Detail

Sediment Pond Geometry:

To determine the sediment pond geometry, first calculate the design surface area (SA) at the top of the riser pipe with the equation:

$$SA = 2 \times Q_2/0.00096$$

OR

2,080 square feet per cfs of inflow

See BMP C240 for more information on the derivation of the surface area calculation.

The basic geometry of the pond can now be determined using the following design criteria:

- Required surface area SA (from the equation above) at top of the riser.
- Minimum 3.5-foot depth from top of riser to the bottom of the pond.
- Maximum 3H:1V interior side slopes and maximum 2H:1V exterior slopes. The interior slopes can be increased to a maximum of 2H:1V if fencing is provided at or above the maximum water surface.
- One foot of freeboard between the top of the riser and the crest of the emergency spillway.
- Flat bottom.
- Minimum 1-foot deep spillway.
- Length-to-width ratio between 3:1 and 6:1.

Sizing of Discharge Mechanisms:

- The outlet for the pond consists of a combination of principal and emergency spillways. These outlets must pass the peak runoff expected from the contributing drainage area for a 100-year recurrence interval storm. If, due to site conditions and pond geometry, a separate emergency spill-way is not feasible, the principal spillway must pass the entire peak runoff expected from the 100-year recurrence interval storm. However, an attempt to provide a separate emergency spillway shall always be made.
- The runoff calculations shall be based on the site conditions during construction. The flow through the dewatering orifice cannot be utilized when calculating the 100-year recurrence interval storm elevation because of its potential to become clogged; therefore, available spillway storage must begin at the principal spillway riser crest.

- The principal spillway designed by the procedures contained in this standard will result in some reduction in the peak rate of runoff. However, the riser outlet design will not adequately control the pond discharge to the predevelopment discharge limitations as stated in Core Requirement #7: Flow Control. However, if the basin for a permanent stormwater detention pond is used for a temporary sedimentation pond, the control structure for the permanent pond can be used to maintain predevelopment discharge limitations.

- The size of the contributing basin, the expected life of the construction project, the anticipated downstream effects and the anticipated weather conditions during construction, should be considered to determine the need of additional discharge control. See Figure II - 3.24 for riser inflow curves.

- **Principal Spillway:** Determine the required diameter for the principal spillway (riser pipe). The diameter shall be the minimum necessary to pass the peak volumetric flow rate using a 15-minute time step from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Use Figure II - 3.28 Riser Inflow Curves to determine the riser diameter (h = 1-foot). Note: A permanent control structure may be used instead of a temporary riser.

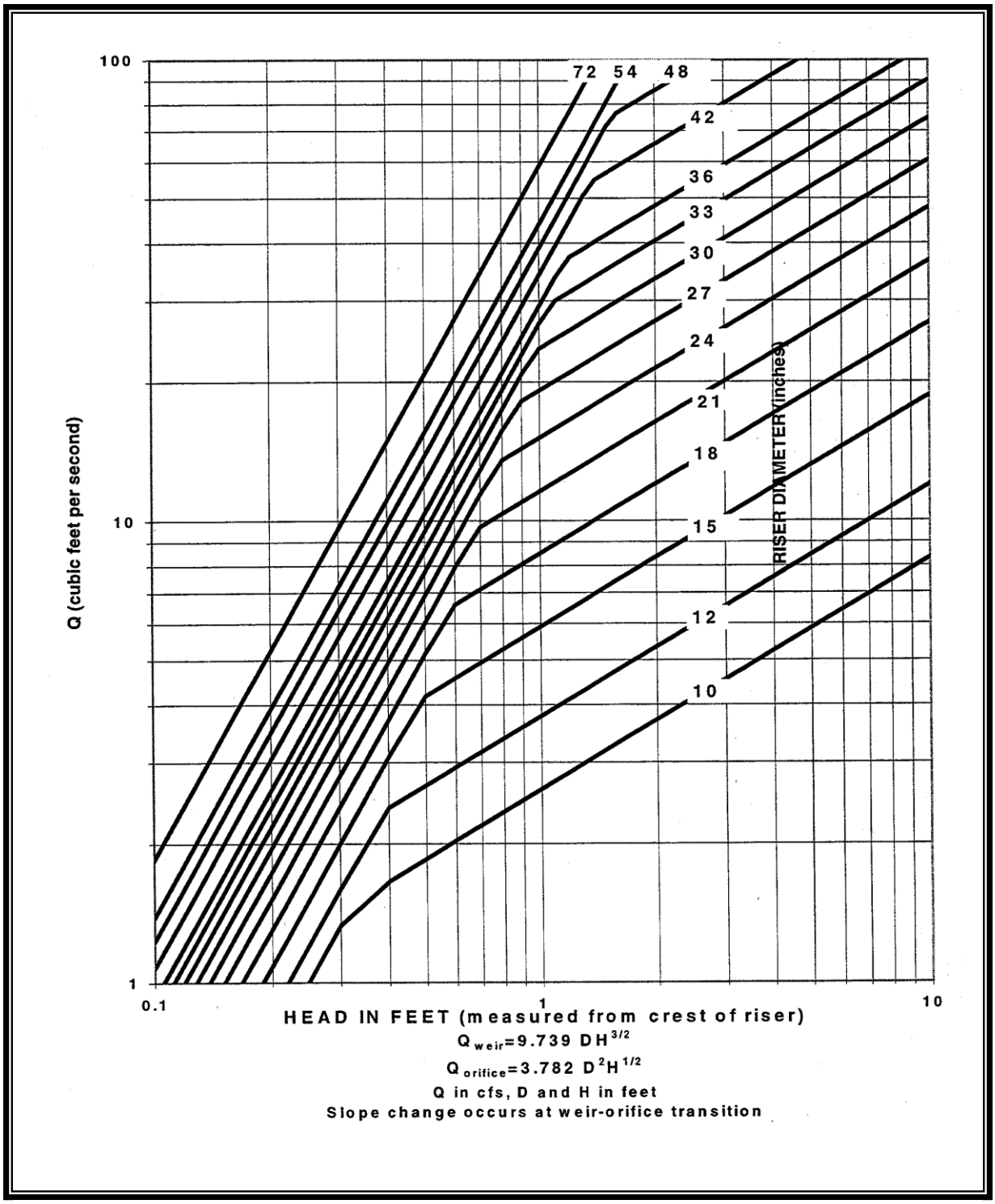


Figure II - 3.28 Riser Inflow Curves

- **Emergency Overflow Spillway:** Size the emergency overflow spillway for the peak volumetric flow rate using a 10-minute time step from a Type 1A, 100-year, 24-hour frequency storm for the developed condition.

