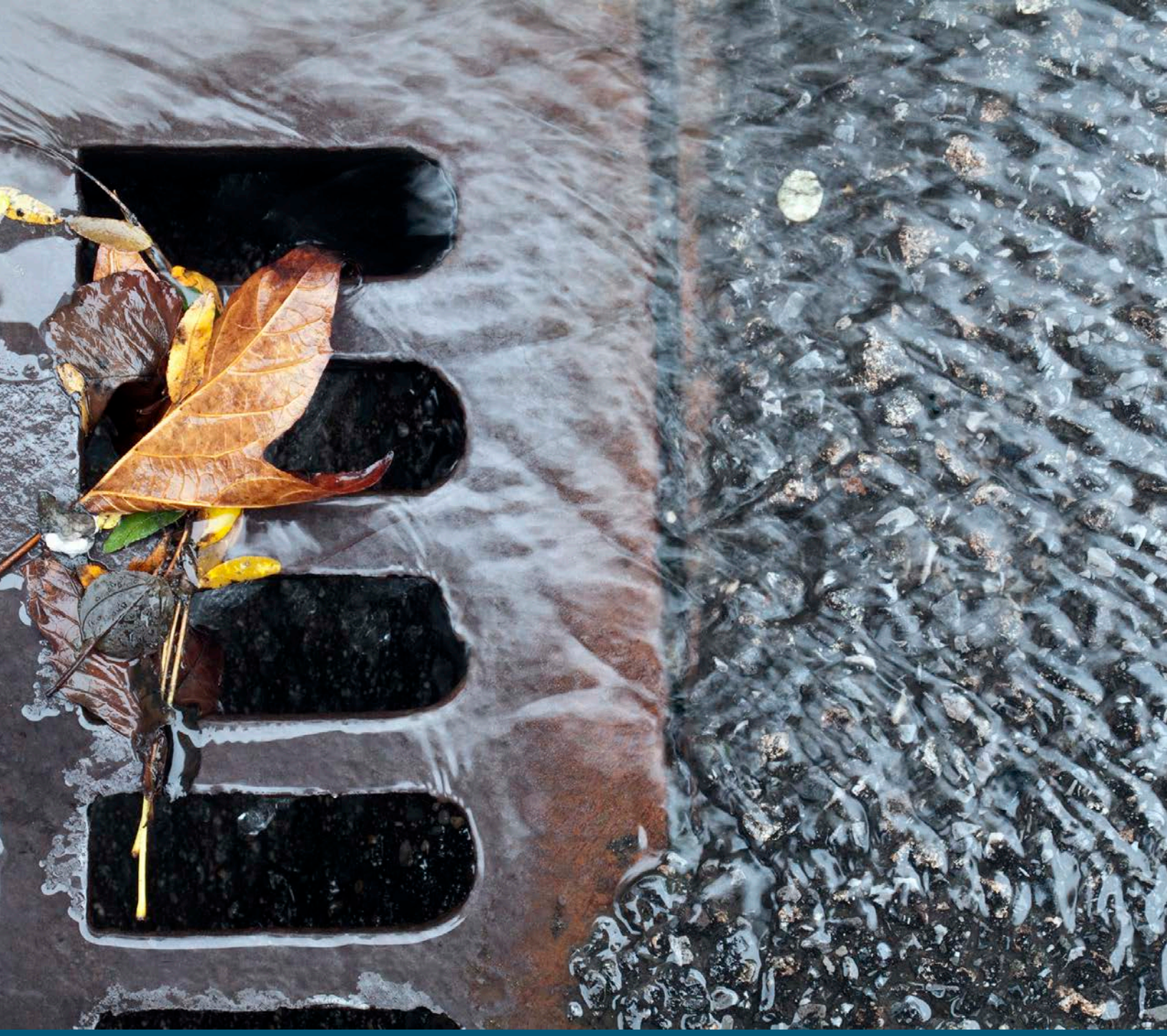


Pierce County Stormwater Management and Site Development Manual

Adopted July 2021

Table of Contents

Volume I Minimum Technical Requirements and Site Planning

Chapter 1. Introduction 1-1
1.1 Objective 1-1
1.2 Organization of this Manual 1-2
1.3 How to Use this Volume 1-3
1.4 Site Design Techniques and Requirements 1-4
1.5 Maintenance of Stormwater Best Management Practices 1-5
1.6 Development of BMPs for Stormwater Management 1-5
1.7 Relationship of this Manual to Federal, State, and Local Regulatory Requirements 1-6
Chapter 2. Minimum Requirements for New Development and Redevelopment 2-1
2.1 Overview 2-1
2.2 Exemptions 2-2
2.3 Applicability of the Minimum Requirements 2-2
2.4 Minimum Requirements 2-7
Chapter 3. Drainage Control Plan and Abbreviated Plan Submittal Requirements 3-1
3.1 Projects and Activities Requiring Plan Submittal 3-1
3.2 Abbreviated Plan 3-3
3.3 Drainage Control Plan 3-8
Chapter 4. BMP and Facility Selection Process for Permanent Stormwater Control Plans 4-1
4.1 Purpose 4-1
4.2 BMP and Facility Selection Process 4-1
Volume I References Ref-1
Appendix I-A – Example Maintenance Checklists A-1
Appendix I-B – Wetland Protection Guidelines B-1
Appendix I-C –Underground Injection Control (UIC) Program Guidelines C-1
Glossary, Acronyms, and Notations GLOS-1

Volume II Construction Stormwater Pollution Prevention

Chapter 1. Introduction to Construction Stormwater Pollution Prevention 1-1
1.1 Purpose of This Volume 1-1
1.2 Content and Organization of This Volume 1-1
1.3 Thirteen Elements of Construction Stormwater Pollution Prevention 1-2

1.4 Water Quality Standards 1-2
Chapter 2. Planning 2-1
2.1 General Guidelines 2-1
2.2 Construction SWPPP Requirements 2-3
2.3 Step-by-Step Procedure 2-7
Chapter 3. Best Management Practices Standards and Specifications 3-1
3.1 Source Control BMPs 3-1
3.2 Runoff Conveyance and Treatment BMPs 3-53
3.3 Protection of LID Facilities During Construction 3-113
Appendix II-A –
Recommended Standard Notes for Construction Stormwater Pollution Prevention Plans A-1

Volume III Hydrologic Analysis and Flow Control BMPs

Chapter 1. Introduction 1-1
1.1 Purpose of This Volume 1-1
1.2 Content and Organization of This Volume 1-2
1.3 How to Use This Volume 1-2
Chapter 2. Hydrologic Analysis and Design Standards 2-1
2.1 Minimum Computational Standards 2-1
2.2 Western Washington Hydrology Model 2-4
2.3 Closed Depression Analysis 2-7
2.4 Flow Control Criteria 2-8
2.5 Infiltration Facilities for Flow Control 2-8
2.6 Underground Injection Control 2-17
Chapter 3. Flow Control Design 3-1
3.1 Soil Preservation and Amendment (Ecology BMP T5.13) 3-1
3.2 Dispersion Facilities 3-6
3.3 Tree Planting and Tree Retention (for Flow Control Credit, Ecology BMP T5.16) 3-13
3.4 Bioretention Cells, Swales, and Planter Boxes (Ecology BMPs T5.14 and T7.30) 3-19
3.5 Permeable Paving (Ecology BMP T5.15) 3-40
3.6 Infiltration Trenches (Ecology BMP T7.20) 3-57
3.7 Infiltration Basins (Ecology BMP T7.10) 3-59
3.8 Rain Gardens (Ecology BMP T5.14A) 3-61
3.9 Roof Downspout Controls 3-65

3.10 Vegetated Roofs (Ecology BMP T5.17) 3-78
3.11 Roof Rainwater Collection Systems (Ecology BMP T5.20) 3-82
3.12 Detention Facilities 3-85
Chapter 4. Conveyance Systems and Hydraulic Structures 4-1
4.1 Overview 4-1
4.2 Design Event Storm Frequency 4-1
4.3 Determination of Design Flows 4-2
4.4 Backwater Analysis 4-2
4.5 Conveyance System Route Design 4-2
4.6 Easements, Access, and Dedicated Tracts 4-3
4.7 Pipe System Design Criteria 4-4
4.8 Outfalls 4-12
4.9 Flow Spreading Options 4-14
4.10 Culvert Criteria 4-20
4.11 Open Conveyances 4-22
4.12 Private Drainage Systems 4-22
Volume III References and Information Sources Ref-1
Appendix III-A –
Methods for Determining Design Infiltration Rates A-1
Appendix III-B –
Design Aids: Design Storm Precipitation Values, Isopluvial Maps, SCS Curve Numbers, Roughness Coefficients, and Soil Types B-1
Appendix III-C –
Nomographs for Various Culvert Sizing Needs C-1
Appendix III-D –
Onsite Stormwater Management BMP Infeasibility Criteria D-1

Volume IV Source Control

Chapter 1. Introduction to Volume IV 1-1
1.1 What is the Purpose of this Volume? 1-1
1.2 How Do I Know Whether Any of this Applies to Me? 1-1
1.3 What Type of Pollutants are Targeted with This Volume? 1-1
1.4 What are Best Management Practices? 1-3
1.5 Explanation of Required BMPs 1-4
1.6 What if I am Already Implementing Best Management Practices? 1-5

1.7 How Do I Get Started? 1-6
1.8 Some Important Requirements to Note 1-6
Chapter 2. Worksheet for Commercial and Industrial Activities 2-1
Chapter 3. Best Management Practices for Single-Family Residences 3-1
3.1 Automobile Washing 3-1
3.2 Automobile Maintenance 3-2
3.3 Storage of Solid Wastes and Yard Wastes 3-2
3.4 Composting 3-4
3.5 Yard Maintenance and Gardening 3-5
3.6 Swimming Pool and Spa Cleaning and Maintenance 3-6
3.7 Household Hazardous Material Use, Storage, and Disposal 3-7
3.8 Pet Waste Management 3-9
3.9 On-Site Sewage Maintenance and Operation 3-10
3.10 Activities in Wetlands and Wetland Buffers 3-11
Chapter 4. Best Management Practices for Commercial and Industrial Activities 4-1
Chapter 5. Source Control Best Management Practices 5-1
5.1 Index of BMP Descriptions 5-1
5.2 Source Control BMPs 5-2
Chapter 6. Regulations and Requirements 6-1
6.1 Pierce County Codes and Ordinances 6-1
6.2 State, Federal, and Other Regulations and Requirements 6-2
Chapter 7. Quick Reference Phone Numbers and Websites 7-1
Volume IV References Ref-1
Appendix IV-A –
Recycling/Disposal of Vehicle Fluids/Other Wastes* A-1
Appendix IV-B –
Example of an Integrated Pest Management Program B-1
Appendix IV-C –
Recommendations for Management of Street Wastes C-1

Volume V Runoff Treatment BMPs

Chapter 1. Introduction 1-1
1.1 Purpose of This Volume 1-1
1.2 Content and Organization of This Volume 1-1
1.3 How to Use This Volume 1-1

1.4 Runoff Treatment Facilities 1-1
Chapter 2. Treatment Facility Selection Process 2-1
2.1 Step-by-Step Selection Process for Treatment Facilities 2-1
2.2 Other Treatment Facility Selection Factors 2-8
Chapter 3. Treatment Facility Menus 3-1
3.1 Guide to Applying Menus 3-1
3.2 Oil Control Menu 3-1
3.3 Phosphorus Treatment Menu 3-3
3.4 Enhanced Treatment Menu 3-4
3.5 Basic Treatment Menu 3-5
Chapter 4. General Requirements for Stormwater Treatment Facilities 4-7
4.1 Design Volume and Flow 4-7
4.2 Sequence of Facilities 4-9
4.3 Facility Liners 4-9
Chapter 5. Pretreatment 5-1
5.1 Purpose 5-1
5.2 Applications 5-1
5.3 Best Management Practices for Pretreatment 5-1
Chapter 6. Infiltration and Bioretention Treatment Facilities 6-1
6.1 Purpose 6-1
6.2 Applications and Limitations 6-1
6.3 Soil Requirements for Infiltration for Water Quality Treatment 6-2
6.4 Best Management Practices for Infiltration and Bioretention Treatment 6-3
Chapter 7. Filtration Treatment Facilities 7-1
7.1 Purpose 7-1
7.2 Description 7-1
7.3 Performance Objectives 7-11
7.4 Applications and Limitations 7-11
7.5 Site Suitability 7-11
7.6 Design Requirements 7-12
7.7 Construction Criteria 7-13
7.8 Best Management Practices for Sand Filtration 7-14
Chapter 8. Biofiltration Treatment Facilities 8-1
8.1 Purpose 8-1

8.2 Applications 8-1
8.3 Site Suitability 8-1
8.4 Best Management Practices 8-1
Chapter 9. Wet Pool Facilities 9-1
9.1 Purpose 9-1
9.2 Applications 9-1
9.3 Best Management Practices for Wet Pool Facilities 9-1
Chapter 10. Oil and Water Separators 10-1
10.1 Purpose 10-1
10.2 Description 10-1
10.3 Performance Objectives 10-1
10.4 Site Suitability 10-1
10.5 Design Criteria – General Considerations 10-4
10.6 Oil and Water Separator BMPs 10-5
Chapter 11. Emerging Technologies 11-1
11.1 Background 11-1
11.2 Evaluation of Emerging Technologies 11-1
11.3 Applicability and Restrictions 11-1
Volume V References Ref-1
Appendix V-A – Geotextile Specifications A-1

Volume VI Comprehensive Low Impact Development Site Designs

Chapter 1. Introduction and Requirements 1-1
1.1 Volume Intent 1-1
1.2 Applicability and Administration 1-1
1.3 Performance Goal and Objectives 1-2
1.4 Conduct a Site Analysis Prior to Designing a LID Project 1-3
Chapter 2. Low Impact Development Strategies and BMPs 2-1
2.1 Introduction 2-1
2.2 Maintenance Criteria 2-1
2.3 Full Dispersion (Ecology BMP T5.30) 2-1
2.4 Better Site Design (Ecology BMP T5.41) 2-11
2.5 Preserving Native Vegetation (Ecology BMP T5.40) 2-14
2.6 Restoring Site Vegetation 2-15

2.7 Minimize Impervious Areas 2-17
2.8 Soil Preservation and Amendment (Ecology BMP T5.13) 2-20
Chapter 3. Easements, Maintenance, and Enforcement 3-1
3.1 Dedicated Tracts and Conservation Easements 3-1
3.2 Maintenance Requirements 3-1
3.3 Enforcement 3-1
Volume VI References Ref-1

Attachments - Sections A through H

Section A - Quantity Design Details A-3
Section B - Quality Design Details B-1
Section C - Erosion and Sediment Control Plan Details C-1
Section D - Soil Evaluation Report Forms D-1
Section E - Standard Stormwater Notes E-1
Section F - Stormwater Facility Informational Sign Specifications F-1
Section G - Covenants Forms F-4
Section H - Change Order Review Form F-6

Pierce County
Stormwater Management and Site Development Manual

Volume I
Minimum Technical Requirements and Site Planning

Prepared by: Pierce County Planning & Public Works

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Table of Contents

Volume I Minimum Technical Requirements and Site Planning

Chapter 1. Introduction 1-1

1.1 Objective 1-1

1.2 Organization of this Manual 1-2

1.2.1 Overview of Manual Content 1-2

1.2.2 Organization of this Manual 1-2

1.2.3 Organization of Volume I 1-3

1.3 How to Use this Volume 1-3

1.4 Site Design Techniques and Requirements 1-4

1.4.1 Site Planning and Layout 1-4

1.4.2 Protection and Establishment of Natural Buffer Areas 1-4

1.5 Maintenance of Stormwater Best Management Practices 1-5

1.6 Development of BMPs for Stormwater Management 1-5

1.6.1 Best Management Practices 1-5

1.6.2 Construction Stormwater BMPs (Volume II) 1-5

1.6.3 Flow Control BMPs (Volume III) 1-5

1.6.4 Source Control BMPs (Volume IV) 1-6

1.6.5 Treatment BMPs (Volume V) 1-6

1.6.6 Low Impact Development – LID (Volume III & VI) 1-6

1.7 Relationship of this Manual to Federal, State, and Local Regulatory Requirements 1-6

1.7.1 The Manual's Role as Technical Guidance and Requirements 1-7

1.7.2 More Stringent Measures 1-8

1.7.3 Presumptive Versus Demonstrative Approaches to Protecting Water Quality 1-8

1.7.4 Phase I – NPDES and State Waste Discharge Stormwater Permits for Municipalities 1-8

1.7.5 Industrial Stormwater General Permit 1-9

1.7.6 Construction Stormwater General Permit 1-9

1.7.7 Endangered Species Act 1-10

1.7.8 Section 401 Water Quality Certifications (included in JARPA) 1-10

1.7.9 Hydraulic Project Approvals (included in JARPA) 1-11

1.7.10 Aquatic Lands Use Authorizations (included in JARPA) 1-11

1.7.11 Requirements Identified through Watershed/Basin Planning or Total Maximum Daily Loads 1-11

1.7.12 Underground Injection Control – UIC Program....1-11
Chapter 2. Minimum Requirements for New Development and Redevelopment....2-1
2.1 Overview....2-1
2.2 Exemptions....2-2
2.3 Applicability of the Minimum Requirements....2-2
2.3.1 New Development....2-5
2.3.2 Redevelopment....2-6
2.4 Minimum Requirements....2-7
2.4.1 Minimum Requirement #1: Preparation of Stormwater Site Plans....2-7
2.4.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention....2-7
2.4.3 Minimum Requirement #3: Source Control of Pollution....2-8
2.4.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls....2-9
2.4.5 Minimum Requirement #5: Onsite Stormwater Management....2-10
2.4.6 Minimum Requirement #6: Runoff Treatment....2-16
2.4.7 Minimum Requirement #7: Flow Control....2-18
2.4.8 Minimum Requirement #8: Wetlands Protection....2-23
2.4.9 Minimum Requirement #9: Operation and Maintenance....3-2
2.4.10 Minimum Requirement #10: Financial Liability....3-2
Chapter 3. Drainage Control Plan and Abbreviated Plan Submittal Requirements....3-1
3.1 Projects and Activities Requiring Plan Submittal....3-1
3.2 Abbreviated Plan....3-3
3.2.1 Abbreviated Plans – Basic and Advanced Plan Requirements....3-4
3.2.2 Abbreviated Plan – Critical Areas Requirements....3-5
3.2.3 Abbreviated Plan – Supporting Documents and Calculations....3-5
3.2.4 Abbreviated Plan – Licensed Engineer Required for Roads....3-5
3.2.5 Abbreviated Plan – Drawing Size and Quality....3-5
3.2.6 Abbreviated Plan – Site Development Drawings....3-6
3.2.7 Abbreviated Plan – Construction SWPPP Requirements (Advanced Plans Only)....3-7
3.2.8 Abbreviated Plan – Soils Report Requirements (Advanced Plans Only)....3-7
3.2.9 Abbreviated Plan – Establishment of Maintenance Covenant (Advanced Plans Only)....3-8
3.3 Drainage Control Plan....3-8
3.3.1 Phased Project Submittals....3-10