- **Dewatering Orifice:** Determine the size of the dewatering orifice(s) (minimum 1-inch diameter) using a modified version of the discharge equation for a vertical orifice and a basic equation for the area of a circular orifice. Determine the required area of the orifice with the following equation:

$$A_o = \frac{A_s (2h)^{0.5}}{0.6\text{x}3600Tg^{0.5}}$$

Where: A_O = orifice area (square feet)

A_S = pond surface area (square feet)

h = head of water above orifice (height of riser in feet)

T = dewatering time (24 hours)

g = acceleration of gravity (32.2 feet/second^2)

Convert the required surface area to the required diameter D of the orifice:

$$D = 24\text{x}\sqrt{\frac{A_o}{\pi}} = 13.54\text{x}\sqrt{A_o}$$

The vertical, perforated tubing connected to the dewatering orifice must be at least 2 inches larger in diameter than the orifice to improve flow characteristics. Make the size and number of perforations in the tubing so that the tubing does not restrict flow. The orifice should control the flow rate.

Maintenance Standards

- Sediment shall be removed from the pond when it reaches 1 foot in depth.
- Any damage to the pond embankments or slopes shall be repaired.

BMP C250: Construction Stormwater Chemical Treatment

Purpose

This BMP applies when using stormwater chemicals in batch treatment or flow-through treatment.

Turbidity is difficult to control once fine particles are suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling but are ineffective at removing smaller particulates such as clay and fine silt. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Chemical treatment may be used to reduce the turbidity of stormwater runoff.

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants. Traditional BMPs used to control soil erosion and sediment loss from sites under development may not be adequate to ensure compliance with the water quality standard for turbidity in the receiving water. Chemical treatment may be required to meet turbidity stormwater discharge requirements and protect streams from the impact of turbid stormwater discharges, especially when construction is to proceed through the wet season.

Conditions of Use

Formal written approval from Ecology and acceptance by the County is required for the use of chemical treatment regardless of site size. See https://fortress.wa.gov/ecy/publications/SummaryPages/ecy070258.html for a copy of the Request for Chemical Treatment form. The intention to use Chemical Treatment shall be indicated on the Notice of Intent for coverage under the General Construction Permit. Chemical treatment systems should be designed as part of the Construction SWPPP, not after the fact. Chemical treatment may be used to correct problem sites in limited circumstances with formal written approval from Ecology and acceptance by the County.

The intention to use chemical treatment should be included in the SEPA documentation for the project. The SEPA review authority (typically Thurston County) must be notified at the application phase of the project review (or the time that the SEPA determination on the project is performed) that chemical treatment is proposed. If it is added after this stage, an addendum may be necessary and may result in project approval delay.

Chemically treated stormwater discharged from construction sites must be nontoxic to aquatic organisms. The Chemical Technology Assessment Protocol (CTAPE) must be used to evaluate chemicals proposed for stormwater treatment. Only chemicals approved by Ecology under the CTAPE may be used for stormwater treatment. The approved chemicals, their allowable application techniques (batch treatment or flow-through treatment), allowable application rates, and conditions of use can be found at the Department of Ecology Emerging Technologies website:

https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

Background on Chemical Treatment Systems

Coagulation and flocculation have been used for over a century to treat water. Both are used less frequently for the treatment of wastewater, and their use for treating stormwater is a very recent application. Experience with water and wastewater treatment has resulted in a basic understanding of the process, especially factors that affect performance. This experience can provide insights on how to most effectively design and operate similar systems in the treatment of stormwater.

Fine particles suspended in water give it a milky appearance, measured as *turbidity*. Their small size, often much less than 1 µm in diameter, give them a very large surface area relative to their volume. These fine particles typically carry a negative surface charge. Largely because of these two factors, (small size and negative charge), these particles tend to stay in suspension for extended periods of time, making removal by gravity settling impractical. These are called stable suspensions. Chemicals like polymers, as well as inorganic chemicals such as alum, speed the settling process. The added chemical destabilizes the suspension and causes the smaller particles to flocculate. The process consists of three steps: coagulation, flocculation, and settling or clarification. Ecology requires a fourth step, filtration, on all stormwater chemical treatment systems to reduce floc discharge and to provide monitoring prior to discharge.

General Design and Installation Specifications

- Chemicals approved for use in Washington State are listed on Ecology's TAPE website, http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html, under the "Construction" tab.
- Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. Stormwater that has been chemically treated must be filtered through BMP C251: Construction Stormwater Filtration for filtration and monitoring prior to discharge.
- System discharge rates must take into account downstream conveyance integrity.
- The following equipment should be located on site in a lockable shed:
    - The chemical injector.
    - Secondary containment for acid, caustic, buffering compound, and treatment chemical.

- Emergency shower and eyewash.
- Monitoring equipment which consists of a pH meter and a turbidimeter.

- There are two types of systems for applying the chemical treatment process to stormwater: the batch chemical treatment system and the flow-through chemical treatment system. See below for further details for both types of systems.

Batch Chemical Treatment Systems

A batch chemical treatment system consists of four steps: *coagulation, flocculation, clarification,* and polishing and monitoring via *filtration.*

Step 1: Coagulation

Coagulation is the process by which negative charges on the fine particles are disrupted. By disrupting the negative charges, the fine particles are able to flocculate. Chemical addition is one method of destabilizing the suspension, and polymers are one class of chemicals that are generally effective. Chemicals that are used for this purpose are called coagulants. Coagulation is complete when the suspension is destabilized by the neutralization of the negative charges. Coagulants perform best when they are thoroughly and evenly dispersed under relatively intense mixing. This rapid mixing involves adding the coagulant in a manner that promotes rapid dispersion, followed by a short time period for destabilization of the particle suspension. The particles are still very small and are not readily separated by clarification until flocculation occurs.

Step 2: Flocculation

Flocculation is the process by which fine particles that have been destabilized bind together to form larger particles that settle rapidly. Flocculation begins naturally following coagulation but is enhanced by gentle mixing of the destabilized suspension. Gentle mixing helps to bring particles in contact with one another such that they bind and continually grow to form "flocs." As the size of the flocs increase, they become heavier and settle.

Step 3: Clarification

The final step is the settling of the particles, or clarification. Particle density, size and shape are important during settling. Dense, compact flocs settle more readily than less dense, fluffy flocs. Because of this, flocculation to form dense, compact flocs is particularly important during chemical treatment. Water temperature is important during settling. Both the density and viscosity of water are affected by temperature; these in turn affect settling. Cold temperatures increase viscosity and density, thus slowing down the rate at which the particles settle.

The conditions under which clarification is achieved can affect performance. Currents can affect settling. Currents can be produced by wind, by differences between the temperature of the incoming water and the water in the clarifier, and by flow conditions near the inlets and outlets. Quiescent water, such as that which occurs during batch clarification, provides a good environment for settling. One source of currents in batch chemical treatment systems is movement of the water leaving the clarifier unit. Because flocs are relatively small and light, the velocity of the water must be as low as possible. Settled flocs can be resuspended and removed by fairly modest currents.

Step 4: Filtration

After clarification, Ecology requires stormwater that has been chemically treated to be filtered and monitored prior to discharge. The sand filtration system continually monitors the stormwater effluent for turbidity and pH. If the discharge water is ever out of an acceptable range for turbidity or pH, the water is returned to the untreated stormwater pond where it will begin the treatment process again

Design and Installation of Batch Chemical Treatment Systems

A batch chemical treatment system consists of the stormwater collection system (either temporary diversion or the permanent site drainage system), an untreated stormwater storage pond, pumps, a chemical feed system, treatment cells, and interconnecting piping.

The batch treatment system shall use a minimum of two lined treatment cells in addition to the untreated stormwater storage pond. Multiple treatment cells allow for clarification of treated water while other cells are being filled or emptied. Treatment cells may be ponds or tanks. Ponds with constructed earthen embankments greater than 6 feet high or which impound more than 10 acre-feet are subject to the Washing Dam Safety Regulati9ons (Chapter 173-175 WAC) See BMP D.01 Detention Ponds for more information regarding dam safety considerations for ponds.

Stormwater is collected at interception point(s) on the site and is diverted by gravity or by pumping to an untreated stormwater storage pond or other untreated stormwater holding area. The stormwater is stored until treatment occurs. It is important that the holding pond be large enough to provide adequate storage.

The first step in the treatment sequence is to check the pH of the stormwater in the untreated stormwater storage pond. The pH is adjusted by the application of carbon dioxide or a base until the stormwater in the storage pond is within the desired pH range, 6.5 to 8.5. When used, carbon dioxide is added immediately downstream of the transfer pump. Typically, sodium bicarbonate (baking soda) is used as a base, although other bases may be used. When needed, base is added directly to the untreated stormwater storage pond. The stormwater is recirculated with the treatment pump to provide mixing in the storage pond. Initial pH adjustments should be based on daily bench tests. Further pH adjustments can be made at any point in the process. See

BMP C252: Treating and Disposing of High pH Water for more information on pH adjustments a part of chemical treatment.

Once the stormwater is within the desired pH range (which is dependent on the coagulant being used), the stormwater is pumped from the untreated stormwater storage pond to a treatment cell as polymer is added. The coagulant is added upstream of the pump to facilitate rapid mixing.

The water is kept in the lined treatment cell for clarification. In a batch mode process, clarification typically takes from 30 minutes to several hours. Prior to discharge, samples are withdrawn for analysis of pH, coagulant concentration, and turbidity. If these levels are acceptable, the treated water is withdrawn, filtered, and discharged.

Several configurations have been developed to withdraw treated water from the treatment cell. The original configuration is a device that withdraws the treated water from just beneath the water surface using a float with adjustable struts that prevent the float from settling on the cell bottom. This reduces the possibility of picking up floc from the bottom of the cell. The struts are usually set at a minimum clearance of about 12 inches; that is, the float will come within 12 inches of the bottom of the cell. Other systems have used vertical guides or cables which constrain the float, allowing it to drift up and down with the water level. More recent designs have an H-shaped array of pipes, set on the horizontal.

This scheme provides for withdrawal from four points rather than one. This configuration reduces the likelihood of sucking settled solids from the bottom. It also reduces the tendency for a vortex to form. Inlet diffusers, a long floating or fixed pipe with many small holes in it, are also an option.

Safety is a primary concern. Design should consider the hazards associated with operations, such as sampling. Facilities should be designed to reduce slip hazards and drowning. Tanks and ponds should have life rings, ladders, or steps extending from the bottom to the top.

Sizing Batch Chemical Treatment Systems

Chemical treatment systems must be designed to control the velocity and peak volumetric flow rate that is discharged from the system and consequently the project site. See Chapter 2, Element 3: Control Flow Rates for further details on this requirement.

The total volume of the untreated stormwater storage pond and treatment ponds or tanks must be large enough to treat the volume of stormwater that is produced during multiple day storm events. It is recommended that at a minimum the untreated stormwater storage pond be sized to hold 1.5 times the volume of runoff generated from the site during the 10-year, 24-hour storm event. Bypass shall be provided around the chemical treatment system to accommodate extreme storm events.

Runoff volume shall be calculated using the methods presented in Volume III. Worst-case land cover conditions (i.e., producing the most runoff) shall be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

Primary settling should be encouraged in the untreated stormwater storage pond. A forebay with access for maintenance may be beneficial.

There are two opposing considerations in sizing the treatment cells. A larger cell is able to treat a larger volume of water each time a batch is processed. However, the larger the cell the longer the time required to empty the cell. A larger cell may also be less effective at flocculation and therefore require a longer settling time. The simplest approach to sizing the treatment cell is to multiply the allowable discharge flow rate (as determined by the guidance in Element 3: Control Flow Rates) times the desired drawdown time. A 4-hour drawdown time allows one batch per cell per 8-hour work period, given 1 hour of flocculation followed by 2 hours of settling.

See BMP C251: Construction Stormwater Filtration for details on sizing the filtration system at the end of the batch chemical treatment system.

If the chemical treatment system design does not allow you to discharge at the rates as required by Element #3: Control Flow Rates, and if the site has a permanent Flow Control BMP that will serve the planned development, the discharge from the chemical treatment system may be directed to the permanent Flow Control BMP to comply with Element #3: Control Flow Rates. In this case, all discharge (including water passing through the treatment system and stormwater bypassing the treatment system) will be directed into the permanent Flow Control BMP. If site constraints make locating the untreated stormwater storage pond difficult, the permanent Flow Control BMP may be divided to serve as the untreated stormwater storage pond and the post-treatment temporary flow control pond. A berm or barrier must be used in this case, so the untreated water does not mix with the treated water. Both untreated stormwater storage requirements, and adequate post-treatment flow control must be achieved. The designer must document in the Construction SWPPP how the permanent Flow Control BMP is able to attenuate the discharge from the site to meet the requirements of Element #3: Control Flow Rates. If the design of the permanent Flow Control BMP was modified for temporary construction flow control purposes, the construction of the permanent Flow Control BMP must be finalized, as designed for its permanent function, at project completion.

Flow-Through Chemical Treatment Systems

Background on Flow-Through Chemical Treatment Systems

A flow-through chemical treatment system adds a sand filtration component to the batch chemical treatment system's treatment train following flocculation. The coagulant is added to the stormwater upstream of the sand filter so that the coagulation and flocculation step occur immediately prior to the filter. The advantage of a flow-through chemical treatment system is the time saved by immediately filtering the water, as

opposed to waiting for the clarification process necessary in a batch chemical treatment system. See BMP C251: Construction Stormwater Filtration for more information on filtration.

Design and Installation of Flow-Through Chemical Treatment Systems

At a minimum, a flow-through chemical treatment system consists of a stormwater collection system (either temporary diversion or the permanent site drainage system), an untreated stormwater storage pond, and the chemically enhanced sand filtration system.

As with batch treatment systems, stormwater is collected at interception point(s) on the site and is diverted by gravity or by pumping to an untreated stormwater storage pond or other untreated stormwater holding area. The stormwater is stored until treatment occurs. It is important that the holding pond be large enough to provide adequate storage.

Stormwater is then pumped from the untreated stormwater storage pond to the chemically enhanced sand filtration system where coagulant is added. Adjustments to pH may be necessary before coagulant addition. The sand filtration system continually monitors the stormwater effluent for turbidity and pH, the water is returned to the untreated stormwater pond where it will begin the treatment process again.