3.3.2 Drainage Control Plan – General Site Development Drawing Requirements .. 3-10
3.3.3 Drainage Control Plan – Site Development Drawings 3-11
3.3.4 Drainage Control Plan – Drainage Report 3-14
3.3.5 Drainage Control Plan – Construction SWPPP Report 3-21
3.3.6 Drainage Control Plan – Maintenance and Source Control Manual 3-23
3.3.7 Drainage Control Plan – Establishment of Maintenance Covenant 3-25
Chapter 4. BMP and Facility Selection Process for Permanent Stormwater Control Plans 4-1
4.1 Purpose 4-1
4.2 BMP and Facility Selection Process 4-1
Step I: Determine and Read the Applicable Minimum Requirements 4-1
Step II: Select Source Control BMPs 4-1
Step III: Determine Threshold Discharge Areas and Applicable Requirements for Treatment, Flow Control, and Wetlands Protection 4-1
Step IV: Select Flow Control BMPs and Facilities 4-3
Step V: Select Treatment Facilities 4-4
Step VI: Review Selection of BMPs and Facilities 4-4
Step VII: Complete Development of Permanent Stormwater Control Plans and Submittals 4-4
Volume I References Ref-1
Appendix I-A – Example Maintenance Checklists A-1
Appendix I-B – Wetland Protection Guidelines B-1
B.1 Scope and Principles for Wetland Protection B-1
B.1.1 Purpose B-1
B.1.2 Wetland Rating System B-1
B.1.3 Regulatory Authority B-1
B.1.4 Wetland Protection Levels B-2
B.1.5 Informational Needs B-2
B.2 General Protection B-2
B.3 Protection from Pollutants B-3
B.4 Wetland Hydroperiod Protection B-3
B.4.1 Method 1: 1-yr Wetland Monitoring and Wetland Stage Modeling B-4
B.4.2 Method 2: Site Discharging Modeling B-6
B.5 Wetland Hydroperiod Data Collection and Evaluation Procedures B-7
B.5.1 Method 1 ..... B-7

B.5.2 Method 2 ..... B-11
B.6 Compensatory Mitigation of Wetlands B-12
B.7 Jurisdictional Planning for Wetland Protection from Stormwater B-13
B.8 Wetland Protection Definitions B-17
Appendix I-C –Underground Injection Control (UIC) Program Guidelines C-1
C.1 Introduction to UIC Wells C-1
C.2 Rule-Authorization or Permit C-2
C.3 Registration C-2
C.3.1 New UIC Wells C-2
C.3.2 Existing UIC Wells C-2
C.4 Meeting the Non-Endangerment Standard C-2
C.4.1 New UIC Wells C-3
C.4.2 Existing UIC Wells C-3
C.4.3 Requirements for Municipal UIC Wells C-3
C.5 Well Assessment C-4
C.5.1 Evaluating High Threat to Groundwater C-4
C.6 Preservation and Maintenance Projects C-5
C.7 Emergency Situations C-5
C.8 The Presumptive Approach C-5
C.9 The Demonstrative Approach C-6
C.10 Siting and Design Of New UIC Wells C-6
C.10.1 Minimum Sitting Requirements for Rule-Authorization of New UIC Wells C-6
C.10.2 Design and Construction Requirements for Rule-Authorization of New UIC Wells C-8
C.11 Operation and Maintenance of UIC Wells C-9
C.12 Prohibitions C-9
C.13 Source Control and Runoff Treatment Requirements C-10
C.13.2 Runoff Treatment C-11
C.14 Spills and Illicit Discharges C-14
C.15 Deep UIC Wells C-14
C.16 Determining Treatment Requirements C-15
C.16.1 Exceptions Based on Site-Specific or Local Studies C-16
C.16.2 Vadose Zone Treatment Capacity C-17
C.17 Classification of Vadose Zone Treatment Capacity C-17

C.17.1 Classification of Vadose Zone Treatment Capacity C-19
C.17.2 Depth to Groundwater C-20
C.18 Site Suitability Criteria (SSC) C-24
C.19 UIC Program Guidelines - Definitions C-27
Glossary, Acronyms, and Notations GLOS-1
Glossary GLOS-1
Acronyms GLOS-38
Notations GLOS-40

List of Tables

Table 2.1 - Onsite Stormwater Management Requirements for Projects Triggering Minimum Requirements #1 – #10. 2-12

Table 2.2 - The List Approach for Minimum Requirement #5 Compliance 2-14

Table 3.1 - Thresholds for Abbreviated Plans, Construction Stormwater Pollution Prevention Plans, and Drainage Control Plans. 3-2

Table 3.2 - Other Potential Permits 3-22

Table C.1. Examples of Geologic Material Descriptions C-17

Table C.2 Vadose Zone Treatment Capacity C-21

Table C.3 Pollutant Loading Classifications for Solids, Metals, and Oil in Stormwater Runoff Directed to UIC Wells C-23

Table C.4. Treatment Required for Solids, Oil, and Metals C-24

Table of Figures

Figure 2.1 - Flow Chart for Determining Requirements for New Development. 2-3
Figure 2.2 - Flow Chart for Determining Requirements for New Development. 2-4
Figure 2.3 - Flow Chart for Determining Minimum Requirement #5 Requirements 2-11
Figure 2.4 - Flow Chart for Determining Wetland Protection Level Requirements 3-1
Figure 3.1 - Typical Abbreviated Plan Components. 3-4
Figure 3.2 - Typical Drainage Control Plan Components. 3-10
Figure 4.1 - Threshold Discharge Areas 4-2
Figure C.1 - Schematic Vadose Zone Treatment Layer Example C-19

Chapter 1. Introduction

1.1 Objective

The objective of this manual is to provide guidance and requirements to control the quantity and quality of stormwater produced by new development and redevelopment, such that they comply with water quality standards and contribute to the protection of beneficial uses of the receiving waters.

Water quality standards include:

- Chapter 173-200 of the Washington Administrative Code (WAC), Water Quality Standards for Groundwaters of the State of Washington
- Chapter 173-201A WAC, Water Quality Standards for Surface Waters of the State of Washington
- Chapter 173-204 WAC, Sediment Management Standards.

This volume identifies the minimum requirements for stormwater control and site development requirements for all new development and redevelopment in the county and applies to all sites as detailed in Chapter 2 – Minimum Requirements for New Development and Redevelopment, and Chapter 3 – Drainage Control and Abbreviated Plan Submittal Requirements. These requirements are, in turn, satisfied by the application of best management practices (BMPs) from Volumes II through VI. The Director shall have the authority to increase requirements to protect the health, safety, and welfare of the public on the basis of information regarding threatened water quality, erosion problems, habitat destruction, historic flooding, protection of uninterruptible services, endangerment to property, or increases in requirements imposed by state or federal agencies or other pertinent factors.

Water quantity design criteria, water quality controls, erosion and sediment control practices, and site development are outlined in this manual and apply throughout the county, and within the jurisdictional boundaries of any governmental entity which adopts this manual. This manual is applicable to all types of land development – including residential, commercial, industrial, and roads.

- The intent and purpose of this manual is to:
- Establish criteria for review and analysis of all development
- Manage stormwater to minimize contact with contaminants
- Mitigate the impacts of increased runoff due to urbanization
- Manage runoff from developed property and that being developed
- Protect the health, safety, and welfare of the public.

It is not the intent of this manual to preclude alternative engineering solutions to design situations. It is expected that the professional engineer will bring to each project the best of his/her skills and abilities to see that the project is thoroughly analyzed and designed correctly, accurately, and in compliance with generally accepted engineering practices. Alternatives to standard plans, specifications, and design details found in this manual will be accepted if they meet or exceed the performance of these standards as determined by the County. Engineers are encouraged to be innovative. The burden of proof, however, is on the engineer to document that

his/her innovations meet or exceed the performance of the standards.

This manual is based on the premise that development and redevelopment shall not negatively impact adjacent and/or downstream property owners nor degrade groundwater or the natural drainage system, including but not limited to streams, ravines, wetlands, potholes, and rivers. Further, development activities should not impact adjacent and/or downstream property owners in a detrimental manner compared to the predeveloped condition.

It is not the intent of this manual to make Pierce County a guarantor or protector of public or private property with regards to land development activities.

Through this manual, Pierce County is complying with the Clean Water Act, the Puget Sound Water Quality Management Plan, and the National Pollutant Discharge Elimination System (NPDES) Stormwater Permit. Where requirements in this document are also covered in any other law, ordinance, resolution, rule, or regulation of any kind the more restrictive law shall govern.

1.2 Organization of this Manual

1.2.1 Overview of Manual Content

To accomplish the objective described in Section 1.1, the manual includes the following:

- **Minimum requirements** that cover a range of issues, such as submittal requirements, pollution prevention during the construction phase of a project, control of potential pollutant sources, treatment of runoff, control of stormwater flow volumes, protection of wetlands, and long-term operation and maintenance (O&M). The minimum requirements applicable to a project vary depending on the type and size of the proposed project.
- **Best management practices (BMPs)** that can be used to meet the minimum requirements. BMPs are schedules of activities, prohibitions of practices, maintenance procedures, managerial practices, or structural features that prevent or reduce pollutants or other adverse impacts to waters of Washington. BMPs are divided into those for short-term control of stormwater from construction sites (Volume II), and those addressing long-term management of stormwater at developed sites. Long-term BMPs are further subdivided into those covering management of the volume and timing of stormwater flows (Volume III and VI), prevention of pollution from potential sources (Volume IV), treatment of runoff to remove sediment and other pollutants (Volume V), and BMPs designed to achieve Comprehensive Low Impact Development (LID) Site Designs (Volume VI, as required by Pierce County Code [PCC] Title 18A – Development Regulations – Zoning, and PCC Title 18J – Development Regulations – Design Standards and Guidelines).
- **Guidance on how to prepare and implement stormwater submittals.** Chapter 3 of this volume covers Pierce County submittals required depending on the nature of the project or site characteristics.

1.2.2 Organization of this Manual

Volume I of this manual serves as an introduction, summarizes minimum requirements, and describes submittal requirements. The remaining volumes of this manual cover BMPs for specific aspects of stormwater management. Volumes II through VI are organized as follows:

- Volume II covers BMPs for short-term stormwater management at construction sites.
- Volume III covers hydrologic analysis and BMPs to control flow rates and volumes from

developed sites. Appendix III-D also provides a summary of onsite stormwater management BMP infeasibility criteria, to aid single family residential and other small project applicants.

- Volume IV addresses BMPs to minimize pollution generated by potential pollution sources at developed sites.
- Volume V presents BMPs to treat runoff that contains sediment or other pollutants from developed sites.
- Volume VI presents strategies, BMPs, and related guidelines and requirements for achieving Comprehensive LID Site Designs.

1.2.3 Organization of Volume I

Following this introduction, Volume I contains three additional chapters:

- *Chapter 2 – Minimum Requirements for New Development and Redevelopment* identifies the minimum requirements for stormwater management at all new development and redevelopment projects.
- *Chapter 3 – Drainage Control Plan and Abbreviated Plan Submittal Requirements* describes submittal requirements. One or more of the following submittals will be required depending on the nature of the project: Drainage Control Plan, Construction Stormwater Pollution Prevention Plan, Abbreviated Plan, and Maintenance and Source Control Manual. Chapter 3 describes each of these submittals and provides step-by-step guidance on how to develop these plans.
- *Chapter 4 – BMP and Facility Selection Process for Permanent Stormwater Control Plans* describes the process for selecting BMPs for long-term management of stormwater flows and quality.
- *Appendix IA – Example Maintenance Checklists* provides information on drainage facility O&M requirements.
- *Appendix IB – Wetland Protection Guidelines* provides information on stormwater management impacts and mitigation related to wetlands.
- *Appendix I-C – Underground Injection Control (UIC) Program Guidelines* provides information on site suitability, treatment requirements and design criteria for UIC Wells.

This volume concludes with a glossary of terms.

1.3 How to Use this Volume

To ensure that projects are in compliance with state, federal, and local regulations pertaining to stormwater, it is recommended that, at a minimum, project applicants refer to the following manual sections:

1. Chapter 1, Section 1.7 for general information on permits, regulations, and requirements that may apply to a project depending on its location and specific concerns of receiving waters.
2. Chapter 2 to determine what minimum requirements apply.
3. Chapter 3 to determine what submittal requirements apply. Submittal forms can be obtained from Pierce County Planning and Public Works' (PPW) website.

4. Chapter 4 to select appropriate BMPs.

These manual sections will direct the user to other relevant sections of the manual for specific BMP design guidance (Volumes III through VI) and construction practices (Volume II). For specific measures that must be implemented to achieve the County's Comprehensive LID Site Design requirements (per PCC Title 18A and 18J), refer to Volume VI.

1.4 Site Design Techniques and Requirements

The design professional is strongly encouraged to address the issue of stormwater management, both quantity and quality, in the early phases of the site planning process. Through careful consideration of site planning, effective impervious areas (EIAs) can be reduced thereby reducing the size and costs for facilities; efficient stormwater facilities can be integrated into the specific site parameters such as topography, soils, etc.; and source control measures can be utilized to prevent problems both during and post construction.

1.4.1 Site Planning and Layout

Some of the things that should be considered during site planning and layout include: minimizing creating impervious surfaces (e.g., roofs; and non-permeable roadways, roofs, sidewalks, parking, etc.); clustering buildings and preserving larger areas of open space; minimizing directly connected impervious areas (try to separate impervious surfaces with areas of turf, or other vegetation); incorporation of low maintenance landscaping that doesn't need frequent applications of fertilizers, herbicides, and pesticides; and minimizing the impact area and soil compaction during construction.

The approach to considering and minimizing stormwater impacts at the site layout stage is commonly referred to as low impact development (LID). Low impact development is a land use development strategy that emphasizes protection and use of onsite natural features integrated with engineered, small-scale hydrologic controls at the parcel and subdivision scale to manage stormwater and more closely mimic predevelopment watershed hydrologic functions. This is achieved by recognizing and focusing on the relationship among the overland and subsurface flow, infiltration, storage, and evapotranspiration characteristics of the site. Low impact development strategies focus on evaporating, transpiring, and infiltrating stormwater onsite through native or amended soils, vegetation, and bioengineering applications to reduce and treat overland flow. Additional details on LID approaches and requirements in Pierce County are outlined in Volume III. Requirements for meeting the county's specific requirements for Comprehensive LID Site Designs (per PCC Title 18A and 18J) are provided in Volume VI.

1.4.2 Protection and Establishment of Natural Buffer Areas

Natural buffer areas may be required to protect drainage courses from erosion and pollutants. Natural buffer areas are required adjacent to all wetlands, per the County's requirements, as documented in the Pierce County Wetland Atlas and required by the Critical Areas Ordinance, PCC Title 18E. Where development is proposed near buffer zones that have been established by the County near an environmentally sensitive area, obtain the County's regulations regarding buffer zones.

Natural buffer areas are not to be confused with vegetated filter strips. Specifically, untreated sediment laden waters will not be allowed to discharge directly to a natural buffer area for treatment. Further, concentrated flows that could cause erosive damages will not be allowed.

1.5 Maintenance of Stormwater Best Management Practices

The importance of maintenance for the proper functioning of stormwater control facilities cannot be over-emphasized. Maintenance is crucial to performance of runoff treatment and flow control BMPs with a substantial portion of failures (clogging of filters, resuspension of sediments, loss of storage capacity, etc.) of such facilities resulting from inadequate maintenance. In addition, maintenance must be a basic consideration in design and in determination of cost. Therefore, provisions to facilitate maintenance operations must be built into the project when the BMP is installed.

Likewise, for both private and public facilities, it is important to include maintenance personnel early and throughout the design process. During discussions with maintenance personnel, describe the maintenance procedures that will need to be performed on the BMP. This will help ensure that future maintenance work and potential access needs are clearly understood.

The description of each BMP in subsequent volumes includes a brief section on facility maintenance. Appendix IA includes additional information on stormwater maintenance, including a detailed checklist of maintenance requirements for all drainage facilities. In addition, Section 3.3.6 outlines the specific requirements related to the project Maintenance and Source Control Manual submittal.

1.6 Development of BMPs for Stormwater Management

1.6.1 Best Management Practices

BMPs are activities, restrictions, or constructed stormwater facilities, that when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to waters of Washington. The types of BMPs are source control, treatment, flow control, and LID (also referred to as onsite stormwater management BMPs). BMPs that involve construction of engineered structures are often referred to as facilities in this manual. For instance, the BMPs referenced in the menus in Volume V, Chapter 3 are called treatment facilities.

The primary purpose of using BMPs is to protect beneficial uses of water resources through the reduction of pollutant loads and concentrations, through reduction of discharges (volumetric flow rates) causing stream channel erosion, and through reductions in deviations from natural hydrology. If it is found that, after the implementation of BMPs advocated in this manual, beneficial uses are still threatened or impaired, additional controls may be required.

1.6.2 Construction Stormwater BMPs (Volume II)

Construction stormwater BMPs can be source control, treatment, or flow control BMPs. Examples include stabilized construction entrances, silt fences, check dams, and sediment traps. Volume II contains construction stormwater BMPs.

1.6.3 Flow Control BMPs (Volume III)

Flow control BMPs typically control the volume, rate, frequency, and flow duration of stormwater surface runoff. The need to provide flow control BMPs depends on where the development site runoff is discharged to, e.g., to a stream system, wetland, or closed depression – either directly or indirectly.

Construction of a detention pond is probably the most common means of meeting flow control requirements. Construction of an infiltration facility is the preferred option but is feasible only

where more permeable soils are available.

Previous versions of the Pierce County Stormwater Management and Site Development Manual (2005 and earlier) focused primarily on controlling the peak flow release rates for recurrence intervals of concern – the 2, 10, and 100year rates. This level of control did not adequately address the increased duration at which those high flows occur because of the increased volume of water from the developed condition as compared to the predeveloped conditions. To protect stream channels from increased erosion, it is necessary to control the durations over which a stream channel experiences geomorphically significant flows such that the energy imparted to the stream channel does not increase significantly. Geomorphically significant flows are those that are capable of moving sediments. This target will translate into lower release rates and significantly larger detention ponds than earlier county standards. The size of such a facility can be reduced by changing the extent to which a site is disturbed. In addition, projects are encouraged to also look for means to improve or restore natural conditions to compliment, or in lieu of, traditional flow control measures. The onsite stormwater management BMPs presented in Volume III as well as Volume VI will help accomplish this goal. See also Section 1.6.6 below.

1.6.4 Source Control BMPs (Volume IV)

Source control BMPs typically prevent pollution, or other adverse effects of stormwater, from occurring. Source control BMPs are classified as operational or structural. Examples of source control BMPs include methods as various as using mulches and covers on disturbed soil, putting roofs over outside storage areas, and berming areas to prevent stormwater runon and pollutant runoff.

It is generally more cost effective to use source controls to prevent pollutants from entering runoff, than to treat runoff to remove pollutants. However, since source controls cannot prevent all impacts, some combination of measures will always be needed.

1.6.5 Treatment BMPs (Volume V)

Treatment BMPs include facilities that remove pollutants by simple gravity settling of particulate pollutants, centrifugal separation, filtration, biological uptake, and/or media or soil adsorption. Treatment BMPs can accomplish significant levels of pollutant load reductions if properly designed and maintained.

1.6.6 Low Impact Development – LID (Volume III & VI)

Low impact development is a land use development strategy that emphasizes protection and use of onsite natural features integrated with engineered, small-scale hydrologic controls at the parcel and subdivision scale to infiltrate and/or, disperse stormwater runoff onsite as a means to more closely mimic predevelopment watershed hydrologic functions. Certain onsite stormwater management BMPs and LID techniques are required as part of Minimum Requirement #5 (see Chapter 2), with additional techniques available to supplement or replace traditional stormwater approaches. Volume III presents design guidelines for several of the most common onsite stormwater management (i.e., LID) BMPs, while Volume VI outlines the County's specific requirements for Comprehensive LID Site Designs (per PCC Title 18A and 18J).

1.7 Relationship of this Manual to Federal, State, and Local

Regulatory Requirements

This section describes some of the local, state, and federal regulations and permits that may apply to your project depending on the nature of the project and site characteristics. Pierce County staff is available to help in determining which permits apply and helping project applicants through the permitting process.

The Pierce County website has information on the County's permitting process, including online permit information .

Permit information can also be obtained by calling the general information line at (253) 7983739, or visiting the Development Center Permit Counter at 2401 S. 35th Street in Tacoma.

The Joint Aquatic Resources Permit Application (JARPA) is another resource that can help to streamline the environmental permitting process. As noted in the following sections, several of the permits described in this section are included in the JARPA, so they can be covered under a single permit application. Refer to the Access Washington, one-stop epermitting website for more information .

1.7.1 The Manual's Role as Technical Guidance and Requirements

The Pierce County Stormwater Management and Site Development Manual is to be used for identifying, selecting, and designing BMPs and completing submittal requirements to comply with County permits.