Sizing Flow-Through Chemical Treatment Systems

Refer to BMP C251: Construction Stormwater Filtration for sizing requirements of flow-through chemical treatment systems.

Factors Affecting the Chemical Treatment Process

Coagulants

Cationic polymers can be used as coagulants to destabilize negatively charged turbidity particles present in natural waters, wastewater and stormwater. Polymers are large organic molecules that are made up of subunits linked together in a chain-like structure. Attached to these chain-like structures are other groups that carry positive or negative charges or have no charge. Polymers that carry groups with positive charges are called cationic, those with negative charges are called anionic, and those with no charge (neutral) are called nonionic. In practice, the only way to determine whether a polymer is effective for a specific application is to perform preliminary or onsite testing.

Aluminum sulfate (alum) can also be used as a coagulant, as this chemical becomes positively charged when dispersed in water.

Polymers are available as powders, concentrated liquids, and emulsions (which appear as milky liquids). The latter are petroleum based, which are not allowed for construction stormwater treatment. Polymer effectiveness can degrade with time and also from other

influences. Thus, manufacturers' recommendations for storage should be followed. Manufacturers' recommendations usually do not provide assurance of water quality protection or safety to aquatic organisms. Consideration of water quality protection is necessary in the selection and use of all polymers.

Application

Application of coagulants at the appropriate concentration or dosage rate for optimum turbidity removal is important for management of chemical cost, for effective performance, and to avoid aquatic toxicity. The optimum dose in a given application depends on several site-specific features. Turbidity of untreated water can be important with turbidities greater than 5,000 NTU. The surface charge of particles to be removed is also important. Environmental factors that can influence dosage rate are water temperature, pH, and the presence of constituents that consume or otherwise affect coagulant effectiveness. Laboratory experiments indicate that mixing previously settled sediment (floc sludge) with the untreated stormwater significantly improves clarification, therefore reducing the effective dosage rate. Preparation of working solutions and thorough dispersal of coagulants in water to be treated is also important to establish the appropriate dosage rate.

For a given water sample, there is generally an optimum dosage rate that yields the lowest residual turbidity after settling. When dosage rates below this optimum value (underdosing) are applied, there is an insufficient quantity of coagulant to react with, and therefore destabilize, all of the turbidity present. The result is residual turbidity (after flocculation and settling) that is higher than with the optimum dose. Overdosing, application of dosage rates greater than the optimum value, can also negatively impact performance. Like underdosing, the result of overdosing is higher residual turbidity than that with the optimum dose.

Mixing

The G-value, or just "G", is often used as a measure of the mixing intensity applied during coagulation and flocculation. The symbol G stands for “velocity gradient”, which is related in part to the degree of turbulence generated during mixing. High G-values mean high turbulence, and vice versa.

High G-values provide the best conditions for coagulant addition. With high G's, turbulence is high, and coagulants are rapidly dispersed to their appropriate concentrations for effective destabilization of particle suspensions.

Low G-values provide the best conditions for flocculation. Here, the goal is to promote formation of dense, compact flocs that will settle readily. Low G's provide low turbulence to promote particle collisions so that flocs can form. Low G's generate sufficient turbulence such that collisions are effective in floc formation, but do not break up flocs that have already formed.

pH Adjustment

The pH must be in the proper range for the coagulants to be effective, which is typically 6.5 to 8.5. As polymers tend to lower the pH, it is important that the stormwater have sufficient buffering capacity. Buffering capacity is a function of alkalinity. Without sufficient alkalinity, the application of the polymer may lower the pH to below 6.5. A pH below 6.5 not only reduces the effectiveness of the polymer as a coagulant, but it may also create a toxic condition for aquatic organisms. Stormwater may not be discharged without readjustment of the pH to above 6.5. The target pH should be within 0.2 standard units of the receiving water's pH.

Experience gained at several projects in the City of Redmond has shown that the alkalinity needs to be at least 50 mg/L to prevent a drop in pH to below 6.5 when the polymer is added.

Maintenance Standards

Monitoring

At a minimum, the following monitoring shall be conducted. Test results shall be recorded on a daily log kept on site. Additional testing may be required by the NPDES Permit based on site conditions.

Operational Monitoring:

- Total volume treated and discharged.
- Flow must be continuously monitored and recorded at not greater than 15-minute intervals.
- Type and amount of chemical used for pH adjustment.
- Type and amount of coagulant used for treatment.
- Settling time.

Compliance Monitoring:

- Influent and effluent pH, flocculent chemical concentration, and turbidity must be continuously monitored and recorded at not greater than 15-minute intervals.
- pH and turbidity of the receiving water.

Biomonitoring:

- Treated stormwater must be non-toxic to aquatic organisms. Treated stormwater must be tested for aquatic toxicity or residual

chemical content. Frequency of biomonitoring will be determined by Ecology.

- Residual chemical tests must be approved by Ecology prior to their use.
- If testing treated stormwater for aquatic toxicity, you must test for acute (lethal) toxicity. Bioassays shall be conducted by a laboratory accredited by Ecology, unless otherwise approved by Ecology. Acute toxicity tests shall be conducted per the CTAPE protocol.

Discharge Compliance

Prior to discharge, treated stormwater must be sampled and tested for compliance with pH, flocculent chemical concentration, and turbidity limits. These limits may be established by the Construction Stormwater General Permit or a site-specific discharge permit. Sampling and testing for other pollutants may also be necessary at some sites. The pH must be within the range of 6.5 to 8.5 standard units and not cause a change in the pH of the receiving water of more than 0.2 standard units.

Treated stormwater samples and measurements shall be taken from the discharge pipe or another location representative of the nature of the treated stormwater discharge.

Samples used for determining compliance with the water quality standards in the receiving water shall not be taken from the treatment pond prior to decanting. Compliance with the water quality standards is determined in the receiving water.

Operator Training

Each contractor who intends to use chemical treatment shall be trained by an experienced contractor on an active site. Each site using chemical treatment must have an operator trained and certified by an organization approved by Ecology.

Sediment Removal and Disposal

- Sediment shall be removed from the storage or treatment cells as necessary. Typically, sediment removal is required at least once during a wet season and at the decommissioning of the cells.
- Sediment remaining in the cells between batches may enhance the settling process and reduce the required chemical dosage.
- Sediment that is known to be non-toxic may be incorporated into the site away from drainages.

BMP C251: Construction Stormwater Filtration

Purpose

To remove sediment from runoff originating from disturbed areas of the site using filtration.

Conditions of Use

Traditional BMPs used to control soil erosion and sediment loss from sites under development may not be adequate to ensure compliance with the water quality standard for turbidity in the receiving water. Filtration may be used in conjunction with gravity settling to remove sediment as small as fine silt (0.5 µm). The reduction in turbidity will be dependent on the particle size distribution of the sediment in the stormwater. In some circumstances, sedimentation and filtration may achieve compliance with the water quality standard for turbidity.