The requirements of this manual apply to all unincorporated areas of Pierce County. These requirements also apply to cross-jurisdictional projects (e.g., utility, port, irrigation, drainage or flood control district, city, town, county, or other local, state, or federal government entity) located totally, or in part of, the County unless one of the following applies:

- Activity is exempted from submittal requirements (see Section 2.2).
- Development/redevelopment and stormwater activities are conducted in accordance with an approved stormwater management manual consistent with the Washington State Department of Ecology's Stormwater Management Manual for Western Washington (Ecology manual).

The manual provides technical guidance on measures to control the quantity and quality of stormwater runoff from new development and redevelopment projects. These measures are considered to be necessary to achieve compliance with state water quality standards and to contribute to the protection of the beneficial uses of the receiving waters (both surface and groundwaters). Stormwater management techniques applied in accordance with this manual are presumed to meet the technology-based treatment requirement of state law to provide all known available and reasonable methods of treatment, prevention, and control (AKART; Revised Code of Washington [RCW] 90.52.040 and RCW 90.48.010).

This technology-based treatment requirement does not excuse any discharge from the obligation to apply additional stormwater management practices as necessary to comply with state water quality standards. The state water quality standards include: Chapter 173200 WAC, Water Quality Standards for Ground Waters of the State of Washington; Chapter 173201A, Water Quality Standards for Surface Waters of the State of Washington; and Chapter 173204 WAC, Sediment Management Standards.

Severability

If any provisions of the manual or their application to any person or property are amended or held to be invalid, the remainder of the provisions in this manual in their application to other persons or circumstances shall not be affected.

Penalties and Enforcement

Penalties and enforcement shall be per PCC Title 17A.

Appeals

Appeals shall be handled per PCC Title 17A.

1.7.2 More Stringent Measures

Total maximum daily loads (TMDL) – which are also known as Water Cleanup Plans – may identify more stringent measures needed to restore water quality in an impaired water body. For more information, refer to the Washington State Department of Ecology (Ecology) website .

In addition, approved community plans may include additional stormwater management requirements applicable to new development. See PCC Title 18A and 18J.

1.7.3 Presumptive Versus Demonstrative Approaches to Protecting Water Quality

Wherever a discharge permit or other water-quality-based project approval is required, project applicants may be required to document the technical basis for the design criteria used to design their stormwater management BMPs. This includes: how stormwater BMPs were selected; the pollutant removal performance expected from the selected BMPs; the scientific basis, technical studies, and/or modeling which supports the performance claims for the selected BMPs; and an assessment of how the selected BMP will comply with Federal technology-based treatment requirements, state water quality standards, and satisfy "all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the State of Washington." This statutory requirement is generally known by the acronym AKART.

The BMPs presented in this manual are approved by Pierce County and Ecology and are *presumed* to protect water quality and instream habitat – and meet the stated environmental objectives of the regulations described in this chapter. Project applicants always have the option of not following the stormwater management practices in this manual. However, if a project applicant chooses not to follow the practices in the manual then the project applicant will be required to individually *demonstrate* that the project will not adversely impact water quality by collecting and providing appropriate supporting data to show that the alternative approach is protective of water quality and satisfies state and federal water quality laws. Project applicants interested in pursuing the demonstrative approach should contact Pierce County Planning and Public Works early in the process.

If a project applicant wants to follow the demonstrative approach for a water quality treatment BMP, the Ecology manual and website have more information on setting up an approved water quality monitoring plan to demonstrate that a project will protect water quality and satisfy state and federal laws. Additional Pierce County requirements will also apply. Contact Pierce County Planning and Public Works (PPW) for additional information (253) 798-3739.

1.7.4 Phase I – NPDES and State Waste Discharge Stormwater Permits for

Municipalities

Certain municipalities and other entities are subject to permitting under the U.S. Environmental Protection Agency (U.S. EPA) Phase I Stormwater Regulations (40 CFR Part 122). In western Washington, Ecology has issued joint NPDES and state waste discharge permits to regulate the discharges of stormwater from the municipal separate storm sewer systems operated by large cities and counties, including Pierce County.

The Phase 1 NPDES Municipal Stormwater Permit was reissued on July 1, 2019 and is available on the Ecology website .

1.7.5 Industrial Stormwater General Permit

Facilities covered under Ecology's Industrial Stormwater General Permit (i.e., NPDES and State Waste Discharge General Permit for Stormwater Discharges Associated With Industrial Activities) must manage stormwater in accordance with specific terms and conditions including: the development and implementation of an Industrial Stormwater Pollution Prevention Plan (Industrial SWPPP), monitoring, reporting, and ongoing adaptive management based on sampling and inspections.

The Industrial Stormwater General Permit (ISGP) requires Industrial SWPPPs to include certain mandatory BMPs, including those BMPs identified as "required" to specific industrial activities in Volume IV and V of this manual. Facilities with new development or redevelopment must evaluate whether flow control BMPs are necessary. BMPs must be consistent with this manual, or other stormwater management guidance documents that are approved by Ecology and incorporated into the ISGP. Facilities may also use alternative BMPs if their Industrial SWPPP includes documentation that the BMPs selected are demonstrably equivalent to practices contained in stormwater technical manuals approved by Ecology, including the proper selection, implementation, and maintenance of all applicable and appropriate best management practices for onsite pollution control.

Ecology's Industrial Stormwater Webpage has a fill-in-the-blank Industrial SWPPP template for use by industrial facilities.

1.7.6 Construction Stormwater General Permit

Coverage under the Construction Stormwater General Permit is generally required for any clearing, grading, and/or excavating if the project site discharges:

- Stormwater from the site into surface water(s) of the State, or
- Into storm drainage systems that discharge to a surface water(s) of the State. "Surface waters of the State" are broadly defined by state law and includes storm drains, ditches, wetlands, creeks, rivers, lakes, and marine waters.

And:

- Disturbs one or more acres of land area, or
- Disturb less than 1 acre of land area, if the project or activity is part of a larger common plan of development or sale.

Any construction activity discharging stormwater that Ecology and/or the County determines to be a significant contributor of pollutants to waters of the State may also require permit coverage, regardless of project size, at the discretion of the agencies.

The Construction Stormwater General Permit requires application of stabilization and structural practices to reduce the potential for erosion and the discharge of sediments from the site. The stabilization and structural practices cited in the permit are similar to the minimum requirements for sedimentation and erosion control (Minimum Requirement #2) in Chapter 2 of this volume. Developers must file a Notice of Intent with Ecology and develop a Construction SWPPP prior to beginning construction. It is the responsibility of the project applicant to contact Ecology to determine if these or other requirements apply to their project. However, to minimize review time and effort by both the project applicant and the County, the Construction SWPPP required by the County has been structured to be consistent with Ecology's Construction SWPPP requirements.

The permit also requires construction sites within western Washington to implement stormwater BMPs contained in stormwater management manuals published or approved by Ecology, or BMPs that are demonstrably equivalent. Volume II of this manual further describes the requirements and BMPs appropriate for managing construction site stormwater.

1.7.7 Endangered Species Act

With the listing of multiple species of salmon as threatened or endangered across much of Washington State, and the probability of more listings in the future, implementation of the requirements of the Endangered Species Act impacts many aspects of stormwater management. Provisions of the Endangered Species Act (ESA) that can apply to stormwater management include the Section 4(d) rules, Section 7 consultations, and Section 10 Habitat Conservation Plans (HCP).

The ESA can be of particular concern for construction sites because of potential adverse impacts from discharges of sediment, turbidity, or abnormal pH. Specific adverse impacts include:

- Suffocation of eggs or fry
- Displacement and elimination of aquatic invertebrates used for food
- Reduction in the biodiversity of aquatic invertebrates
- Reduction of foraging abilities in turbid water
- Irritation of gill tissue that can lead to disease or death
- Filling of resting or feeding areas, or spawning gravels with sediment.

These impacts could be determined to be a "take" under ESA.

The stranding of listed species behind erosion and sediment control features or the impairment of their access into certain areas due to the presence of erosion and sediment control features could also be determined to be a take under ESA.

For more information on ESA and how it affects your project, please contact the National Oceanic and Atmospheric Administration Fisheries Service or the U.S. Fish and Wildlife Service .

1.7.8 Section 401 Water Quality Certifications (included in JARPA)

For projects that require a fill or dredge permit under Section 404 of the Clean Water Act, Ecology must certify to the permitting agency, the U.S. Army Corps of Engineers that the proposed project will not violate water quality standards. In order to make such a determination, Ecology may do a more specific review of the potential impacts of a stormwater discharge from the construction phase of the project and from the completed project. As a result of that review, Ecology may condition its certification to require application of the minimum requirements in this volume, or more stringent requirements.

1.7.9 Hydraulic Project Approvals (included in JARPA)

Under Chapter 77.55 RCW, the Hydraulics Act, the Washington State Department of Fish and Wildlife (WDFW) has the authority to require actions when stormwater discharges related to a project would change the natural flow or bed of state waters. The implementing mechanism is the issuance of a Hydraulics Project Approval (HPA) permit. In exercising this authority, WDFW may require application of the minimum requirements in this volume, or more stringent requirements.

1.7.10 Aquatic Lands Use Authorizations (included in JARPA)

The Washington State Department of Natural Resources (WDNR), as the steward of public aquatic lands, may require a stormwater outfall to have a valid use authorization, and to avoid or mitigate resource impacts. Through its use authorizations, which are issued under authority of Chapter 79.90 through 96, Chapter 79.105-79.140 RCW, and in accordance with Chapter 33230 WAC, WDNR may require application of the minimum requirements in this volume, or more stringent requirements.

1.7.11 Requirements Identified through Watershed/Basin Planning or Total Maximum Daily Loads

A number of the requirements of this manual can be superseded by the adoption of ordinances and rules to implement the recommendations of watershed plans or basin plans. In accordance with the Watershed Management Act (Chapter 90.82 RCW) or the basin planning option per Chapter 40012 WAC, the state allows Pierce County to initiate their own watershed/ basin planning processes to identify more stringent or alternative requirements. As long as the actions or requirements identified in those plans and implemented through local or state ordinances or rules comply with applicable state and federal statutes, they can supersede the requirements in this manual. The decisions concerning whether such locally derived requirements comply with federal and state statutes rest with the regulatory agencies responsible for implementing those statutes.

A requirement of this manual can also be superseded or added to through the adoption of actions and requirements identified in a TMDL that is approved by the U.S. EPA. However, it is likely that at least some TMDLs will require use of the BMPs in this manual.

1.7.12 Underground Injection Control – UIC Program

One of the provisions of the Safe Drinking Water Act is to protect underground sources of drinking water (USDW). In 1984, Ecology received authority from the U.S. EPA to administer the Underground Injection Control (UIC) Program to protect USDW by regulating the discharges of fluids into the subsurface by UIC wells.

Ecology has adopted Chapter 173218 WAC to implement the program; however, the UIC program rule protects all groundwater, not just USDW. The U.S. EPA organizes UIC wells into six classes. The Washington UIC program regulates Class I through Class V UIC wells, except for wells located on tribal land. UIC wells used to manage stormwater are considered Class V wells. For more information visit Ecology's web page for the UIC program and "Guidance for UIC Wells that Manage Stormwater."

The UIC program has two requirements:

1. A non-endangerment performance standard must be met, prohibiting discharges that allow movement of fluids containing contaminants to reach groundwater.

2. All UIC facility owners/operators must complete online UIC well registration with Ecology.

The UIC program defines a UIC well as a well that is used to discharge fluids from the ground surface into the subsurface and is one of the following:

- A bored, drilled, or driven shaft, or dug hole whose depth is greater than the largest surface dimension; or
- A dug hole whose depth is greater than the largest surface dimension, or
- An improved sinkhole; which is a natural crevice that has been modified, or
- A subsurface fluid distribution system which includes perforated pipes, drain tiles or other similar mechanisms intended to distribute fluids below the surface of the ground.

Examples of UIC wells or subsurface infiltration systems are the following:

- Drywells
- Drainfields
- Infiltration trenches with perforated pipe
- Storm chamber systems with the intent to infiltrate
- French Drains
- Bioretention systems intending to infiltrate water from a perforated pipe below the treatment soil
- Other similar devices that discharge into the ground

The following are not UIC wells:

- Buried pipe and/or tile networks that serve to collect water and discharge that water to a drainage system or to a receiving water
- Surface infiltration basins and flow dispersion stormwater facilities
- Infiltration trenches designed without perforated pipe or a similar mechanism
- Bioretention systems transporting water via a perforated pipe to a drainage system or to a receiving water

Depending upon the manner in which it is accomplished, the discharge of stormwater into the ground can be classified as a Class V injection well. **UICs are required to be registered with Ecology** with the exception of UIC wells at single-family homes (or duplexes) that only receive residential roof runoff or for basement flooding control (WAC 173-218-070 (1)(e)).

The UIC rule (Chapter 173-218 WAC) applies to all Class V UIC wells that receive stormwater discharges. These wells must be sited, designed, constructed, managed, operated, and maintained according to the requirements throughout Appendix I-C -Underground Injection Control (UIC) Program Guidelines.

If all stormwater runoff from the project site discharges to a Class V UIC well, the Municipal Stormwater Permits do not pertain to the project, and the Minimum Requirements do not apply. The UIC rule (Chapter 173-218 WAC) applies in such cases. See Appendix I-C - Underground Injection Control (UIC) Program Guidelines for details on the rules, registration requirements, regulations, non-endangerment standard, treatment requirements and operation guidelines.

This manual represents several BMPs to infiltrate stormwater. Additional information on

underground injection control and how it applies to infiltration and stormwater management is included in Volume III, Section 2.6 and Appendix I-C. For more information and for a listing on potential stormwater facilities that may have Class V classification refer to the UIC Program available on Ecology's Website.

Chapter 2. Minimum Requirements for New Development and Redevelopment

2.1 Overview

This chapter identifies the 10 minimum requirements for stormwater management applicable to new development and redevelopment sites. The minimum requirements are:

1. Preparation of stormwater site plans
2. Construction stormwater pollution prevention
3. Source control of pollution
4. Preservation of natural drainage systems and outfalls
5. Onsite stormwater management
6. Runoff treatment
7. Flow control
8. Wetlands protection
9. Operation and maintenance
10. Financial liability.

Depending on the type and size of the proposed project, different combinations of these minimum requirements or UIC Program regulations apply. See Appendix I-C for information on the UIC Program regulations. In general, small sites are required to control erosion and sedimentation from construction activities and to apply simpler approaches for treatment and flow control of stormwater runoff from the developed site. Controlling flows from small sites is important because the cumulative effect of uncontrolled flows from many small sites can be as damaging as those from a single large site. For small sites, including single family and small commercial developments, Section 3.2 provides separate applicable submittal, design, and stormwater management requirements.

Larger sites must provide erosion and sedimentation control during construction, permanent control of stormwater runoff from the developed site through selection of appropriate BMPs and facilities, and other measures to reduce and control the onsite and offsite impacts of the project. Sites being redeveloped must generally meet the same minimum requirements as new development for the new hard surfaces and pervious surfaces converted to lawn or landscaped areas. Redevelopment sites must also provide erosion control, source control, and onsite stormwater management for the portion of the site being redeveloped. In addition, if the redevelopment meets certain cost or space (as applied to roads) thresholds, updated stormwater management for the redeveloped pervious and hard surfaces must be provided. There may also be situations in which additional controls are required for sites, regardless of type or size, as a result of basin plans or special water quality concerns.

Development sites are to demonstrate compliance with these requirements through the preparation of stormwater site plans. The plans are described in detail in Chapter 3.

Section 2.3 and 2.4 provide additional information on applicability of the minimum requirements to different types of sites, and Chapter 3 provides details on required stormwater-related plan

submittals.

Finally, it is important to note that other county requirements beyond those outlined in this chapter, but still related to stormwater management, may apply to a given project. For example, PCC Title 18J identifies situations where the County's requirements for Comprehensive LID Site Designs apply (see also Volume VI). Project proponents are responsible for identifying and addressing all requirements applicable to their proposed project.

2.2 Exemptions

See exemptions listed in PCC Title 17A. All other projects are subject to one or more of the minimum requirements (see Section 2.4).

2.3 Applicability of the Minimum Requirements

Not all of the minimum requirements apply to every development or redevelopment project. The applicability varies depending on the project type and size. This section identifies thresholds that determine the applicability of the minimum requirements to different projects. First, determine if all runoff is infiltrating into a UIC well (i.e. approved continuous runoff modeling methods indicate that the entire runoff file is infiltrated). If it is, refer to Appendix I-C – Underground Injection Control (UIC) Program Guidelines. If not, use the flow charts in Figures 2.1 and 2.2 to determine which of the minimum requirements apply. The minimum requirements themselves are presented in Section 2.4.

Note: For definitions related to the minimum requirements (impervious surface, redevelopment, converted pervious surface, pollutant generating surface, etc.) refer to the glossary in Volume I. A common question when using this section and figures 2.1. and 2.2. is whether gravel is considered an impervious surface. The answer to this question is yes. Gravel that is typically used in lieu of asphalt or concrete for parking areas, driveways or roads is considered an impervious surface. An existing gravel surface upgraded to concrete or asphalt is considered new impervious surface.

Use the thresholds in Figures 2.1 and 2.2 at the time of application for a subdivision, plat, short plat, building permit, or other construction permit. The plat or short plat approval shall identify permanent stormwater BMPs that are required for each lot.

Figure 2.1 - Flow Chart for Determining Requirements for New Development.

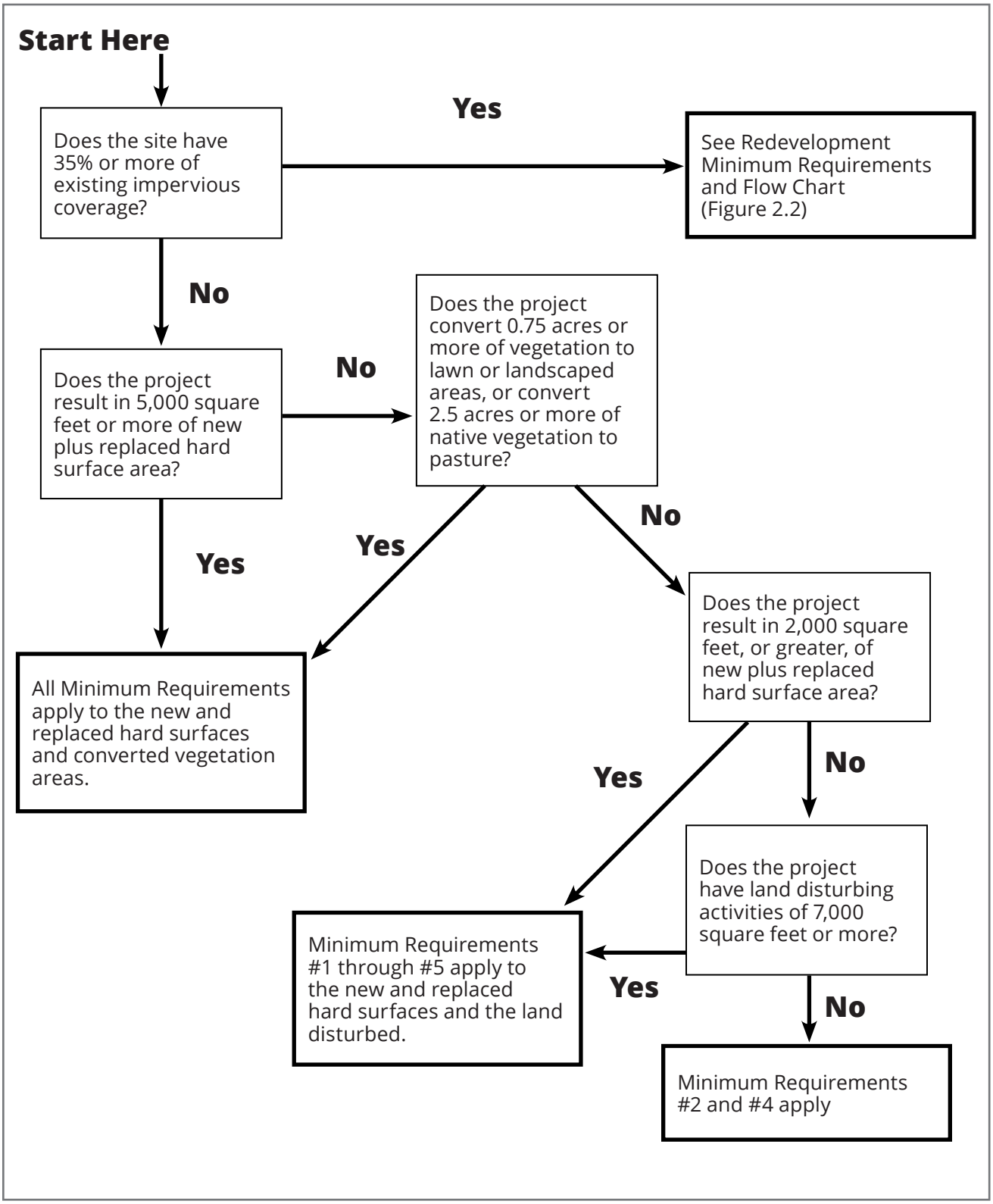
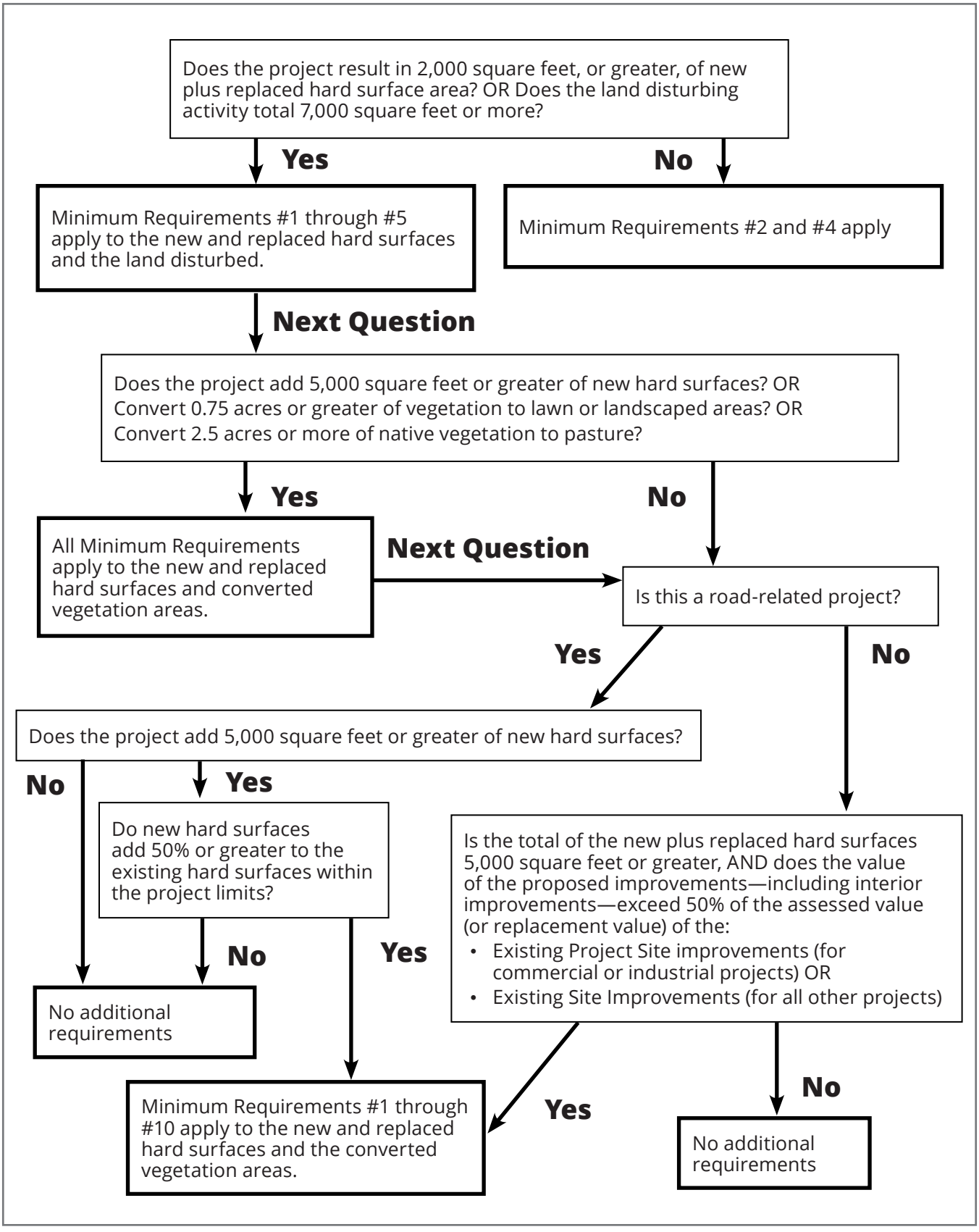


Figure 2.2 - Flow Chart for Determining Requirements for New Development.



2.3.1 New Development

All new development shall be required to comply with Minimum Requirement #2 and #4.

The following new development shall comply with Minimum Requirements #1 through #5 for the new and replaced hard surfaces and the land disturbed:

- Results in 2,000 square feet, or greater, of new, replaced, or new plus replaced hard surface area, or
- Has land disturbing activity of 7,000 square feet or greater.

The following new development shall comply with Minimum Requirements #1 through #10 for the new and replaced hard surfaces and the converted vegetation areas:

- Results in 5,000 square feet, or greater, of new plus replaced hard surface area, or
- Converts three-fourths acres, or more, of vegetation to lawn or landscaped areas, or
- Converts 2.5 acres, or more, of native vegetation to pasture.

Supplemental Guidelines

Approved community plans may include additional stormwater management requirements applicable to new development. See PCC Title 18A and 18J.

Regional stormwater facilities (new, or county-approved existing facilities) may be used as an alternative method of meeting Minimum Requirements #6, #7, and #8. Such facilities must be operational prior to development, and must have the capacity and capability to meet the performance criteria applicable to the new development, as documented through engineering reports detailing how the proposed facilities meet these requirements for the sites that drain to them.

Subdivisions

For the purposes of applying the thresholds in Chapter 3, Table 3.1, to a proposed subdivision (i.e., a plat or short plat project), the hard surface coverage, as well as the converted vegetation areas, must be specified for each lot and recorded with the County on the face of the final plat (or an alternative acceptable to the County).

Compensatory Flow Control or Treatment

Where new development projects require improvements (e.g., frontage improvements) that are not within the same threshold discharge area, Pierce County may allow the minimum requirements to be met for an equivalent (flow and pollution characteristics) area that drains to the same receiving water.

2.3.2 Redevelopment

All redevelopment shall be required to comply with Minimum Requirement #2 and #4.

The following redevelopment shall comply with Minimum Requirements #1 through #5 for the new and replaced hard surfaces and the land disturbed:

- Results in 2,000 square feet or greater, of *new plus replaced* hard surface area, or
- Has land disturbing activity of 7,000 square feet or greater.

The following redevelopment shall comply with Minimum Requirements #1 through #10 for the new hard surfaces and converted pervious areas:

- Adds 5,000 square feet or more of new hard surfaces
- Converts three-fourths acres, or more, of vegetation to lawn or landscaped areas
- Converts 2.5 acres, or greater, of native vegetation to pasture.

Pierce County may allow the minimum requirements to be met for an equivalent (flow and pollution characteristics) area within the same threshold discharge area (TDA).

Underground utility projects that replace the ground surface with in-kind material or materials with similar runoff characteristics should not be subject to redevelopment requirements except construction site erosion control (Minimum Requirement #2) and preservation of natural drainage systems and outfalls (Minimum Requirement #4).

Additional Requirements for Redevelopment

For road-related projects, runoff from the replaced and new hard surfaces (including pavement, shoulders, curbs, and sidewalks) and the converted vegetated areas shall meet all the minimum requirements if the new hard surfaces total 5,000 square feet or greater and total 50 percent or more of the existing hard surfaces within the project limits. The project limits shall be defined by the length of the project and the width of the right-of-way.

Other types of redevelopment projects shall comply with Minimum Requirements #1 through #10 for the new and replaced hard surfaces and the converted vegetated areas if:

The total of new plus replaced hard surfaces is 5,000 square feet or greater, and

For commercial or industrial projects: the valuation of proposed improvements, including interior improvements, exceeds 50 percent of the assessed value of the existing Project Site improvements as determined by the County Building Official.

For all other projects: the valuation of the proposed improvements, including interior improvements, exceeds 50 percent of the assessed value of the existing Site improvements as determined by the County Building Official.

Finally, if the County determines that the project site contributes to an existing water quality, flooding, or erosion problem, the County may require that the project site comply with additional stormwater management requirements. The County shall base the determination on the results of basin planning for the basin in which the project is located; historic water quality data; or historic information on flooding, erosion, or habitat degradation in receiving waters.

Objective

Redevelopment projects have the same requirements as new development projects in order to minimize the impacts from new surfaces. To not discourage redevelopment projects, replaced

surfaces are not required to be brought up to new stormwater standards unless the noted cost or space thresholds are exceeded. As long as the replaced surfaces have similar pollution-generating potential, the amount of pollutants discharged shouldn't be significantly different. However, if the redevelopment project scope is sufficiently large that the cost or space criteria noted above are exceeded, it is reasonable to require the replaced surfaces to be brought up to current stormwater standards. This is consistent with other utility standards.

2.4 Minimum Requirements

This section describes the minimum requirements for stormwater management at development and redevelopment sites. Section 2.3 should be consulted to determine which requirements apply to any given project. Figures 2.1 and 2.2 should be consulted to determine whether the minimum requirements apply to new surfaces, replaced surfaces, or new and replaced surfaces. Volumes II through VI of this manual present BMPs for use in meeting the minimum requirements.

2.4.1 Minimum Requirement #1: Preparation of Stormwater Site Plans

All projects meeting the thresholds in Section 2.3 are required to prepare one or more stormwater site planning documents for county review. **In addition, Pierce County requires Abbreviated Plan submittals for some projects that fall below the Minimum Requirement #1 threshold identified in Section 2.3.** The information required in the various stormwater site plans varies depending on the nature of the project and its location. Stormwater Site Plans shall use site-appropriate development principles, as required by PCC Title 18A and 18J, to retain native vegetation and minimize impervious surfaces to the extent feasible. Each of the plan submittals listed below are described in detail in Chapter 3. See Chapter 3 and Table 3.1 for the specific information on required plans and plan content.

- Abbreviated Plan
- Drainage Control Plan
- Construction Stormwater Pollution Prevention Plan.

Completing the applicable plan in accordance with the requirements in Chapter 3 will meet Minimum Requirement #1.

Objective

The 2,000 square foot threshold for hard surfaces and 7,000 square foot threshold for land disturbance are specified by Ecology to capture most single family home construction and their equivalent. The county-specific thresholds identified in Chapter 3, Table 3.1, were developed to meet more specific Pierce County needs and interests, without negating Ecology's requirements.

2.4.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention

Thresholds

All new development and redevelopment projects are responsible for preventing erosion and discharge of sediment and other pollutants into receiving waters, and shall comply with Construction SWPPP Elements #1 through #13 as detailed in Volume II, Section 2.3.3. The thirteen elements are summarized below, but project applicants must refer to Volume II, Section 2.3.3 for the full description of applicable requirements.

Projects which result in 2,000 square feet or more of new plus replaced hard surface area, or which disturb 7,000 square feet or more of land must prepare a Construction SWPPP as part of the Stormwater Site Plan (see Section 2.4.1). Each of the thirteen elements must be considered and included in the Construction SWPPP unless site conditions render the element unnecessary and the exemption from that element is clearly justified in the narrative of the Construction SWPPP.

Projects that result in less than 2,000 square feet of new plus replaced hard surface area, or disturb less than 7,000 square feet of land are not required to prepare a Construction SWPPP, but must consider all of the thirteen elements of Construction Stormwater Pollution Prevention and develop controls for all elements that pertain to the project site.

These elements cover the general water quality protection strategies of limiting site impacts, preventing erosion and sedimentation, and managing activities and sources during the construction phase of a project.

The 13 elements 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.

If a Construction SWPPP is found to be inadequate (with respect to Erosion and Sediment Control requirements), Pierce County may require that other BMPs be implemented as needed.

A complete description of each element and the associated BMPs are given in Volume II, Chapter 2.

2.4.3 Minimum Requirement #3: Source Control of Pollution

All known, available and reasonable source control BMPs must be applied to all projects. Source control BMPs must be selected, designed, and maintained according to this manual.

Objective

The intent of source control BMPs is to prevent stormwater from coming in contact with pollutants. They are a cost-effective means of reducing pollutants in stormwater, and, therefore, should be a first consideration in all projects.

Supplemental Guidelines

An adopted and implemented basin plan or a TMDL (also known as a Water Cleanup Plan) may be used to develop more stringent source control requirements that are tailored to a specific basin.

Source control BMPs include operational BMPs and structural source control BMPs. See Volume IV for design details of these BMPs. For construction sites, see Volume II.

Structural source control BMPs should be identified in the stormwater site plan and should be shown on all applicable plans submitted for county review and approval.

2.4.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls

All new development and redevelopment projects are responsible for maintaining natural drainage patterns, and discharges from the project site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and downgradient properties. When downstream drainage courses are inadequate or systems are undersized, or when in the opinion of the County, property or properties may be adversely affected by the existing and/or proposed stormwater release rates, additional stormwater flow control measures may be required. Such determination by the County may be based upon existing information indicating problem areas or based upon current or past litigation over drainage problems within the vicinity of the project. If additional stormwater flow control measures are required by the County, the applicant may have the option to correct and/or improve downstream drainage conditions so that the proposed stormwater release rate does not have to be further restricted. Any offsite improvements will require the applicant to obtain easements from the owners of any property where work is to take place.

All outfalls require energy dissipation.

Objective

To preserve and utilize natural drainage systems to the fullest extent because of the multiple stormwater benefits these systems provide; and to prevent erosion at and downstream of the discharge location.

Supplemental Guidelines

Creating new drainage patterns results in more site disturbance and more potential for erosion and sedimentation during and after construction. Creating new discharge points can create significant stream channel erosion problems as the receiving water body typically must adjust to the new flows. Diversion can cause greater impacts than would otherwise occur by discharging runoff at the natural location.

Where no conveyance system exists at the adjacent downgradient property line and the discharge was previously unconcentrated flow or significantly lower concentrated flow, then measures must be taken to prevent downgradient impacts. Drainage easements from downstream property owners may be needed and shall be obtained prior to approval of the engineering plans.

The following discharge requirements apply:

- Where no conveyance system exists at the abutting downstream property line and the natural (existing) discharge is unconcentrated, any runoff concentrated by the proposed project must be discharged as follows:

- If the 100-year peak discharge, as estimated by using an approved continuous runoff model using 15-minute time steps, is less than or equal to 0.3 cfs under existing conditions and will remain less than or equal to 0.3 cfs under developed conditions, then the concentrated runoff may be discharged onto a rock pad or to any other system that serves to disperse flows.
- If the 100-year peak discharge, as estimated by using an approved continuous runoff model using 15-minute time steps, is less than or equal to 0.5 cfs under existing conditions and will remain less than or equal to 0.5 cfs under developed conditions, then the concentrated runoff may be discharged through a dispersal trench or other dispersal system, provided the applicant can demonstrate that there will be no significant adverse impact to downgradient properties or drainage systems.
- If the 100-year peak discharge, as estimated by using an approved continuous runoff model using 15-minute time steps, is greater than 0.5 cfs for either existing or developed conditions, or if a significant adverse impact to downgradient properties or drainage systems is likely, then a conveyance system must be provided to convey the concentrated runoff across the downstream properties to an acceptable discharge point (i.e., an enclosed drainage system or open drainage feature where concentrated runoff can be discharged without significant adverse impact).

2.4.5 Minimum Requirement #5: Onsite Stormwater Management

Projects shall employ onsite stormwater management BMPs in accordance with the following projects thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff onsite to the extent feasible without causing flooding or erosion impacts. A flow chart (Figure 2.3) is provided at the end of this section to help summarize the core components of this minimum requirement.

In addition, projects subject to the County's Comprehensive LID Site Design requirements (per PCC Title 18A and 18J) should review Volume VI in conjunction with Minimum Requirements #5, #6, and #7. Some of the requirements of PCC Title 18J will partially or fully achieve the requirements of Minimum Requirements #5, #6, and #7.

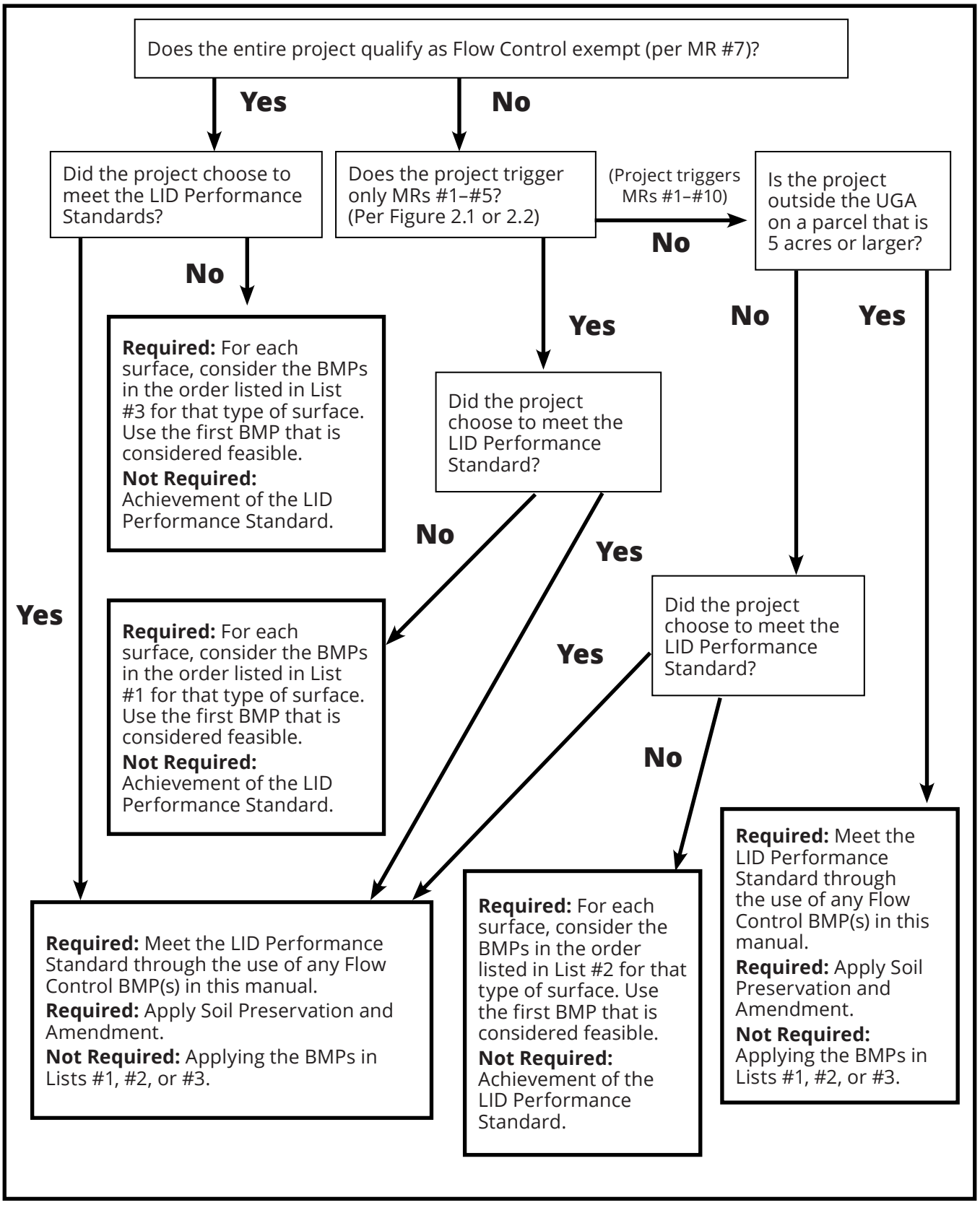
Project Thresholds

Projects triggering only Minimum Requirements #1 through #5 shall either:

a. Use onsite stormwater management BMPs from List #1 for all surfaces within each type of surface in List #1; or

b. Demonstrate compliance with the LID Performance Standard. Projects selecting this option cannot use rain gardens. They may choose to use bioretention areas as described in Volume III, Section 3.4 to achieve the LID Performance Standard. Projects selecting this option must implement the soil preservation and amendment BMP described in Volume III, Section 3.1 if feasible.