The use of construction stormwater filtration does not require prior approval from Ecology or Thurston County as long as treatment chemicals are not used. Filtration in conjunction with BMP C250: Construction Stormwater Chemical Treatment requires testing under the Chemical Technology Assessment Protocol – Ecology (CTAPE) before it can be initiated. Approval from the appropriate regional Ecology office and acceptance by Thurston County must be obtained at each site where chemical use is proposed prior to use. For more guidance on stormwater chemical treatment see BMP C250.

Design and Installation Specifications

Two types of filtration systems may be applied to construction stormwater treatment: rapid and slow.

Rapid filtration systems are the typical system used for water and wastewater treatment. They can achieve relatively high hydraulic flow rates, on the order of 2 to 20 gpm/sf, because they have automatic backwash systems to remove accumulated solids.

Slow filtration systems have very low hydraulic rates, on the order of 0.02 gpm/sf, because they do not have backwash systems. To date, slow filtration systems have generally been used as post construction BMPs to treat stormwater. Slow filtration is mechanically simple in comparison to rapid filtration but requires a much larger filter area.

Filtration Types and Efficiencies

Sand media filters are available with automatic backwashing features that can filter to 50 µm particle size. Screen or bag filters can filter down to 5 µm. Fiber wound filters can remove particles down to 0.5 µm. Sequence filters from the largest to the smallest pore opening. Sediment removal efficiency will be related to particle size distribution in the stormwater.

Treatment Process and Description

Stormwater is collected at interception point(s) on the site and is diverted to a sediment pond or tank for removal of large sediment and storage of the stormwater before it is treated by the filtration system. The untreated stormwater is pumped from the trap, pond, or tank through the filtration system in a rapid sand filtration system. Slow sand filtration systems are designed as flow through systems using gravity.

Sizing

Filtration treatment systems must be designed to control the velocity and peak volumetric flow rate that is discharged from the system and consequently the project site. See Element 3: Control Flow Rates for further details on this requirement.

The untreated stormwater storage pond or tank should be sized to hold 1.5 times the volume of runoff generated from the site during the 10-year, 24-hour storm event, minus the filtration treatment system flowrate for an 8-hour period. For a chitosan-enhanced sand filtration system, the filtration treatment system flowrate should be sized using a hydraulic loading rate between 6-8 gpm/ft2. Other hydraulic loading rates may be more appropriate for other systems. Bypass should be provided around the filtration treatment system to accommodate extreme storm events. Runoff volume shall be calculated using the methods presented in Volume III, Appendix III-B Single Event Model Guidance. Worst-case land cover conditions (i.e., producing the most runoff) should be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

If the filtration treatment system design does not allow you to discharge at the rates as required by Element #3: Control Flow Rates, and if the site has a permanent Flow Control BMP that will serve the planned development, the discharge from the filtration treatment system may be directed to the permanent Flow Control BMP to comply with Element #3: Control Flow Rates. In this case, all discharge (including water passing through the treatment system and stormwater bypassing the treatment system) will be directed into the permanent Flow Control BMP. If site constraints make locating the untreated stormwater storage pond difficult, the permanent Flow Control BMP may be divided to serve as the untreated stormwater storage pond and the post-treatment temporary flow control pond. A berm or barrier must be used in this case so the untreated water does not mix with the treated water. Both untreated stormwater storage requirements, and adequate post-treatment flow control must be achieved. The designer must document in the Construction SWPPP how the permanent Flow Control BMP is able to attenuate the discharge from the site to meet the requirements of Element #3: Control Flow Rates. If the design of the permanent Flow Control BMP was modified for temporary construction flow control purposes, the construction of the permanent Flow Control BMP must be finalized, as designed for its permanent function, at project completion.

Maintenance Standards

- Rapid sand filters typically have automatic backwash systems that are triggered by a pre-set pressure drop across the filter. If the backwash water volume is not large or substantially more turbid than the stormwater stored in the holding pond or tank, backwash return to the pond or tank may be appropriate. However, land application or another means of treatment and disposal may be necessary. Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged.
- Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged.
- Sediment shall be removed from the storage and/or treatment ponds as necessary. Typically, sediment removal is required once or twice during a wet season and at the decommissioning of the ponds.
- Disposal of filtration equipment must comply with applicable local, state, and federal regulations.

BMP C252: Treating and Disposing of High pH Water

Purpose

When pH levels in stormwater rise above 8.5, it is necessary to lower the pH levels to the acceptable range of 6.5 to 8.5 prior to discharge to surface or groundwater. A pH level range of 6.5 to 8.5 is typical for most natural watercourses, and this neutral pH is required for the survival of aquatic organisms. Should the pH rise or drop out of this range, fish and other aquatic organisms may become stressed and may die.

Conditions of Use

- The water quality standard for pH in Washington State is in the range of 6.5 to 8.5. Stormwater with pH levels exceeding water quality standards may be either neutralized on site or disposed of to a sanitary sewer or concrete batch plant with pH neutralization capabilities.

- Neutralized stormwater may be discharged to surface waters under the Construction Stormwater General permit.

- Neutralized process water such as concrete truck wash-out, hydro-demolition, or sawcutting slurry must be managed to prevent discharge to surface waters. Any stormwater contaminated during concrete work is considered process wastewater and must not be discharged to water of the State or stormwater collection systems.

- The process used for neutralizing and/or disposing of high pH stormwater from the site must be documented in the Construction Stormwater Pollution Prevention Plan.

Causes of High pH

High pH at construction sites is most commonly caused by the contact of stormwater with poured or recycled concrete, cement, mortars, and other Portland cement or lime-containing construction materials. (See BMP C151: Concrete Handling for more information on concrete handling procedures.) The principal caustic agent in cement is calcium hydroxide (free lime).

Calcium hardness can contribute to high pH values and cause toxicity that is associated with high pH conditions. A high level of calcium hardness in waters of the state is not allowed. Groundwater standard for calcium and other dissolved solids in Washington State is less than 500 mg/l.

Treating High pH Stormwater by Carbon Dioxide Sparging

Advantages of CO_2 Sparging

- Rapidly neutralizes high pH water

- Cost effective and safer to handle than acid compounds
- CO_2 is self-buffering. It is difficult to overdose and create harmfully low pH levels.
- Material is readily available.

The Chemical Process of Carbon Dioxide Sparging

When carbon dioxide (CO_2) is added to water (H_2O), carbonic acid (H_2CO_3) is formed which can further dissociate into a proton (H^+) and a bicarbonate anion (HCO_3^-) as shown below:

$$CO_2 + H_2O \longleftrightarrow H_2C0_3 \longleftrightarrow H^+ + HCO_3^-$$

The free proton is a weak acid that can lower the pH. Water temperature has an effect on the reaction as well. The colder the water temperature is the slower the reaction occurs and the warmer the water temperature is the quicker the reaction occurs. Most construction applications in Washington State have water temperatures in the 50°F or higher range so the reaction is almost simultaneous.