Figure 2.3 - Flow Chart for Determining Minimum Requirement #5 Requirements



Projects triggering Minimum Requirements #1 through #10, must meet the requirements in Table 2.1

Table 2.1 - Onsite Stormwater Management Requirements for Projects Triggering Minimum Requirements #1 – #10.

Project Location and Parcel Size	Requirement
Projects inside the UGA, on any size parcel	Use the LID BMPs from List #2 for all surfaces within each type of surface in List #2; or Use any Flow Control BMP(s)1 desired to achieve the LID Performance Standard, and apply Soil Preservation and Amendment BMP.
Projects outside the UGA, on a parcel smaller than 5 acres	
Projects outside the UGA, on a parcel 5 acres or larger	Use any Flow Control BMP(s)1 desired to achieve the LID Performance Standard, and apply Soil Preservation and Amendment BMP.

Note: This text refers to the Urban Growth Area (UGA) as designated under the Growth Management Act (GMA) (Chapter 36.70.A RCW) of the State of Washington.

Flow Control Exempt Projects:

Projects qualifying as Flow Control exempt in accordance with the TDA Exemption in Vol. I, Sec. 2.4.7 Minimum Requirement #7: Flow Control shall either:

- Use the LID BMPs from List #3 for all surfaces within each type of surface in List #3;

  or

- Use any Flow Control BMP(s)1 desired to achieve the LID Performance Standard, and apply Soil Preservation and Amendment BMP.

If the project has multiple TDAs, all TDAs must be Flow Control exempt per the TDA Exemption in Vol. I, Sec. 2.4.7 Minimum Requirement #7: Flow Control for the project to use the options listed here.

A Rain Garden BMP cannot be used to achieve the LID Performance Standard.

Low Impact Development Performance Standard

The LID Performance Standard compliance method for Minimum Requirement #5 requires modeling the proposed Flow Control BMPs to demonstrate the flow reduction as described below. Note that in order to meet the LID Performance Standard, the chosen Flow Control BMPs will most likely need to include infiltration.

Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8 percent of the 2-year peak flow to 50 percent of the 2-year peak flow. Refer to the Standard Flow Control Requirement section in Minimum Requirement #7 for information about the assignment of the pre-developed condition. Project sites that must also meet Minimum Requirement #7 – flow control – must match flow durations between 8 percent of the 2-year flow through the full 50-year flow.

A Rain Garden BMP cannot be used to achieve the LID Performance Standard. Use a Bioretention BMP to achieve the LID Performance.

The List Approach

The List Approach compliance method for Minimum Requirement #5 requires evaluating the BMPs in Table 2.2. The List Approach for Minimum Requirement #5 Compliance.

For each surface, evaluate the feasibility of the BMPs in the order listed, and use the first BMP that is considered feasible. The designer must document the site conditions and infeasibility criteria used to deem each BMP infeasible. Once a BMP is deemed feasible and used for a surface, no other BMP from the list is necessary for that surface.

If all BMPs in the list are infeasible, then the designer must document the site conditions and infeasibility criteria used to deem each BMP infeasible. This documentation will demonstrate compliance with Minimum Requirement #5.

Feasibility shall be determined by evaluation against:

- Design criteria, limitations, and infeasibility criteria identified for each BMP in this manual; and
- Competing Needs Criteria listed below.
- (See also Volume III, Appendix III-D for a summary of infeasibility criteria for all BMPs.)

Table 2.2 - The List Approach for Minimum Requirement #5 Compliance

List #1 (For MR #1- #5 Projects That Are Not Flow Control Exempt)	List #2 (For MR #1- #10 Projects That Are Not Flow Control Exempt)	List #3 (For Flow Control Exempt Projects)
Surface Type: Lawn and Landscaped Areas		
Soil Preservation and Amendment BMP in Volume III, Section 3.1	Soil Preservation and Amendment BMP in Volume III, Section 3.1	Soil Preservation and Amendment BMP in Volume III, Section 3.1
Surface Type: Roofs		
1. Full Dispersion BMP in Volume VI, Section 2.3 or Downspout Infiltration Systems in Volume III, Section 3.9.3	1. Full Dispersion BMP in Volume VI, Section 2.3 or Downspout Infiltration Systems in Volume III, Section 3.9.3	1. Downspout Infiltration Systems in Volume III, Section 3.9.3
2. Rain Gardens BMP in Volume III, Section 3.8 or Bioretention BMP in Volume III, Section 3.4 or ONLY for sites that are underlain by Spanaway soils[1], Downspout Dispersion Systems in Volume III, Section 3.9.4	2. Bioretention BMP in Volume III, Section 3.4 or ONLY for sites that are underlain by Spanaway soils[1], Downspout Dispersion Systems in Volume III, Section 3.9.4	2. Downspout Dispersion Systems in Volume III, Section 3.9.4
3. Downspout Dispersion Systems in Volume III, Section 3.9.4	3. Downspout Dispersion Systems in Volume III, Section 3.9.4	3. Perforated Stub-out Connections in Volume III, Section 3.9.5
4. Perforated Stub-out Connections in Volume III, Section 3.9.5	4. Perforated Stub-out Connections in Volume III, Section 3.9.5	
Surface Type: Other Hard Surfaces		
1. Full Dispersion BMP in Volume VI, Section 2.3	1. Full Dispersion BMP in Volume VI, Section 2.3	Sheet Flow Dispersion BMP in Volume III, Section 3.2.3 or
2. Permeable Pavement BMP in Volume III, Section 3.5 or Rain Garden BMP in Volume III, Section 3.8 or Bioretention BMP in Volume III, Section 3.4	2. Permeable Pavement BMP in Volume III, Section 3.5	

3. Sheet Flow Dispersion BMP in Volume III, Section 3.2.3 or Concentrated Flow Dispersion BMP in Volume III, Section 3.2.4	3. Bioretention BMP in Volume III, Section 3.4	Concentrated Flow Dispersion BMP in Volume III, Section 3.2.4
	4. Sheet Flow Dispersion BMP in Volume III, Section 3.2.3 or Concentrated Flow Dispersion BMP in Volume III, Section 3.2.4	
General Notes for using the List Approach: Size Rain Gardens and Bioretention used in the List Approach to have a minimum horizontal projected surface area below the overflow which is at least 5% of the area draining to it. Downspout Dispersion Systems must have a slope of 10 percent or less. When the designer encounters Permeable Pavements in the List Approach, it is not a requirement to pave these surfaces. Where pavement is proposed, it must be permeable to the extent feasible unless Full Dispersion is employed As defined by the Soils Survey of Pierce County Area (USDA 1979), and field verified by a professional soil scientist certified by the Soil Science Society of America (or an equivalent national program); a locally licensed onsite sewage designer; or by other suitably trained persons working under the supervision of a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington.		

Objective

To use practices as feasible, distributed across a development, which reduce the amount of disruption of the natural hydrologic characteristics of the site.

Competing Needs

The onsite stormwater management BMPs can be superseded or restricted where they are in conflict with:

- Requirements of the following federal or state laws, rules, and standards: Historic Preservation Laws and Archaeology Laws as listed at https://dahp.wa.gov/project-review/preservation-laws, Federal Superfund or Washington State Model Toxics Control Act, Federal Aviation Administration requirements for airports, Americans with Disabilities Act.
- Where a LID requirement has been found to be in conflict with special zoning design criteria and community plans found in PCC Title 18, 18A, and 18J the existing local codes may supersede or reduce the LID requirement.
- Critical Area Ordinance – PCC Title 18E that provides protection of tree species.
- Public health and safety standards.
- Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way.
- A local code or rule adopted as part of a Wellhead Protection Program established under the Federal Safe Drinking Water Act; or adopted to protect a Critical Aquifer Recharge Area established under the State Growth Management Act.

Supplemental Guidelines

In order to meet the LID Performance Standard, designers may use any Flow Control BMP in this manual. There are no specific Flow Control BMPs that must be used to meet the LID Performance Standard.

"Flooding or erosion impacts" include flooding of septic systems, crawl spaces, living areas, outbuildings, etc.; increased ice or algal growth on sidewalks/roadways; earth movement/ settlement; erosion and other potential damage.

Note also that rain gardens cannot be used to meet the requirements of the Low Impact Development Performance Standard outlined above. This is because the LID Performance Standard requires the submittal of an engineered design and analysis. For projects proposing to meet the LID Performance Standard, a bioretention area must be used in lieu of a rain garden, even though they may look and perform similarly in practice.

2.4.6 Minimum Requirement #6: Runoff Treatment

Projects must provide runoff treatment to reduce the water quality impacts of stormwater runoff from pollution generating surfaces. This will include treatment for oil products, phosphorus control, and basic or enhanced treatment for dissolved metals and suspended solids for projects that meet specified thresholds.

Treatment Facility Selection, Design, and Maintenance

Stormwater treatment facilities shall be:

- Selected in accordance with the process identified in Chapter 4 of this volume and detailed in Volume V
- Designed in accordance with the design criteria in Volume V
- Maintained in accordance with the maintenance checklists in Appendix IA.

Thresholds

When assessing a project against the following thresholds, only consider those hard and pervious surfaces that are subject to this minimum requirement as determined in Section 2.3 of this chapter.

The following require construction of stormwater treatment facilities:

- Projects in which the total of pollution-generating hard surface (PGHS) is 5,000 square feet or more in a threshold discharge area of the project, or
- Projects in which the total of pollution-generating pervious surfaces (PGPS) – not including permeable pavements – is three-fourths of an acre or more in a threshold discharge area, and from which there will be a surface discharge in a natural or man-made conveyance system from the site.

Treatment Facility Sizing

Size stormwater treatment facilities for the entire area that drains to them, even if some of those areas are not pollution-generating, or were not included in the project site threshold decisions (Section 2.3 of this chapter) or the treatment threshold decisions of this minimum requirement.

- Water Quality Design Storm Volume:
    - Using the latest version of an Ecology approved continuous runoff model (e.g., the Western Washington Hydrology Model [WWHM]), the water quality design storm volume shall be equal to the simulated daily volume that represents the upper limit of the range of daily volumes that accounts for 91 percent of the entire runoff volume over a multi-decade period of record.

- Water Quality Design Flow Rate:
    - **Preceding Detention Facilities or when Detention Facilities are not required:** The flow rate at or below which 91 percent of the runoff volume, as estimated by an approved continuous runoff model, will be treated. At a minimum, 91 percent of the total runoff volume, as estimated by an approved continuous runoff model, must pass through the treatment facility(ies) at or below the approved hydraulic loading rate for the facility(ies).
    - **Downstream of Detention Facilities:** The water quality design flow rate must be the full 2year recurrence interval release rate from the detention facility.

Additional Requirements

Direct discharge of untreated stormwater from pollution-generating hard surfaces to groundwater is prohibited. Volume V, Section 6.3 details the soil requirements to achieve water quality treatment through infiltration.

Objective

The purpose of runoff treatment is to reduce pollutant loads and concentrations in stormwater runoff using physical, biological, and chemical removal mechanisms so that beneficial uses of receiving waters are maintained and, where applicable, restored. When site conditions are appropriate, infiltration can potentially be the most effective BMP for runoff treatment.

Supplemental Guidelines

See Volume V for more detailed guidance on selection, design, and maintenance of treatment facilities. Volume V includes performance goals for basic, enhanced, phosphorus, and oil control treatment, and a menu of facility options for each treatment type. Treatment facilities that are selected from the appropriate menu and designed in accordance with their design criteria are presumed to meet the applicable performance goals.

An adopted and implemented basin plan or a TMDL may be used to develop runoff treatment requirements that are tailored to a specific basin. However, treatment requirements shall not be less than that achieved by facilities in the basic treatment menu (see Volume V, Section 3.5).

Treatment facilities applied consistent with this manual are presumed to meet the requirement of state law to provide all known available and reasonable methods of treatment (RCW 90.52.040, RCW 90.48.010). This technology-based treatment requirement does not excuse any discharge from the obligation to apply whatever technology is necessary to comply with state water quality standards, Chapter 173201A WAC; state groundwater quality standards, Chapter 173 200 WAC; state sediment management standards, Chapter 173204 WAC; and the underground injection control program, Chapter 173218 WAC. Additional treatment to meet those standards may be required by federal, state, or local governments.

Infiltration through use of onsite stormwater management BMPs can provide both treatment of stormwater, through the ability of certain soils to remove pollutants, and volume control of stormwater, by decreasing the amount of water that runs off to surface water. Infiltration through engineered treatment facilities that utilize the natural soil profile can also be very effective at treating stormwater runoff. However, note that pretreatment is required for most infiltration facilities, and soil conditions must also be appropriate to achieve effective treatment while not impacting groundwater resources. See Volume V, Chapter 6 for further details.

Discharge of pollution-generating surfaces into a drywell, after pretreatment for solids reduction, can be acceptable if the soil conditions provide sufficient water quality treatment capacity. Drywells into gravelly soils are not likely to have sufficient treatment capability and must be preceded by at least a basic treatment BMP. See Volume V, Chapters 2 and 6 for details.

2.4.7 Minimum Requirement #7: Flow Control

Projects must provide flow control to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions. The requirements below apply to projects that discharge stormwater directly, or indirectly through a conveyance system, into a fresh waterbody– except for projects that discharge to one of the following flow control-exempt receiving waters:

- Any saltwater body
- Nisqually River downstream of Big Creek including Alder Lake
- Carbon River, Downstream of confluence with South Prairie Creek
- Puyallup River, half-mile downstream of confluence with Kellog Creek (below Electron Diversion Dam)
- White River, downstream of confluence with Huckleberry Creek.

Discharges to flow control-exempt receiving waters are only allowed in accordance with the following restrictions:

- Direct discharge to the exempt receiving water does not result in the diversion of drainage from any perennial stream classified as Types 1, 2, 3, or 4 in the State of Washington Interim Water Typing System, or Types “S”, “F”, or “Np” in the Permanent Water Typing System, or from any Category I, II, or III wetland.
- If flow splitters or conveyance elements are applied to route natural runoff volumes from the project site to any downstream Type 5 stream or Category IV wetland, then:
- Design of flow splitters or conveyance elements must be based on approved continuous simulation modeling analysis. The design must assure that flows delivered to Type 5 stream reaches will approximate, but in no case exceed, durations ranging from 50 percent of the 2year to the 50year recurrence interval peak flow.
- Flow splitters or conveyance elements that deliver flow to Category IV wetlands must also be designed using approved continuous simulation modeling to preserve preproject wetland hydrologic conditions unless specifically waived or exempted by regulatory agencies with permitting jurisdiction.
- The project site must be drained by a conveyance system that is comprised entirely of manmade conveyance elements (e.g., pipes, ditches, outfall protection) and extends to the ordinary high-water line of the exempt receiving water.
- The conveyance system between the project site and the exempt receiving water shall have sufficient hydraulic capacity to convey discharges from future build-out conditions (under current zoning) from contributing areas of the site, and the existing condition from contributing offsite areas.
- Any erodible elements of the manmade conveyance system must be adequately stabilized to prevent erosion under the conditions noted above.

If the discharge is to a stream that leads to a wetland, or to a wetland that has an outflow to a

stream, both this requirement and Minimum Requirement #8 apply.

Thresholds

When assessing a project against the following thresholds, consider only those impervious, hard, and pervious surfaces that are subject to this minimum requirement as determined in Section 2.3 of this chapter.

The following circumstances require achievement of the standard flow control requirement for western Washington:

- Projects in which the total of effective impervious surfaces is 10,000 square feet or more in a threshold discharge area.
- Projects that convert three-fourths of an acre or more of native vegetation, pasture, scrub/shrub, or unmaintained non-native vegetation to lawn or landscape, or convert 2.5 acres or more of native vegetation to pasture in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site.
- Projects that through a combination of effective hard surfaces and converted vegetation areas cause a 0.15 cubic feet per second (cfs) or greater increase in the 100year flow frequency from a threshold discharge area as estimated using WWHM, or other approved continuous simulation model and using 15-minute time steps. See the supplemental guidelines below for example scenarios that could trigger this requirement.

Discharge Requirements

The allowable release rates from a project are dependent upon the ultimate destination for the stormwater. All projects not directly attributable to one of the four categories defined below, and not exempted per the flow-control exempt receiving waters outlined above, shall use Category A for determining the allowable discharge rates.

Category A: Discharge to a minor water body as defined below:

Any water body not defined as a flow control-exempt receiving waters (presented above), closed depression, a publicly owned regional retention and/or detention facility, or privately constructed regional retention and/or detention facility.

In regard to implementation of the revised flow control requirement for highly urbanized basins, Ecology has published maps listing total impervious area for basins in western Washington. At the time this manual was published, no basins in unincorporated Pierce County meet the 40 percent of the total impervious area/20year criterion.

Requirements:

Stormwater discharges shall match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50 percent of the 2year recurrence interval peak flow up to the full 50year peak flow. The predeveloped condition to be matched shall be a forested land cover unless:

- Reasonable, historic information is provided that indicates the site was prairie prior to settlement (modeled as “pasture” in the WWHM).
- The drainage area of the immediate stream and all subsequent downstream basins have had at least 40 percent total impervious area since 1985. In this case, the predeveloped condition to be matched shall be the existing land cover condition. Where basin-specific

studies determine a stream channel to be unstable, even though the above criterion is met, the predeveloped condition assumption shall be the "historic" land cover condition, or a land cover condition commensurate with achieving a target flow regime identified by an Ecology and Pierce County approved basin study.

This standard requirement is waived for sites that will reliably infiltrate all the runoff from hard surfaces and converted vegetation areas.

Alternative Requirement

An alternative requirement may be established through application of watershed-scale hydrological modeling and supporting field observations. Possible reasons for an alternative flow control requirement include:

- Establishment of a stream-specific threshold of significant bedload movement other than the assumed 50 percent of the 2year recurrence interval peak flow
- Zoning and Land Clearing Ordinance restrictions that, in combination with an alternative flow control standard, maintain or reduce the naturally occurring erosive forces on the stream channel
- A duration control standard is not necessary for protection, maintenance, or restoration of designated and existing beneficial uses or Clean Water Act compliance.

Objective

To prevent increases in the stream channel erosion rates that are characteristic of natural conditions (i.e., prior to disturbance by European settlement). The standard intends to maintain the total amount of time that a receiving stream exceeds an erosion-causing threshold based upon historic rainfall and natural land cover conditions. That threshold is assumed to be 50 percent of the 2year recurrence interval peak flow. Maintaining the naturally occurring erosion rates within streams is vital, though by itself insufficient, to protect fish habitat and production.

Category B: Discharge to a Closed Depression

Applies to discharges to any low-lying area(s) which has/have no outlet, or such a limited surface outlet that in most storm events the area acts as a retention basin holding water for infiltration or evaporation shall be considered a pothole area. Appropriate water quality treatment BMPs will be applied to all discharges.

Requirements:

- Due to the significant adverse impacts which can result from increasing the rate, volume, and duration of stormwater runoff to closed depressions, the contributing area to each depression must be analyzed using a continuous runoff model for the 100year recurrence interval developed runoff condition. When a proposed development is contributory to a pothole area, discharge to the pothole may be allowed when the discharge matches durations to predeveloped (existing) durations for the range of discharges from 50 percent of the 2year recurrence interval flow up to the full 50year flow. In addition, discharge rates must match the predeveloped (existing) rates for the 2, 10, and 100year recurrence interval flows. In addition, a mandatory additional 20 percent safety factor must also be added to the final design storage volume. Appropriate water quality treatment BMPs must also be applied to all discharges. When selecting appropriate treatment BMPs, the engineer shall assume the soil is fully saturated all year within the closed depression unless the engineer provides supporting documentation for an alternative condition.

- Potential overflow routes from the closed depression shall be analyzed, using a fully developed contributing basin, and the engineer will identify and address potential adverse impacts. Any overflow must still meet all applicable minimum requirements outlined in this chapter. The closed depression will be analyzed, at a minimum, for uncontrolled discharge from the site to the pothole.
- If the project site discharges excess volumes to a privately owned closed depression, the applicant must obtain written permission/easements from the owner(s) of record for drainage course to the closed depression, the closed depression, and potential overflow. The applicant shall record the information with the Pierce County Auditor. This information shall be recorded with all affected property titles including those for the depression, overflow route, and the applicant's property. If easements cannot be obtained, discharge to the pothole may be allowed on a case by case basis in accordance with the first bullet of this requirement.

Category C: Discharge to a publicly owned regional retention facility. Applies to discharges to existing and any future publicly owned regional retention facilities.

Requirements:

- If the public retention facility is determined by the County to have capacity the developer shall have the option of paying the county a one-time buy in fee, as determined by the County, for the right to discharge excess stormwater flow, rates, and volumes from the developed site. On a case by case basis the County may determine that it is reasonable and feasible for the developer to infiltrate the excess volumes on site, and thereby reject the request to discharge to the public facility.
- The project site must be located within the existing natural drainage basin tributary to the publicly owned regional retention facility.
- Water quality treatment is always required prior to discharge from the project site. Discharge to regional retention facilities that also provide water quality treatment will not be justification to remove this requirement.
- The allowable discharge rates from the project site shall be limited as follows based on the type of conveyance system from the project site to the regional retention facility:
    - Direct discharge (after water quality treatment) may be allowed when the conveyance system to the retention facility is public and has capacity to convey stormwater runoff from its entire contributing basin in a fully developed condition. The retention facility must be designed or retrofitted to accept the increased flows without sustaining any damage. The County may limit the number of connection points into the retention facility to facilitate maintenance.
    - Discharges (after water quality treatment) to existing public conveyance systems that are undersized or have unresolved capacity issues may be required to apply runoff duration and/or peak flow controls on site or install a new conveyance system with increased capacity.
    - Discharge to or through a natural drainage system may be required to have flow controls that protect the channel and maintain flow capacity.
- The publicly owned regional retention facility must be available by the time of the construction of the new development or redevelopment with adequate capacity as determined by the County.

Category D: Privately constructed regional detention and/or retention facilities.

Requirements:

- In lieu of individual systems, applicants can design and build regional facilities in accordance with the design requirements of Category A or B, as applicable and with excess capacity which, when completed, may be dedicated to the County. Such a facility can be onsite or offsite. Privately constructed regional facilities shall meet all the requirements outlined above for Category C facilities. In addition, upon County approval of the facility, the County may:
    - Accept the dedicated facility; and
    - If funds are available as determined by the Director of Pierce County Planning and Public Works **and** the facility is constructed in a location within a basin studied by Pierce County Surface Water Management **and** is currently budgeted for in the approved 6year capital facilities plan, reimburse the developer for the excess capacity provided by the facility at a rate mutually agreed upon, or
    - Enter into a latecomer's agreement with the developer for reimbursement as other properties are developed which opt to discharge to the regional facility.

Additional Requirements

Under any of the above categories, when downstream drainage courses are inadequate or systems are undersized, or when in the opinion of the County, property or properties may be adversely affected by the existing and/or proposed stormwater release rate, a restricted release rate may be required. Such determination by the County may be based upon existing information indicating problem areas or based upon current or past litigation over drainage problems within the vicinity of the project.

The release rate will be approved by the County and must be compatible with downstream drainage conditions. If a restricted release rate is required, the applicant may correct and/or improve downstream drainage conditions so that the proposed release rate does not have to be further restricted. When a restricted release rate is used, a corresponding increase in storage must be provided.

In addition, flow control BMPs shall be selected, designed, and maintained according to this manual.

Supplemental Guidelines

Calculations to determine whether a TDA exceeds the 0.15 cubic feet per second (cfs), using a 15-minute time step, increase in the 100year recurrence interval flow must be done individually for each TDA using an approved continuous simulation runoff model. The calculation will compare runoff in the post development site to the predevelopment land cover. Pre-development, for this activity, is the lower runoff of the preproject condition or the site in 1997[1]. The unique site, soil, precipitation, and other project-specific factors will ultimately determine whether this threshold is exceeded. Nonetheless, the following general guidelines (based on hypothetical site designs) may be used to help identify the likelihood of this threshold being exceeded. The following land uses changes are likely to exceed this threshold under certain conditions:

- Converting approximately 5,000 square feet of forest to impervious surface
- Converting approximately 5,000 square feet of pasture to impervious surface

- Converting approximately 0.25 acres of forest to landscape surface
- Converting approximately 1.25 acres of forest to pasture surfaces (in till soil conditions).

Reduction of flows through infiltration decreases surface water runoff and helps to maintain base flow throughout the summer months. However, infiltration shall follow the guidance in this manual to reduce the chance that groundwater quality is threatened by such discharges.

Application of sufficient types of LID and onsite stormwater management BMPs can result in reducing the effective impervious area and the converted vegetation areas, thereby reducing, or eliminating the need for a flow control facility. Impervious surfaces that are fully dispersed in accordance with Full Dispersion in Volume VI, Section 2.3, are not considered effective impervious surfaces. Impervious surfaces that are dispersed in accordance with downspout dispersion in Volume III, Section 3.9.4; concentrated flow dispersion in Volume III, Section 3.2.4; and sheet flow dispersion in Volume III, Section 3.2.3 are still considered effective surfaces though they may be modeled as pervious surfaces if flow path lengths meet the specified minimums. Permeable pavers and modular grid pavements are assigned lower surface runoff calibrations and may also reduce stormwater flow control facility sizes. See Volume III and Volume VI for more complete descriptions of hydrologic credits for LID and onsite stormwater management BMPs.

Diversions of flow from perennial streams and from wetlands can be considered if significant existing (i.e., preproject) flooding, stream stability, water quality, or aquatic habitat problems would be solved or significantly mitigated by bypassing stormwater runoff rather than providing stormwater detention and discharge to natural drainage features. Bypassing should not be considered as an alternative to applicable flow control or treatment if the flooding, stream stability, water quality or habitat problem to be solved would be caused by the project.

2.4.8 Minimum Requirement #8: Wetlands Protection

Applicability

The requirements below apply only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system.

Thresholds

Refer to Figure 2.4. Flow Chart for Determining Wetland Protection Level Requirements to determine what Level(s) of Wetland Protection must be applied to comply with Minimum Requirement #8.

Standard Requirement

Projects shall comply with Appendix I-B – Wetland Protection Guidelines. For general protection see I-B.2, for protection from pollutants see I-B.3 and for wetland hydroperiod protection see I-B.4 for details. A wetland can be considered for hydrologic modification and/or stormwater treatment in accordance with PCC Title 18E and Appendix IB of this volume.

Additional Requirements

Stormwater treatment and flow control facilities shall not be built within a natural vegetated buffer, except for:

- Necessary conveyance systems as approved by Pierce County
- As allowed in I-B.6 Compensatory Mitigation of Wetlands.

An adopted and implemented basin plan, or a TMDL may be used to develop requirements for wetlands that are tailored to a specific basin.

Objective

To ensure that wetlands receive the same level of protection as any other waters of the State. Wetlands are extremely important natural resources that provide multiple functions and values, including groundwater recharge, flood control, and stream channel erosion protection. They are easily impacted by development unless careful planning and management are conducted. Wetlands can be severely degraded by untreated stormwater discharges from urban development due to pollutants in the runoff and also due to disruption of the natural hydrologic pattern of the wetland.

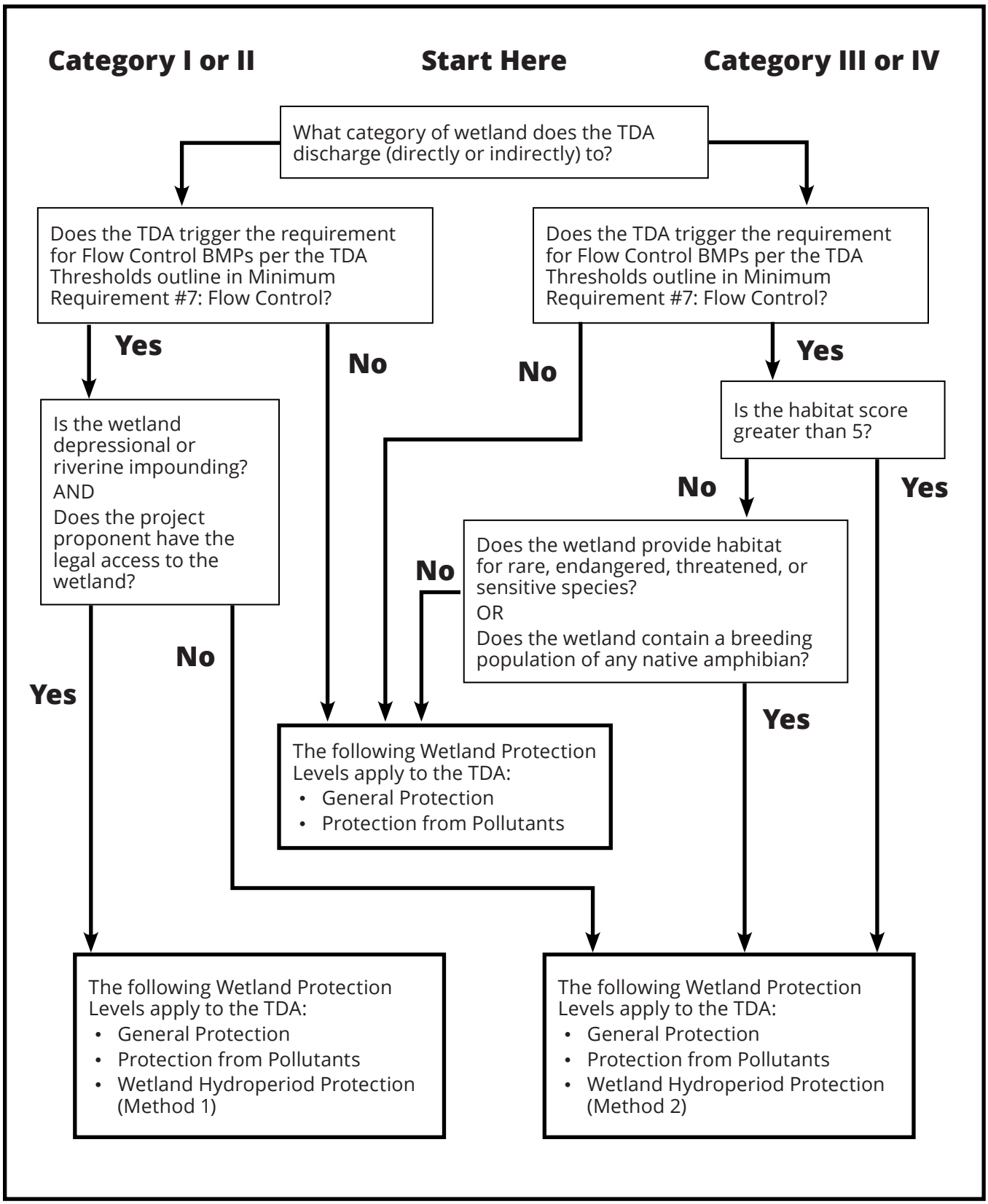
Supplemental Guidelines

Appendix I-B - Wetland Protection Guidelines shall be used for discharges to natural wetlands and mitigated wetlands. While it is always necessary to pre-treat stormwater prior to discharge to a wetland, there are limited circumstances where wetlands may be used for additional treatment and detention of stormwater. These situations must comply with Pierce County Critical Areas Ordinance 18E and Appendix I-B.

In most cases, if Wetland Hydroperiod Protection is required per Minimum Requirement #8: Wetlands Protection, then the Flow Control Performance Standard is also required per Minimum Requirement #7: Flow Control. In these cases, the designer must attempt to meet the requirements for both Minimum Requirements. This may prove to be feasible in many situations because Minimum Requirement #7: Flow Control will seek to adjust the flow in small time intervals and Minimum Requirement #8: Wetlands Protection looks to maintain daily flow volumes.

If the designer is unable to meet both requirements, then the requirement to maintain the hydroperiod of the wetland becomes the overriding concern and the designer must show compliance with Minimum Requirement #8: Wetlands Protection. If this is the case, the designer must also provide documentation detailing why they are unable to meet both requirements.

Figure 2.4 - Flow Chart for Determining Wetland Protection Level Requirements



2.4.9 Minimum Requirement #9: Operation and Maintenance

A Maintenance and Source Control Manual that is consistent with the provisions in this manual shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. At private facilities, a copy of the manual shall be retained onsite or within reasonable access to the site, and shall be transferred with the property to the new owner. For public facilities, a copy of the manual shall be retained in the appropriate department. A log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection by the County.

Objective

To ensure that stormwater control facilities are adequately maintained and operated properly.

Supplemental Guidelines

Inadequate maintenance is a common cause of failure for stormwater control facilities. The Maintenance and Source Control Manual should be viewed as the owner's manual, written for the person who was not the designer, builder, or inspector but who, in the future, is charged with the responsibility to maintain the facilities built for them. While the Maintenance and Source Control Manual may be submitted during permitting at the same time as the complete set of construction plans, the two are often separated after final construction. The manual should be written with sufficient information to describe the number, location, and type of facilities as well as specific details and inspection intervals to ensure proper maintenance long into the future. The description of each BMP in Volumes II, III, and V includes a section on maintenance to assist in writing the Maintenance and Source Control Manual. Appendix I-A of this volume includes maintenance checklists for many drainage facilities.

2.4.10 Minimum Requirement #10: Financial Liability

Performance bonding or other appropriate financial instruments shall be required for all projects to ensure compliance with these standards.

Chapter 3. Drainage Control Plan and Abbreviated Plan Submittal Requirements

This chapter outlines the various requirements for submittal of stormwater plans, reports, and other documents for review by the County. The amount of document preparation and review are tiered in an effort to match the impact potential of a particular project to the appropriate amount of regulatory oversight and control. All projects are subject to the minimum requirements outlined in Chapter 2, and the plans described in this chapter meet the requirements of the stormwater site plan required by Minimum Requirement #1. Based on the project size and proposed conditions, an applicant will have to prepare either an Abbreviated Plan or a Drainage Control Plan (outlined further below).

This chapter is divided into 3 major sections:

- Section 3.1 describes which submittals are required, depending on project thresholds
- Section 3.2 describes Abbreviated Plans
- Section 3.3 describes Drainage Control Plans.

3.1 Projects and Activities Requiring Plan Submittal

Project thresholds are summarized in Table 3.1 based on the scope of the project and site conditions. Project applicants should identify their type of project in the Table 3.1 rows, and then identify the appropriate requirements by each column, as well as any applicable table notes.

In addition, any activity that alters the approved plans for a given project (e.g., stormwater facility maintenance or repair, drainage facility resizing, other project design changes to impervious surfaces or land cover) will require reapproval by the County, regardless of whether the thresholds listed in Table 3.1 have been exceeded. This may include updates to the original Abbreviated Plan or Drainage Control Plan, and associated Construction SWPPP. The County may waive the requirement to update plans depending on the specific activity and associated impacts.

Table 3.1 - Thresholds for Abbreviated Plans, Construction Stormwater Pollution Prevention Plans, and Drainage Control Plans.

Category [1, 2]		≥500 sf New or Replaced Impervious/ Hard Surface	≥2,000 sf New or Replaced Impervious/ Hard Surface or ≥7,000 sf Land Disturbed	≥5,000 sf New or Replaced Impervious/ Hard Surface, or ≥0.75 ac of Vegetation Converted to Lawn, or ≥2.5 ac Native Vegetation Converted to Pasture, or ≥250 cy Materials Moved
1	Subdivisions, Short Plats, and Large Lots	AP	AP, SWPPP	SWPPP, DCP
2	Creation of New Impervious/Hard Surface [5]	AP	AP, SWPPP	SWPPP, DCP
3	Construction of Roads, Shared Accesses, and Alleyways	AP	AP, SWPPP	SWPPP, DCP
4	Maintenance and Repair of Roads, Shared Accesses, and Alleyways		AP, SWPPP	SWPPP, DCP
5	Utility Line Work (construction or maintenance – inside R/W) [3]		AP, SWPPP	SWPPP, DCP
6	Utility Line Work (construction or maintenance – outside R/W) [4, 5]		AP, SWPPP	SWPPP, DCP
7	Building Permit	AP	AP, SWPPP	SWPPP, DCP
8	Clearing	AP	AP, SWPPP	SWPPP, DCP
9	Grading	AP	AP, SWPPP	SWPPP, DCP
10	Driveway culvert installation in Roadside Swales/Ditches [6]			

AP = Abbreviated Plan

DCP = Drainage Control Plan

SWPPP = Construction Stormwater Pollution Prevention Plan

Note: For the purposes of applying the thresholds in Chapter 3, Table 3.1 to a proposed subdivision (i.e., a plat or short plat project), the hard surface coverage, as well as the converted vegetation areas, must be specified for each lot and recorded with the County on the face of the final plat (or an alternative acceptable to the County).

Table 3.1 Notes:

1. For sites that contain critical areas, critical area buffers, or require an offsite analysis, a submittal stamped by a licensed professional engineer is required, unless waived by the County.
2. All development must consider the thirteen elements of Minimum Requirement #2 (see Section 2.4.2). Depending on the scope of the project, components of the Construction SWPPP shall be required with the plan submittal. All development must also consider the requirements of Minimum Requirement #4 (see Section 2.4.4).
3. All work shall be performed in accordance with the "Manual on Accommodating Utilities in Pierce County Right-of-Way," shall include the implementation of the applicable Abbreviated Plan measures, and shall be in compliance with PCC Title 11 for the life of the installation.
4. An individual site development permit is not required if utility line improvements are performed within a larger project (i.e., subdivision construction) that has a site development permit and the utility line improvements have been addressed under the larger project's site development permit.
5. Routine, repetitive maintenance or repair activities that do not meet the threshold for an Abbreviated Plan, Drainage Control Plan, or Construction Stormwater Pollution Prevention Plan shall be performed in accordance with standard BMPs as published by the County.
6. Driveway culvert size and location to be per County inspector's direction. The County may require that the applicant retain an engineer to size and design the culvert in situations where a larger than standard diameter appears necessary. Note that a driveway and/or right-of-way permit may also be required.