The Treatment Process of Carbon Dioxide Sparging

- High pH water may be treated using continuous treatment, continuous discharge systems. These manufactured systems continuously monitor influent and effluent pH to ensure that pH values are within an acceptable range before being discharged.
- All systems must have fail safe automatic shut off switches in the event that pH is not within the acceptable discharge range.
- Only trained operators may operate manufactured systems. System manufacturers often provide trained operators or training on their devices.
- The following procedure may be used when not using a continuous discharge system:
    - Prior to treatment, Thurston County must be notified.
    - Every effort should be made to isolate the potential high pH water in order to treat it separately from other stormwater on-site.
    - Water should be stored in an acceptable storage facility, detention pond, or containment cell prior to treatment.
    - Transfer water to be treated for pH to the pH treatment structure. Ensure that pH treatment structure size is sufficient to hold the amount of water that is to be treated. Do not fill the pH treatment structure completely, allow at least 2 feet of freeboard.

- The operator samples the water within the pH treatment structure for pH and notes the clarity of the water. As a rule of thumb, less CO_2 is necessary for clearer water. The results of the samples and water clarity observations shall be recorded.
- In the pH adjustment structure, add CO_2 until the pH falls in the range of 6.9 to 7.1. Remember that pH water quality standards apply so adjusting pH to within 0.2 pH units of receiving water (background pH) is recommended. It is unlikely that pH can be adjusted to within 0.2 pH units using dry ice. Compressed carbon dioxide gas should be introduced to the water using a carbon dioxide diffuser located near the bottom of the tank; this will allow carbon dioxide to bubble up through the water and diffuse more evenly.
- Slowly discharge the water making sure water does not get stirred up in the process. Release about 80 percent of the water from the pH treatment structure leaving any sludge behind. If turbidity remains above the maximum allowable, consider adding filtration to the treatment train.
- Discharge treated water through a pond or drainage system.
- Excess sludge needs to be disposed of properly as concrete waste. If several batches of water are undergoing pH treatment, sludge can be left in the treatment structure for the next batch treatment. Dispose of sludge when it fills 50 percent of tank volume.
- Disposal must comply with applicable local, state, and federal regulations.

Treating High pH Stormwater by Food Grade Vinegar

Food grade vinegar that meets FDA standards may be used to neutralize high pH water. Food grade vinegar is only 4% to 18% acetic acid with the remainder being water. Food grade vinegar may be used if dosed just enough to lower pH sufficiently. Use a treatment process as described above for CO2 sparging, but add food grade vinegar instead of CO2.

This treatment option for high pH stormwater does not apply to anything but food grade vinegar. Acetic acid does not equal vinegar. Any other product or waste containing acetic acid must go through the evaluation process in Appendix G of Whole Effluent Toxicity Testing Guidance and Test Review Criteria (Marshall, 2016).

Disposal of High pH Stormwater

Sanitary Sewer Disposal

Local sewer authority approval is required prior to disposal via the sanitary sewer.

Concrete Batch Plant Disposal

- Only permitted facilities may accept high pH water.
- Contact the facility to ensure they can accept the high pH water.

Maintenance Standards

Safety and Materials Handling

- All equipment should be handled in accordance with OSHA rules and regulations
- Follow manufacturer guidelines for materials handling.

Operator Records

- Each operator should provide:
  - A diagram of the monitoring and treatment equipment
  - A description of the pumping rates and capacity the treatment equipment is capable of treating.
- Each operator shall keep a written record of the following:
  - Client name and phone number.
  - Date of treatment.
  - Weather conditions.
  - Project name and location.
  - Volume of water treated.
  - pH of untreated water.
  - Amount of CO2 needed to adjust water to a pH range of 6.9 to 7.1.
  - pH of treated water.
  - Discharge point location and description.

A copy of this record shall be given to the client/contractor who shall retain the record for 3 years.

3.3 Low Impact Development BMPs

3.3.1 Introduction

To ensure that LID stormwater facilities and BMPs will be fully functional after construction, it is important to protect these BMPs during construction activities. Protecting native soil and vegetation, minimizing soil compaction, and retaining the

hydrologic function of LID BMPs during the site preparation and construction phases are some of the most important practices during the development process.

The purpose of this section is to provide designers, builders, and inspectors with guidance and tools for meeting Core Requirement #2, Element #13 – Protect Low Impact Development BMPs. This section does not provide guidance on construction or design of LID BMPs (see Volume III, V, and VI), or cover all Construction SWPPP practices (see Sections 3.1 and 3.2), but rather focuses on how to most efficiently reduce impacts on LID BMPs specifically during construction. The practices specified in Section 3.3 must be applied to protect LID BMPs, unless the given practice does not apply to the project site conditions or activities.

General

3.3.2 Erosion and Sediment Control BMPs Applicable to LID

Overall Construction Stormwater Pollution Prevention Plan (SWPPP) requirements are specified in Volume I, Core Requirement #2 and Volume II. In general, Construction SWPPP BMPs limit the impact of site disturbance, erosion, and sediment deposition during construction. Some Construction SWPPP BMPs (presented in more detail in Sections 3.1 and 3.2) focus on providing a physical barrier or deterrent to help minimize construction-related site disturbance and/or erosion, while other Construction SWPPP BMPs help protect the site from concentrated (i.e., erosive) flows. General Construction SWPPP BMPs and their application for protection of LID BMPs are summarized below. These BMPs must be considered for projects subject to Core Requirement #2 that are proposing to construct LID BMPs.

Table II - 3.19 LID Construction BMPs

Construction SWPPP BMP	Application	Section Reference
BMP C103: High Visibility Fence	Use fencing to limit clearing; prevent disturbance of sensitive areas, their buffers, and other areas; limit construction traffic; and protect areas where marking with flagging may not provide adequate protection	3.1
BMP C200: Interceptor Dike and Swale	Use an interceptor dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled	3.2
BMP C201: Grass Lined Channels	Use grass lined channels where concentrated runoff may cause erosion and flooding of the site	3.2
BMP C207: Check Dams	Use check dams in swales or ditches to reduce the velocity and dissipate concentrated flow	3.2
BMP C208: Triangular Silt Dike	(TSD) (Geotextile Encased Check Dam) Use triangular silt dikes as check dams, for perimeter protection, temporary soil stockpile protection, drop inlet protection, or as a temporary interceptor dike	3.2
BMP C231: Brush Barrier	Use brush barriers to decrease flow velocities and reduce transport of coarse sediment from overland flow	3.2
BMP C233: Silt Fence	Use silt fences to decrease flow velocities and reduce transport of sediment from overland flow	3.2
BMP C234: Vegetated Strip	Use vegetated strips to decrease flow velocities and reduce transport of sediment from overland flow	3.2

3.3.3 Additional Construction Techniques for LID BMPs

In addition to the general Construction SWPPP BMPs presented in Section 3.3.2, this section outlines construction-phase techniques to protect LID BMPs. LID BMP protection is still a somewhat new and evolving practice, therefore the specific LID BMP protection measures outlined below are not explicitly called out in Sections 3.1 and 3.2. Rather, the techniques presented in this section supplement the Construction SWPPP BMPs presented above and in Sections 3.1 and 3.2. (Note: these techniques can be

applied to any site, not just those incorporating LID, but these techniques are particularly important for LID BMP protection.)