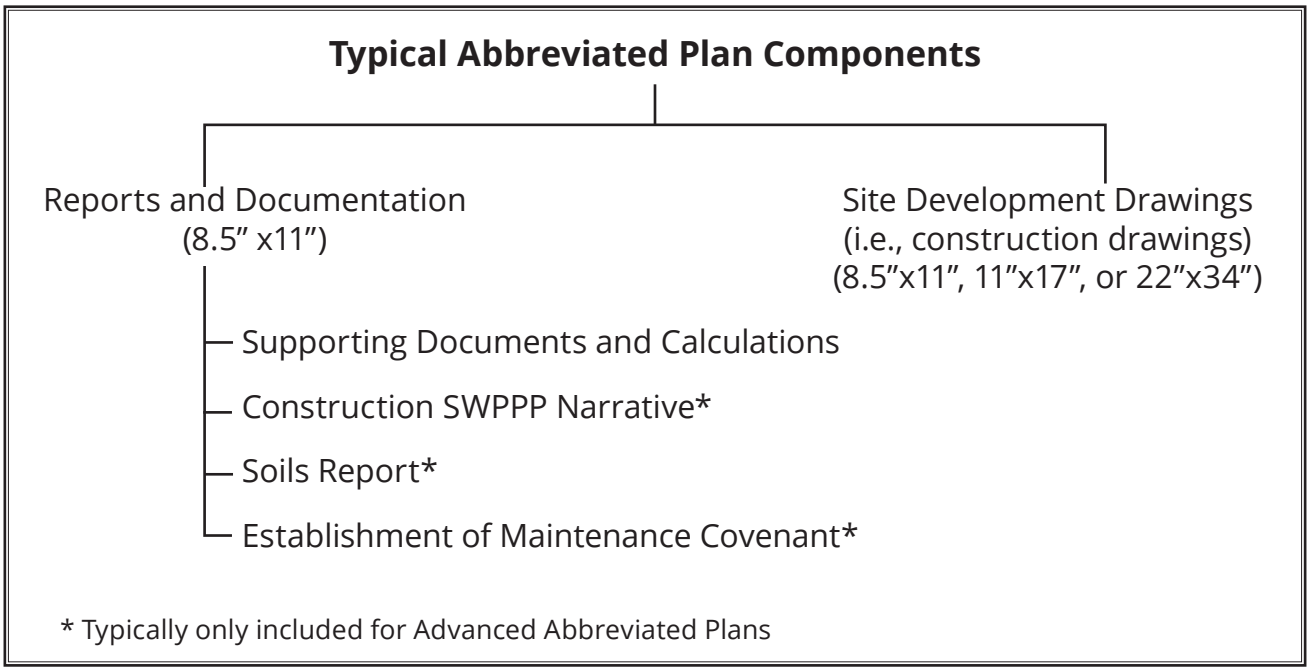
3.2 Abbreviated Plan

Projects that are identified in Table 3.1 as needing an Abbreviated Plan require a Site Development Permit submittal, document preparation, county review, and county inspection. Abbreviated Plans can be simple or complex (referred to as "Basic" Abbreviated Plans and "Advanced" Abbreviated Plans, respectively). The simplest plan may only need to address Minimum Requirement #2 – Construction Stormwater Pollution Prevention, and Minimum Requirement #4 – Preservation of Natural Drainage Systems and Outfalls. The most complex might have to address Minimum Requirements #1 through #5. Detailed descriptions of Basic and Advanced Abbreviated Plan thresholds and requirements are outlined in the following subsections. A schematic showing the components of a typical Abbreviated Plan is presented in Figure 3.1 below.

The purpose of an Abbreviated Plan is:

1. To assure that a project complies with the applicable minimum requirements.
2. To incorporate requirements that achieve the intent and purpose of the Critical Area Regulations. Flood, Landslide, Shoreline Erosion, Wetland, and other critical areas sometimes require measures that must be depicted on Abbreviated Plan drawings to achieve compliance with these regulations.
3. To prevent development related stormwater runoff from impacting neighboring properties.

Figure 3.1 - Typical Abbreviated Plan Components.



3.2.1 Abbreviated Plans – Basic and Advanced Plan Requirements

Basic Abbreviated Plans

Regardless of project size and type, all Abbreviated Plans have several basic requirements that must be met and reflected in the plan drawings and documentation. If new, replaced, or new plus replaced hard surfaces are greater than or equal to 500 square feet but less than 2,000 square feet, or land-disturbing activity is less than 7,000 square feet, a Basic Abbreviated Plan can be submitted. The Basic Abbreviated Plan must demonstrate that Minimum Requirements #2 and #4 are being met. For Minimum Requirement #2, the project must demonstrate and document that the 13 Construction Stormwater Pollution Prevention elements are being considered and addressed as applicable. For Minimum Requirement #4, projects must document how they are preventing downstream impacts to the extent necessary. Application of Minimum Requirement #4 will be project-specific, and will be based on an assessment by county staff of the proposed project's potential to cause stormwater runoff impacts to downstream properties.

Advanced Abbreviated Plans

If new, replaced, or new plus replaced hard surfaces are greater than or equal to 2,000 square feet, or if land-disturbing activity is greater than or equal to 7,000 square feet, an Advanced Abbreviated Plan must be submitted. The Advanced Abbreviated Plan must demonstrate how Minimum Requirements #1 through #5 are being met. Note that Minimum Requirement #5 includes detailed requirements and decision points that can affect the project significantly, which must be reflected in the Abbreviated Plan documentation. Likewise, compliance with Minimum Requirement #2 will require preparation of a full Construction SWPPP.

In many situations, it will be necessary for a licensed professional to prepare components of the

Advanced Abbreviated Plan. In some cases, the additional required information pertinent to the Abbreviated Plan may be available within the plat or other approved documents related to the project.

The following subsections provide further detail on the requirements for Basic and Advanced Abbreviated Plans. The following topics are discussed:

- Critical Areas requirements
- Supporting documents and calculations
- Drawing size and quality requirements
- Drawing requirements for Basic and Advanced Abbreviated Plans, including topographic survey requirements
- Construction SWPPP requirements (Advanced plans only)
- Soils Report requirements (Advanced plans only)
- Establishment of maintenance obligation (Advanced plans only).

Phased Project Submittals

Phased projects shall be completed in accordance with approved Abbreviated Plans. Phasing of projects shall not result in a reduction of drainage control requirements. Drawings showing the overall project, clearly delineating phase boundaries, and estimating dates of construction (if known), shall be part of any initial submittal. A typical phasing example is single-family residence construction where a garage or accessory dwelling unit is built, and the main house is built later.

3.2.2 Abbreviated Plan – Critical Areas Requirements

In addition to the core requirements for Basic or Advanced Abbreviated Plans, projects that involve work in or near critical areas must demonstrate compliance with PCC Title 18E. The Abbreviated Plan must indicate any specific site design and construction requirements that implement the applicable critical area standards and requirements.

3.2.3 Abbreviated Plan – Supporting Documents and Calculations

Abbreviated Plans must include all calculations and/or analyses necessary to demonstrate compliance with applicable minimum requirements. This may include calculations related to sizing stormwater BMPs or conveyance systems, analyses of site or downstream conditions, documentation of infeasibility issues, etc.

3.2.4 Abbreviated Plan – Licensed Engineer Required for Roads

Abbreviated Plans that propose work on public roads, private roads, and unopened county right-of-way must be prepared by a professional engineer licensed in Washington State.

3.2.5 Abbreviated Plan – Drawing Size and Quality

Lines shall be drawn with a straight edge (with the exception of curved lines) and features shall be to scale. Drawings shall be sufficiently clear to see footprints of structures and other features described above, and shall be on 8.5 x 11-inch paper, 11 x 17-inch paper, or plan-size sheets (22 x 34-inch).

3.2.6 Abbreviated Plan – Site Development Drawings

Basic Plan Requirements

The Abbreviated Plan site development drawings generally contain all the pertinent information necessary for construction of a project. This may include applicable drainage, grading, sediment control, and topographic survey information, as well as any applicable notes or details. At a minimum, Basic Abbreviated Plan drawings must contain:

- The location and type of any onsite stormwater management BMPs (e.g., soil amendment, infiltration trenches, dispersion, rain gardens, permeable pavement, etc.)
- The location and type of construction stormwater pollution prevention BMPs used for erosion and sediment control
- The location and type of other construction stormwater pollution prevention BMPs (such as refueling areas)
- Location of stormwater conveyance systems for runoff from structures
- Notes, specifications, and details related to selected BMPs
- Name, address, telephone number, and email address of the applicant
- Name, address, telephone number, and email address of the person preparing the plan
- Name, address, telephone number, and email address of the contractor, if known
- Parcel number(s)
- Scale and north arrow
- Legend if symbols are used
- Property boundaries, dimensions, and area
- Contour lines from the best available source (specify datum used)
- Adjoining street names
- Existing and proposed structures and other hard surfaces such as driveways, patios, etc.
- Location of onsite sewage disposal systems and reserve areas
- Existing and proposed easements
- Established buffers, significant trees (per PCC title 18J), and natural vegetation easements
- Natural drainage channels, wetlands, canyons, gullies, water bodies, etc.
- Clearing limits
- Areas to be graded, filled, excavated, or otherwise disturbed
- Location of known wells, and underground storage tanks
- Proposed location(s) determined for stockpiled materials, i.e., excavation wastes
- Location and details of construction entrance
- Earthwork requirements of PCC Title 17A.

It is useful when these drawings also include:

- Applicable standard driveway approach detail (driveway approaches shall be constructed or

reconstructed to meet the requirements of PCC Title 17B)

- Building setbacks from property lines.

Advanced Plan Requirements

The following additional information must be provided on the site development drawings for projects required to submit an Advanced Abbreviated Plan (i.e., projects subject to Minimum Requirements #1 through #5).

All Advanced Abbreviated Plans must include survey information prepared by a registered land surveyor or other qualified professional that includes:

- Existing public and private development, including utility infrastructure on and adjacent to the site if publicly available
- Minor hydrologic features, including seeps, springs, closed depression areas, and drainage
- Major hydrologic features including streams, wetlands, and water bodies, as well as wetland and buffer boundaries and classifications
- Flood hazard areas on or adjacent to the site
- Geologic hazard areas and associated buffer requirements on or adjacent to the site
- Aquifer and wellhead protection areas on or adjacent to the site
- Topographic features that may act as natural stormwater storage, infiltration, or conveyance
- Locations of soil surveys, soil test pits, and soil borings conducted as part of the required soils report.

In addition, if a geotechnical assessment is required per PCC Title 17A, Soil Engineering – Stability, any recommendations contained in the report must be incorporated into the site development drawings.

3.2.7 Abbreviated Plan – Construction SWPPP Requirements (Advanced Plans Only)

Advanced Abbreviated Plans must include a complete Construction SWPPP. See Volume II, Section 2.2 of this manual for information on the items that shall be included as part of the Construction SWPPP narrative (i.e., report) and drawings.

3.2.8 Abbreviated Plan – Soils Report Requirements (Advanced Plans Only)

In support of the requirements of Minimum Requirement #5, Advanced Abbreviated Plans must include a soils report prepared by: a professional soil scientist certified by the Soil Science Society of America (or an equivalent national program); a locally licensed onsite sewage designer; or by other suitably trained persons working under the supervision of a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington. The report shall include the following information:

- Soil surveys, soil test pits, soil borings, or soil grain analyses sufficient to identify underlying soils on the site.
- The results of saturated hydraulic conductivity (Ksat) testing to assess infiltration capability and the feasibility of rain gardens, bioretention, and permeable pavement. Use one of the

infiltration testing methods outlined in Volume III, Appendix III-A.

- The results of testing for a hydraulic restriction layer (groundwater, soil layer with less than 0.3 in/hr Ksat, bedrock, etc.) under possible sites for a rain garden, bioretention area, or permeable pavement. Testing with a monitoring well or an excavated pit must extend to a depth at least 1 foot below the estimated bottom elevation of a rain garden/bioretention excavation and at least 1 foot below the subgrade surface of a permeable pavement. This analysis should be performed in the winter season (December 21 through March 21). Site historic information and evidence of high groundwater in the soils can also be used.
- If onsite infiltration may result in shallow lateral flow (interflow), the conveyance and possible locations where that interflow may re-emerge shall be assessed by a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington.

3.2.9 Abbreviated Plan – Establishment of Maintenance Covenant (Advanced Plans Only)

To ensure future maintenance of onsite stormwater management BMPs used to meet the requirements of Minimum Requirement #5, a maintenance covenant must be recorded for each parcel that contains onsite stormwater management BMPs. The proposed covenant must be reviewed and approved by the County prior to recording. All required covenants must be recorded prior to final construction approval for the proposed project.

The recorded maintenance covenant must be created on a county-approved form (obtainable from Pierce County Planning and Public Works' website). The covenant shall include an 8.5" x 11" plan view showing the location of onsite stormwater management BMPs relative to structures and property lines, and maintenance instructions for each onsite stormwater management BMP. A map showing the location of newly planted and retained trees claimed as flow reduction credits shall also be attached. All documents and attachments shall meet the recording requirements of the Pierce County Auditor. After approval by the County, the declaration of covenant must be signed and recorded at the Pierce County Auditor's office.

3.3 Drainage Control Plan

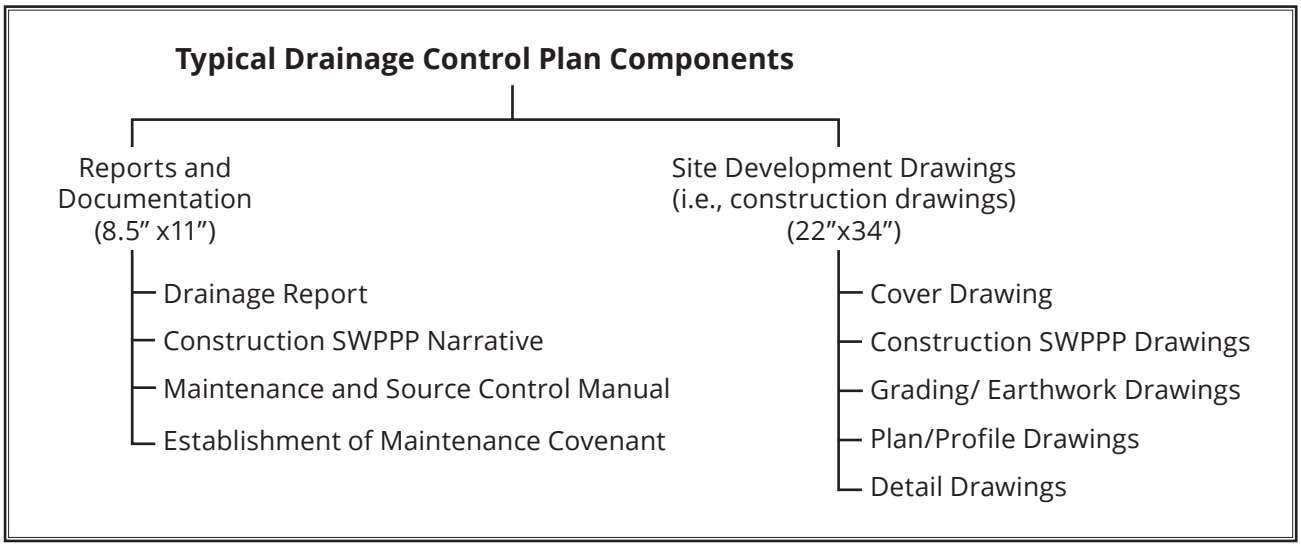
The Drainage Control Plan is the full submittal package meeting all minimum requirements per Chapter 2, Figures 2.1 and 2.2. The Drainage Control Plan submittal package includes the following components: Drainage Report, Construction SWPPP, Maintenance and Source Control Manual, Maintenance Covenant, and Site Development Drawings. A schematic showing the components of a typical Drainage Control Plan is presented in Figure 3.2 below. The Construction SWPPP consists of two parts: a narrative report, and drawings which are included with the other Site Development Drawings. Additional details on each component of the Drainage Control Plan are provided in the following sections.

The County requires that Drainage Control Plans that propose work on public roads private roads, and unopened County right-of-way must be prepared by a professional engineer licensed in Washington State.

While the preparation of a Drainage Control Plan in almost all cases involves the practice of engineering and thus must be prepared by a licensed engineer there are sites and projects that can meet the requirements of this Manual that may not require the practice of engineering. In these situations, the County may allow others to prepare the necessary plans, reports, and

documents necessary to fulfill the requirements of this Manual. Please note that determinations regarding the practice of engineering are the purview of the Washington State Board of Registration for Professional Engineers and Land Surveyors.

Figure 3.2 - Typical Drainage Control Plan Components.



3.3.1 Phased Project Submittals

Phased projects shall be completed in accordance with approved Drainage Control Plans and in accordance with phased development requirements placed upon the development by the County. Phasing of projects shall not result in a reduction of drainage control requirements. Drawings showing the overall project, clearly delineating phase boundaries, and estimating dates of construction (if known), shall be part of any initial submittal.

3.3.2 Drainage Control Plan – General Site Development Drawing Requirements

The drawings for construction purposes submitted to the County shall conform to the following protocols.

- County approval block
- Required sheet size is 22 x 34 inches.
- 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 = 20 feet, 30 feet, or 40 feet for all others. Plats are generally 1 inch = 50 feet which may be reduced to 1 inch = 100 feet with prior County approval.
- All sheets shall have a north arrow, scale, a benchmark reference, datum, the section, township, and range. Each set of drawings shall have a legend to define map symbols. North arrow should point to the top or to the right of the sheet.
- 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.
- Prior to County approval, drawings that are required to be prepared by a licensed professional engineer must be stamped, signed and dated.
- Road alignments with 100foot stationing, preferably increasing to the north or east and

reading from left to right, and 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 the existing county road or state highway as applicable. 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, properly dimensioned lot lines, lot numbers, location, and dimension of all tract and easement areas.
- Show parcel numbers and lot lines for adjacent properties.
- Label all adjacent roads and shared access and identified whether they are public or private.
- All topographic features within project limits and sufficient area beyond to resolve questions of setback, slope, drainage, access onto abutting property, and road continuations.
- 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 adjoining subdivisions when it is pertinent to the scope of the project.
- Existing features shall be ghosted or shaded.

3.3.3 Drainage Control Plan – Site Development Drawings

It is the responsibility of the project engineer to ensure that engineering drawings submitted for review are sufficiently clear to construct the project in proper sequence, using specified methods and materials, and with sufficient dimensions to fulfill the intent of drainage laws and ordinances and these design guidelines.

The most recently adopted editions of standard specifications and standard plans (see Glossary) 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.

Projects that involve work in or near critical areas must demonstrate compliance with PCC Title 18E. The Drainage Control Plan must indicate any site design and construction requirements that implement the applicable critical area standards and requirements.

Drainage Control Plan – Cover Drawing

- Any drawing sets submitted for review and approval 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 and any other pertinent information.
    - 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's and project engineering firm's names, address, telephone number, email address, current owner, and parcel numbers.
- Project name
- An index table of drawings.
- Title block descriptive of project.

Drainage Control Plan – Construction SWPPP Drawings

- Volume II, Section 2.2.2 of this manual describes the items that shall be shown on the Construction SWPPP drawings.

Drainage Control Plan – Grading/Earthwork Drawings

In addition to the general drawing requirements, the site and/or grading plan sheets shall show the following:

- The project's existing and proposed storm drainage along with easements, tracts, drainage facilities, all buffer and screening areas, offsite and onsite existing drainage courses, delineated wetlands, and associated buffers. Indicate 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." For onsite stormwater management BMPs, provide a scale drawing of the lot or lots, and any public-right-of-way that displays the location of the BMPs and the areas served by them.
- Areas of possible significant environmental concern (gullies, ravines, swales, wetlands, steep slopes, estuaries, springs, creeks, lakes, etc.). For natural drainage features show direction of flow.
- 100-year floodplain boundary (if applicable).
- Soil logs, soil log locations, and soils within the project site as verified by field testing (and documented in Drainage Control Plan Section 3).
- Wells and wellhead protection areas – existing and proposed, onsite and on adjacent properties (both of record and not of record) within specified setbacks.
- Utilities.
- Existing paved surfaces, including roads.
- Lot dimensions and areas.
- 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.
- Topographic features that may act as natural stormwater storage, infiltration, or conveyance.
- Proposed grades.
- Property lines, parcel numbers, and ownership.
- Contour intervals shall be as follows:

- 0 percent – 15 percent 2-foot contour interval
- >15 percent – 40 percent slope 5-foot contour interval
- >40 percent slope 10-foot contour interval.

- Grading/clearing setbacks from property lines per PCC Title 17A.
- Earthwork/geotechnical requirements per PCC Title 17A.

Drainage Control Plan – Plan/Profile Drawings

Show the following:

- Plan over profile drawings for new roads, shared accesses, and improvements on existing roads.
- Original ground line at 100foot 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.
- 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.
- Vertical datum shall be based on NAVD88. All bench mark information shall use established U.S.C. and G.S. control or county bench marks when there is an existing bench mark 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 50foot vertical curve.
- Storm drainage text shall be shown in profile only, to avoid duplication of text. Number of structures shall 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).