3.3.4 Construction Site Planning and Sequencing

Construction site planning and sequencing is a procedural BMP that is critical to successful installation and long-term operation of LID BMPs. Proper site planning and construction sequencing will minimize the impact of construction on permanent stormwater facilities by reducing the potential for soil erosion and compaction. Site planning and sequencing techniques to be used as practicable for protection of LID BMPs include:

Table II - 3.20 Construction Sequencing

Construction Site Planning and Sequencing Requirements	Construction Site Planning and Sequencing Techniques
Limit clearing and grading activities	• Keep grading to a minimum by incorporating natural topographic depressions into the development. • Shape final lot grades and topographic features early (i.e., at the site development stage) where feasible. • Limit the amount of cut and fill in areas with permeable soils. • Limit clearing to road, utility, building pad, lawn areas, and the minimum amount of extra land necessary to maneuver machinery (e.g., a 10-foot perimeter around a building).
Limit construction activity in areas designated for LID	• Clearly document – and plan to meet and walk through the site with equipment operators prior to construction – to clarify construction boundaries, limits of disturbance, and construction activities in the vicinity of LID BMPs. • General/primary contractor must inform other subcontractors of applicable LID BMP protection requirements. This is particularly important when working around permeable pavement.
Limit clearing and grading during heavy rainfall seasons	• Time construction activities to start during the summer (lowest precipitation) and end in the fall (when conditions are favorable for the establishment of vegetation), if feasible.
Minimize the amount and time that graded areas are left exposed	• Complete construction and erosion control activities in one section of the site before beginning activity in another section.

Construction Site Planning and Sequencing Requirements	Construction Site Planning and Sequencing Techniques
Utilize permeable and nutrient rich soils	• Preserve any portion of the site with permeable soils to promote infiltration of stormwater runoff. • Leave areas of rich topsoil in place, or if excavated, utilize elsewhere on the site to amend areas with sparse or nutrient deficient topsoil.
Reduce impact of construction access roads	• Reduce the number and size (width/length) of construction access roads. • Locate construction access roads in areas where future roads and utility corridors will be placed (unless utilizing permeable pavement).
Promote sheet flow and minimize concentrated runoff	• Avoid grading that results in steep, continuous slopes, especially in areas contributing runoff to LID BMPs.
LID BMP activation	• LID BMPs shall not begin operation until all erosion causing project improvements (including use of access roads that may contribute sediment) are completed and all exposed ground surfaces are stabilized by revegetation or landscaping in upland areas potentially contributing runoff to the BMP.

3.3.5 Activities During Construction

Many common construction-phase activities pose a risk to LID BMPs. The following techniques will help minimize these impacts. Techniques to be used for protection of LID BMPs include:

Table II - 3.21 LID Erosion Control Requirements

Erosion Control Requirements	Erosion Control Techniques
Protect native topsoil during the construction phase, and reuse on-site	• Where practicable, protect areas of rich topsoil. If excavation is necessary, stockpile native soils that can be used on the site after construction. • Stockpile materials in areas designated for clearing and grading (such as parking areas and future impervious roadways) and away from infiltration and other stormwater facilities. • Cover small stockpiles with weed barrier material that sheds moisture yet allows air transmission. Large stockpiles may need to be seeded and/or mulched.

Erosion Control Requirements	Erosion Control Techniques
	• Do not relocate topsoil or other material to areas where they can cover critical root zones, suffocate vegetation, or erode into adjacent streams.
Use effective revegetation methods	• Use native plant species adapted to the local environment. • Plant during late fall, winter, or early spring months when vegetation is likely to establish quickly and survive. • Utilize proper seedbed preparation. • Fertilize and mulch to protect germinating plants. Apply 1 inch of compost topped with 2 inches of mulch. • Protect areas designated for revegetation from soil compaction by restricting heavy equipment. • Provide proper soil amendments where necessary (refer to Volume III, Section 3.1). • During storage, plants should be protected by solar screens when possible to prevent overexposure and excessive drying.
Perform preconstruction, routine, and post-construction inspections	• Conduct a preconstruction inspection to verify that adequate barriers have been placed around vegetation retention areas, infiltration facilities (as needed), and structural controls are implemented properly. • Conduct routine inspections to verify that structural controls are being maintained and effectively protecting LID BMPs throughout construction. • Conduct a final inspection to verify that revegetation areas are stabilized and that permanent LID BMPs are in place and functioning properly.

3.3.6 BMP-specific Construction Techniques

This section outlines construction-phase BMP protection techniques specific to categories of LID BMPs (e.g., infiltration and dispersion) as well as specific LID BMPs (permeable pavement, bioretention areas/rain gardens, and vegetated roofs). The BMP protection techniques presented previously in Section 3.3.3 are applicable to the overall construction site to help protect LID BMPs. The techniques outlined in this section are based on the specific BMP functions, targeting typical construction activities that pose a risk to individual BMPs.

3.3.7 Infiltration and Dispersion Facility Construction Techniques

It is critical that appropriate methods are used to protect infiltration and dispersion BMPs from compaction and sediment loading during construction. For infiltration facilities in particular, the subgrade soils must be protected from clogging and over-compaction to maintain the soil permeability and ensure BMP performance. Techniques for protection of infiltration and dispersion BMPs during various stages of construction are summarized below.

Table II - 3.22 Techniques for Protecting Infiltration and Dispersion Facilities

Construction Stage	Techniques for Protecting Infiltration and Dispersion Facilities
Prior to construction	• The infiltration/dispersion area shall be clearly identified (e.g., using flagging or high visibility fencing) and protected prior to construction to prevent compaction of underlying soils by vehicle traffic. • Develop a soil and vegetation management plan showing areas to be protected and restoration methods for disturbed areas before land clearing starts. • The Construction SWPPP sheets must outline construction sequencing that will protect the infiltration/dispersion area during construction. • Construction SWPPP BMPs and protection techniques identified in Sections 3.3.2 and 3.3.3 shall be implemented as applicable. In particular, be sure to stabilize upslope construction areas (e.g., using silt fences, berms, mulch, or other Construction SWPPP BMPs) and minimize overland flow distances.
Excavation	• Excavation of infiltration/dispersion areas shall be performed by machinery operating adjacent to the BMP. No heavy equipment with narrow tracks, narrow tires, or large lugged high pressure tires shall be allowed on the infiltration/dispersion area footprint. • Where feasible, excavate infiltration/dispersion areas to final grade only after all disturbed areas in the up-gradient project drainage area have been permanently stabilized. (If infiltration areas must be excavated before permanent site stabilization, initial excavation must be conducted to no less than 6 inches of the final elevation of the facility floor.) • Excavation of infiltration areas shall not be allowed during wet or saturated conditions. • The use of draglines and track hoes should be considered for constructing infiltration and dispersion areas. • The sidewalls and bottom of an infiltration facility excavation must be raked or scarified to a minimum depth of 3 inches after final excavation to restore infiltration rates. • Scarify soil along the dispersion flow path if disturbed during construction.
Sediment control	• Bioretention, rain garden, and permeable pavement BMPs shall not be used as sediment control facilities, and all drainage shall be directed away from the BMP location after initial rough grading. • Direct construction site flow away from the infiltration/dispersion area using applicable Construction SWPPP BMPs (e.g., temporary diversion swales)

3.3.8 Permeable Pavement

There are many potential applications and site scenarios where permeable pavement can be applied. The following techniques highlight the most broadly applicable techniques to be used to protect permeable pavement BMPs during construction. Refer to the previous section for construction protection methods that are applicable to all infiltration BMPs, as well as Section 3.3.2 and 3.3.3 for general site protection measures. In addition to those techniques, the following techniques apply specifically for protection of permeable pavement during construction:

- Use procedural BMPs to plan construction. For example, phase construction to minimize compaction, sedimentation, or structural damage to the permeable pavement.
- Use physical Construction SWPPP BMPs and/or grade the site to avoid sediment laden runoff from reaching permeable pavements.
- Place protective surfaces (e.g., waterproof tarps and steel plates) over any permeable pavement areas used for construction staging.
- Do not drive sediment-laden construction equipment on the base material or pavement. Do not allow sediment-laden runoff on permeable pavements or base materials.
- Once the pavement is finished and set, cover the pavement surface with plastic and geotextile to protect from other construction activities. Close and protect the pavement area until the site is permanently stabilized.
- Incorporate measures to protect road subgrade from over compaction and sedimentation if permeable pavement roads are used for construction access.
    - Cover the aggregate base or pavement surface with protective geotextile fabric and protect fabric with steel plates or gravel. Gravel should only be used to protect the fabric placed over aggregate base.
    - Once construction is complete and the site is permanently stabilized, remove protective geotextile, clean, and complete pavement installation.

Refer to the detailed permeable pavement BMP information in Volume III, Section 3.5 for general permeable pavement construction criteria.

3.3.9 Bioretention Areas and Rain Gardens

As with permeable pavements, there are many potential applications and site scenarios where bioretention and rain garden BMPs can be applied. The following techniques highlight the most broadly applicable techniques to be used to protect bioretention and rain garden BMPs during construction. Refer to the beginning of this section for

construction protection methods that are applicable to all infiltration BMPs, as well as Section 3.3.2 and 3.3.3 for general site protection measures. In addition to those techniques, the following techniques apply specifically for protection of bioretention and rain garden BMPs during construction:

- Excavation:
  - If machinery must operate in the bioretention area for excavation, use lightweight, low ground-contact pressure equipment and rip the base at completion to scarify soil to a minimum of 12 inches.
- Protect bioretention soil mix from compaction during construction
  - Do not place bioretention soil mix if saturated or during wet periods.
  - Check for compaction prior to planting. If compaction occurs, aerate the bioretention soil and then proceed to plant.

Refer to the detailed bioretention and rain garden BMP information in Volume V, Section 2.2.5 for general bioretention and rain garden construction criteria.

3.3.10 Vegetated Roofs

The following additional techniques apply for protection of vegetated roof facilities during construction:

- Because of their location and complexity, vegetated roofs typically require more planning and coordination effort relative to ground-level landscaping. For new construction, a critical path approach is highly recommended to establish the sequence of tasks for construction of the vegetated roof system.
- During construction, it is vitally important that the waterproof membrane be protected once installed. The waterproofing should be tested prior to placement of the growth media and other subsequent vegetated roof materials.

Refer to the detailed vegetated roof BMP information in Volume III for general construction criteria.

Resource Materials

Association of General Contractors of Washington, Water Quality Manual.

Clark County Conservation District, Erosion and Runoff Control, January 1981.

King County Conservation District, Construction and Erosion Control, December 1981.

King County Department of Transportation Road Maintenance BMP Manual (Final Draft), May 1998.

King County Surface Water Design Manual, September 1998.

Maryland Erosion and Sedimentation Control Manual, 1983.

Michigan State Guidebook for Erosion and Sediment Control, 1975.

Snohomish County Addendum to the 1992 Ecology Stormwater Management Manual for the Puget Sound Basin, September 1998.

University of Washington, by Loren Reinelt, Construction Site Erosion and Sediment Control Inspector Training Manual, Center for Urban Water Resources Management, October 1991.

University of Washington, by Loren Reinelt, Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity, Center for Urban Water Resources Management, October 1991.

Virginia Erosion and Sediment Control Handbook, 2nd Edition, 1980.

Appendix II-A
Recommended Standard Notes for Construction Stormwater Pollution Prevention Plans

The following standard notes are suggested for use in the erosion control plan prepared as part of the construction stormwater pollution prevention plan (SWPPP). The County has other mandatory notes for construction plans that may be applicable, see Volume I Appendix I-G. Plans should also identify with phone numbers the person or firm responsible for the preparation of and maintenance of the erosion control plan.

Standard Notes

1. Acceptance of this erosion/sediment control (ESC) plan by Thurston County does not constitute an acceptance of permanent road or drainage design (e.g., size and location of roads, pipes, restrictors, channels, retention facilities, utilities, etc.).
2. The implementation of this ESC plan and the construction, maintenance, replacement, and upgrading of ESC facilities is the responsibility of the owner and contractor until all construction is completed and approved and vegetation/landscaping is established.
3. The boundaries of the clearing limits shown on this plan shall be clearly flagged in the field prior to construction. During the construction period, no disturbance beyond the flagged clearing limits shall be permitted. The flagging shall be maintained by the applicant/contractor for the duration of construction.
4. The ESC facilities shown on this plan must be constructed in conjunction with all clearing and grading activities, and in such a manner as to ensure that sediment and sediment laden water does not enter the drainage system, roadways, or violate applicable water standards.
5. The ESC facilities shown on this plan are the core requirements for anticipated site conditions. During the construction period, these ESC facilities shall be upgraded as needed for unexpected storm events and to ensure that sediment and sediment-laden water do not leave the site.
6. The ESC facilities shall be inspected daily by the applicant/contractor and maintained as necessary to ensure their continued functioning.
7. The ESC facilities on inactive sites shall be inspected and maintained a minimum of once a month or within the 48 hours following a major storm event (>1” in 24 hours).
8. At no time shall more than 1 foot or 1/3 of the sump volume, whichever is less, of sediment be allowed to accumulate within a trapped catch basin. All catch basins and conveyance lines shall be cleaned prior to paving. The cleaning operation shall not flush sediment laden water into the downstream system.

9. Stabilized construction entrances shall be installed at the beginning of construction and maintained for the duration of the project. Additional measures may be required to ensure that all paved areas are kept clean for the duration of the project.

Appendix II-B Stormwater Pollution Prevention Site Plan Checklist

The Stormwater Pollution Prevention Site Plan Checklist is available for download on the Thurston County Drainage Design and Erosion Control Manual website at https://www.thurstoncountywa.gov/sw/Pages/dm.aspx. If you need a paper copy, please contact Thurston County Water Resources Division at 360-754-4681.