Drainage Control Plan – Detail Drawings

- All applicable standard notes.
- All applicable County standard drawings and details.
- A minimum of two cross-sections of each retention/detention pond and bioretention area showing original property lines, slope catch points, and all other pertinent information to adequately construct the pond or bioretention area.
- Details of all onsite stormwater management BMPs that are used to help achieve compliance with Minimum Requirement #5. If distributed bioretention areas and/or storage below permeable pavement are used, provide details to confirm accurate facility representation in the runoff models (submitted as part of Drainage Control Plan Section 9).
- Identify locations and approximate size of all permeable pavement surfaces and bioretention areas to be installed, including those that will be installed on individual lots.
- Identify locations and species types for newly planted or retained trees for which impervious surface reduction credits are claimed. Supporting areas such as the flow paths for dispersion BMPs shall also be shown.
- If distributed bioretention areas and/or infiltration below pollution-generating hard surfaces are used to help meet treatment requirements, provide details to confirm accurate representation in the runoff model (submitted as part of Drainage Control Plan Section 9).
- Standard open conveyance system cross-sections if applicable.
- Right-of-way cross-sections as required by the County.
- Construction recommendations from a soils report if applicable.

3.3.4 Drainage Control Plan – Drainage Report

The Drainage Report is a major component of the Drainage Control Plan. The Drainage Report shall include data that facilitate plan review such as (but not limited to): water surface elevations for the design storm(s), invert elevations at breaks in grade, design discharge, design velocity, design depths of reservoir course for permeable pavement, bioretention media thickness, etc. Specific components of the Drainage Report are described in detail below. The Drainage Report shall be 8.5 x 11 inch size.

Cover Sheet:

The Drainage Report will have a cover sheet with the project name; applicant's name, address, telephone number, and email address; project engineer's name, address telephone number, and email address; date of submittal; contact's name, address, telephone number, and email address; and the name, address, telephone number, and email address of the contractor, if known.

Project Engineer's Certification:

The project engineer responsible for completion of a Drainage Control Plan submittal as described herein shall be a professional engineer with a current State of Washington license. 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 Drainage Report shall contain a page with the project engineer's seal with the following statement:

"I hereby state that this Drainage Control Plan 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 Pierce County does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me."

Table of Contents:

Show the page number for each section of the report. Show page numbers of appendices. All pages of the Drainage Report shall be numbered.

Maps:

The Drainage Report shall include the following maps:

- **Basin Map.** Show project boundaries, subbasin boundaries, and offsite area tributary to the project. Show major drainage features (such as channels and detention facilities and floodways), and flow path to receiving waters. Use an appropriate scale for the project site.
- **Work Map (or maps).** On a topographic map at an appropriate scale for the project site, show:
  - Unit areas greater than 1 acre as contributing to a reach of swale or to a catch basin including offsite area. Identify areas contributing to retention/detention facilities. Identify threshold discharge areas (TDAs) where applicable. Show the following on the work map (or on a schedule) for unit areas: total project area; total hard surfaces, pollution generating hard/impervious surface, pollution generating pervious surface, and total disturbed area; average slope; and estimated ultimate infiltration rate and Soil Conservation Service (SCS) Soil Group.
  - Conveyance data, identifier (for reference to model output), length, slope, inverts up and down.
  - Overland flow paths and distances.
  - Soil types.
  - Locations of soil pits and infiltration tests.
  - Spot water surface elevations, discharges, and velocities for the design event.
- **Schedule of Structures.** The Drainage Report shall include a table or "schedule" for the storm drainage structures used on the project, including the following information:
  - Catch basin/manhole number
  - Stationing
  - Washington State Plane Coordinate System (i.e., Northings and Eastings) if used
  - Street name and side located on, if applicable
  - Catch basin/manhole diameter or size
  - Invert elevation in/out
  - Pipe diameter in/out
  - Type of each structure and pipe, i.e., Type II, concrete.

All Drainage Reports shall have each of the following section titles (if some sections do not apply,

list and mark NA):

Drainage Report Section 1 – Proposed Project Description

Describe type of permit for which the applicant is applying, address and legal description of property, parcel number, property zoning, etc. Describe other permits required (hydraulic permits, USACE Section 404 Permit, wetlands, etc.) and present status.

Provide a brief description of the development project (type, size, location, and for additions/remodels only, current assessed value and cost of improvements excluding land value) and the stormwater features to be installed for storage, treatment, conveyance, and disposal/discharge (types, sizes, and locations). Identify which of the minimum requirements apply to the project, and how they are being addressed. Also include justification for those minimum requirements that do not apply. For Minimum Requirement #5, indicate whether the project used the mandatory list option, or the LID performance standard option, and complete documentation demonstrating compliance with either approach (additional guidance provided below).

Summarize calculations for all facilities. Include a tabulation of the current and proposed hard surfaces; new and replaced pollution generating pervious, impervious, and hard surfaces; effective impervious surfaces; disturbed pervious (such as landscaped areas); converted vegetation areas; and undisturbed areas. In this table, indicate any additions of hard surfaces, and the value of any additions or remodels completed, during the last 5 years. Complete engineering calculations, including hydrologic modeling analyses and documentation, must be included with the report. It is recommended that these be placed in appendices and be referenced where appropriate.

Describe the stormwater BMPs and conveyance systems incorporated into the design. Describe the detention system, outlet works, and spillways. Discuss vegetation establishment and management plan for conveyance and detention systems. For LID features and Minimum Requirement #5 specifically, describe the following:

- Project narrative showing how the project will fulfill the requirement for onsite management of stormwater to the extent feasible.
- Total area of vegetation retained.
- For projects using the list option for Minimum Requirement #5, an explanation and documentation, including citation of site conditions identified in a soils report, for any determination that an onsite stormwater management BMP was considered infeasible for the site. Information obtained and documented in the Existing Conditions Description (Section 2, see below) shall be used to substantiate any BMP infeasibility determinations. (See also Volume III, Appendix III-D for a summary of infeasibility criteria for all BMPs.)
- Areas of disturbed soils to be amended. (Note: All lawn and landscaped areas are to meet requirements of soil preservation and amendment [see Volume III, Section 3.1]. Use of compost is one way to meet the requirement).
- Retained trees and newly planted trees for which impervious reduction credits are claimed.

Drainage Report Section 2 – Existing Conditions Description

Existing conditions analysis results shall be submitted as part of the Drainage Control Plan submittal. Information in this section should also be used to help prepare the Construction Stormwater Pollution Prevention Plan.

Low impact development site design in particular is intended to complement the existing

conditions on the site. However, not all sites are appropriate for all LID and onsite stormwater management BMPs, as site conditions often determine the feasibility of using these techniques. The existing conditions site analysis, consistent with the requirements of this section, shall determine the feasibility of using these BMPs.

Describe existing conditions and relevant hydrologic conditions including, but not limited to, the items listed below. Where subsequent report sections call for more details on these issues (e.g., soils, wells, septic systems), a brief description and reference to the specific report section is sufficient.

- Existing ground cover, including pervious (trees, shrubs, lawn, etc.), hard surface, and pollution generating areas.
- Offsite drainage to the property.
- Creeks, lakes, ponds, wetlands, ravines, gullies, steep slopes, springs, erosion hazards, freshwater designations, and other environmentally sensitive areas on or down gradient of the property.
- Is the project located in an aquifer recharge area or wellhead protection area as defined by the Tacoma-Pierce County Health Department, the U.S. EPA or by the County? Cite reports.
- Any specific requirements included in a basin plan for the area.
- Drains, channels, and swales, within the project site and immediately adjacent.
- Points of exit for existing drainage from the property.
- Any known historical drainage problems such as flooding, erosion, etc.
- Proximity to structures, property lines, onsite structures, sewers, septic tanks, septic fields and reserve areas, basements, bulkheads, closed or active landfills, and underground storage tanks.
- Summary of existing soil type, groundwater levels, and soil hydraulic conductivity (details to be covered in Section 3).
- Include references to relevant reports such as basin plans, flood studies, groundwater studies, wetland designations, sensitive area designations, environmental impact statements, environmental checklists, lake restoration plans, water quality reports, soils reports, etc. Where such reports impose additional conditions on the applicant, state these conditions and describe any proposed mitigation measures.

Drainage Report Section 3 – Infiltration Rates/Soils Reports

Specific infiltration testing and documentation requirements are outlined in Volume III, Section 2.5 and Appendix IIIA. For all sites utilizing infiltration for stormwater management, a soils report must be prepared that is stamped by a professional engineer with geotechnical expertise, a licensed geologist, an engineering geologist, or a hydrogeologist, and that summarizes site characteristics and demonstrates that sufficient permeable soil for infiltration exists at the proposed facility location. The reporting requirements depend on the type of facility and analysis being performed. See Volume III, Section 2.5 and Appendix IIIA for the detailed requirements.

If an infiltration and/or detention facility is near the top of a slope that is regulated through local ordinance, then a geotechnical assessment addressing effects of seepage and the potential for slope failure during any precipitation event through the design event is required as part of this section of the Drainage Report.

Drainage Report Section 4 – Wells and Septic Systems

The project engineer shall report the existence of wells and septic systems both of record and others on the site and on adjacent property within the setback distance for stormwater retention/detention facilities identified in Volume III. The project engineer shall inquire with the Tacoma-Pierce County Health Department and neighboring property owners as necessary to obtain location of wells and septic systems that are not of record. Wells and septic systems thus found, both active and abandoned, shall also be shown on the plans or as-builts (if found during construction).

The proper abandonment of wells is a matter regulated by state law (WAC 173160). The Tacoma-Pierce County Health Department regulates drinking water and irrigation wells while Ecology regulates resource protection wells. The respective phone numbers are (253) 798-6500 and (360) 4076872. If a well on the site has not been properly sealed, the applicant shall be responsible for contacting the Tacoma-Pierce County Health Department. The appropriate procedure shall be followed for sealing any well. Proof of proper abandonment (e.g., copies of the well log and invoice from a firm qualified to perform such work) shall be supplied to the Tacoma-Pierce County Health Department or Ecology per its requirements. If no wells or septic systems were found, indicate so.

Drainage Report Section 5 – Fuel Tanks

The project engineer shall report, the existence of fuel tanks, in-use or abandoned. Fuel tanks shall be shown on the plans or as-builts (if found during construction). If fuel tanks will be abandoned, contact the Tacoma-Pierce County Health Department for specific instructions. If no fuel tanks are found, indicate so.

Drainage Report Section 6 – Subbasin Description

Describe offsite drainage tributary to the project. Describe any bypass drainage from the project which will not be controlled.

Describe the drainage system between the site and the receiving surface waters (or pothole, regional detention facility, etc.). Describe emergency services located along the flow path (e.g., fire/police stations, hospitals). Describe environmentally sensitive areas, such as wetlands, etc.

Drainage Report Section 7 – Floodplain Analysis

If the project is within the potential flood hazard area as defined in PCC Title 18E.70, show the 100year flood hazard area on the plans. If the flood hazard area has not been established (or the County determines that it is in error), the County may require per PCC Title 18E.70 the applicant to establish and map the 100year flood hazard area for the proposed project to be submitted with the Drainage Report. Analysis will be for the 100year flood for build out at maximum density allowed by zoning. If the project is determined to be in the flood hazard area additional studies per PCC Title 18E.70 may be required. The project engineer shall contact the County regarding the appropriate computer program(s) for backwater analysis.

Drainage Report Section 8 – Aesthetic Considerations for Facilities

Describe the effort made to make the facilities aesthetically pleasing, how facilities will provide useable open space, and how the facilities will fit into the landscaping plan for the property and be in accordance with any approved community plan. Drainage facilities should be made attractive features of the urban environment. Engineers are encouraged to be creative in shaping and landscaping facilities.

Drainage Report Section 9 – Facility Sizing and Offsite Analysis

The project engineer shall provide calculations for the project's stormwater storage, treatment, and conveyance system components. All relevant work/calculations shall be submitted for county review. Documentation outlining whether and how each of the minimum requirements have been addressed in the Drainage Report shall be submitted for county review. All calculations shall be keyed to features shown on the work map as described above. Also note that, per Volume III, all detention facilities (including detention vaults), and all infiltration facilities designed for greater than 1 foot of ponding depth, are required to include a crest gauge that will record maximum pond water surface elevation after a storm event. In addition, project submittals must include a table that identifies the design facility stage expected for the 2, 5, 10, 25, 50, and 100year recurrence interval flows.

An offsite analysis comprising of a downstream and an upstream analysis is required. The offsite analysis shall assess existing and potential problems related to offsite water quality, stream channel erosion, slope stability, conveyance system capacity, and drainage impacts associated with the project. The analysis shall be qualitative and quantitative.

The engineer shall physically inspect all the existing onsite and offsite stormwater drainage systems of the study area for each discharge location for existing or potential problems and drainage features. The inspection and investigation shall include:

- Prepare a scaled map labeling all drainage components and depicting the downstream study area. The study area shall extend downstream of the proposed project discharge location to a point on the drainage system where the proposed project site constitutes 15 percent or less of the total tributary area, but in no event less than one-fourth (1/4) of a mile.
- Review all available resource information regarding existing and potential water quality, runoff volumes and rates, flooding and streambank erosion problems within the study area.
- Physically inspect the existing onsite and offsite drainage system problems reported in the resources.
- Pierce County GIS drainage data may be used to assist the engineer in determining the capacity of existing systems. Historic comprehensive storm drainage maps, last updated in the early 1990s, can be useful to find drainage features not within the right-of-way, and in understanding development patterns and changed conditions. A copy of the County comprehensive storm drainage map or a map generated from County GIS coverage, updated with current drainage features, delineating the study area, together with the drainage system onto and from the proposed site, and showing the flow route of the onsite water for the minimum of one-fourth of a mile downstream distance must be included in the storm drainage calculations. USGS maps (minimum scale of 1:2400) may be utilized when County maps are not available.
- Describe in a narrative form, observations regarding the makeup and general condition of the drainage system.
- Include information such as pipe sizes, channel characteristics, amount of freeboard in pipes, channels and stormwater facilities.
- Field results of the downstream offsite drainage areas shall be provided in a table format and include the following information:
    - Project site

- Distance to downstream drainage components
- Description of drainage component
- Existing problems
- Potential problems
- Distance to next component
- Etc., to the limit of the downstream analysis
- Photographs to supplement the table information

A secondary component of the offsite analysis report is to identify all upstream tributary areas to the site and quantify the expected flows so they can be accommodated in the design of the project.

If hydrologic modeling (see Chapter 2, and Volumes III and V) is required, the project engineer shall use an approved continuous simulation runoff model and document modeling methods, assumptions, parameters, data sources, and all other relevant information to the analysis. If model parameters are used that are outside the standards of practice, or if parameters are different than those standards, justify the parameters. The applicant must also include digital copies of the model with files sufficient to re-run the model and include input parameters, as well as model output files to the County. Projects taking an impervious surface reduction credit for newly planted or retained trees (see tree planting and tree retention in Volume III, Section 3.3) must provide those calculations and documentation on site plans for the locations of the trees. Projects using Full Dispersion or full downspout infiltration BMPs must provide information to confirm conformance with design requirements that allow removal of the associated drainage areas from computer model input.

For design of water quality treatment systems specifically, if bioretention and/or infiltration below pollution-generating hard surfaces through adequate soils (see Volume V, Section 6.3 and Appendix I-C) will be used to help meet treatment requirements, the runoff model output files must include the volume of water that has been treated through those BMPs. The summation of those volumes and the volume treated through a centralized, conventional treatment system must meet or exceed 91 percent of the total stormwater runoff file. This sum of volumes must include:

- Stormwater that has infiltrated through a bioretention area, and stormwater that has infiltrated below pollution-generating hard surfaces (e.g., permeable pavement) through adequate soils.
- Stormwater that passes through a properly sized treatment facility. Note that stormwater that is re-collected below a bioretention area and routed to a centralized treatment facility should not be counted twice.
- Subtraction of any stormwater that does not receive treatment due to bypass of, or overflow from a treatment facility or a bioretention area (if the overflow is not subsequently routed to a treatment facility).

Include copies of all calculations for capacity of channels, culverts, drains, gutters, etc. If used, include nomographs and tables indicating how they were used. Show headwater and tailwater analysis for culverts when necessary. Provide details on references and sources of information used.

Describe capacities, design flows, and velocities in each reach. Describe required materials or specifications for the design (e.g., rock lining for channels when velocity is exceeded, high density polyethylene pipe needed for steep slope).

For a subdivision project, provide a detailed breakdown on a lot-by-lot basis of the assumptions related to roof, driveway, and other hard surfaces that have been used in the design and sizing of facilities. This breakdown will be used to determine the allowed square footage of hard surfaces for each lot

Drainage Report Section 10 – Utilities

Describe how utilities will be installed to ensure no conflicts with proposed stormwater quantity and quality control measures.

Drainage Report Section 11 – Covenants, Dedications, Easements

Describe legal instruments needed to guarantee preservation of drainage systems and access for maintenance purposes (attach copies if not included as part of other Drainage Control Plan submittals). Describe the organization or person which will be responsible for O&M of storm drainage facilities. For projects subject to Minimum Requirement #5, a declaration of covenant must be recorded for each parcel that contains onsite stormwater management BMPs. This is to ensure future maintenance of onsite stormwater management BMPs. See Section 3.3.7 and Appendix I-A for additional details.

Drainage Report Section 12 – Property Owners' Association Articles of Incorporation

Attach a copy of the Articles of Incorporation, if applicable and available.

Drainage Report Section 13 – Other Permits or Conditions Placed on the Project

Construction of road and drainage facilities may require additional permits from other agencies. These additional permits may contain more restrictive drainage control requirements. This section should provide the title of any other necessary permits, the agencies requiring the other permits, and identify the permit requirements that affect the project.

Other agencies including, but not limited to, those listed below may require drainage review for a proposed project's impact on surface and stormwater and conveyance systems. The applicant should take care to note that these other agency drainage requirements are separate from, and in addition to, Pierce County's drainage requirements. The applicant will be responsible to coordinate joint agency drainage review, including resolution of any conflicting requirements between agencies.

The additional agencies that may require permits for some projects are listed in Table 3.2. However, this is not a complete list of permits that may be required.

3.3.5 Drainage Control Plan – Construction SWPPP Report

Volume II, Section 2.2 of this manual describes the items that shall be included in the Construction SWPPP report.

Note: The Construction SWPPP consists of two parts: a narrative report and drawings. A complete Construction SWPPP (both report and drawings) is required as part of the Drainage Control Plan submittal. Depending on the scope of the project, components of the Construction SWPPP may be required with an Abbreviated Plan. At a minimum, all 13 Construction Stormwater Pollution Prevention elements in accordance with Minimum Requirement #2 (Section 2.4.2) must be addressed.

Table 3.2 - Other Potential Permits

Agency	Permit/Approval
Tacoma-Pierce County Health Department	Onsite Sewage Disposal and Well Permits
Washington State Department of Transportation (WSDOT)	Developer/Local Agency Agreement
Washington State Department of Ecology	Short Term Water Quality Modification Approval
Washington State Department of Ecology	Dam Safety Permit
Washington State Department of Fish and Wildlife	Hydraulic Project Approval
United States Army Corps of Engineers	Section 10 Permit
United States Army Corps of Engineers	Section 401 Certification
United States Army Corps of Engineers	Section 404 Permit
Pierce County Planning & Public Works (PPW)	Shoreline Permit
Pierce County Planning & Public Works (PPW)	ROW Permit
Pierce County Planning & Public Works (PPW)	Wetlands Permit or Fish and Wildlife Permit

* This is not a complete list of possible permits that may be required.

3.3.6 Drainage Control Plan – Maintenance and Source Control Manual

In accordance with Minimum Requirement # 9 and Table 3.1, a Maintenance and Source Control Manual must be developed for projects that require a Drainage Control Plan. For privately maintained facilities, a copy of the manual shall be retained onsite or within reasonable access to the site. For example, the Maintenance and Source Control Manual for a subdivision should be kept by a member of the Homeowner's Association. In the case of a commercial property the Maintenance and Source Control Manual should be kept in the office by those employees with maintenance responsibilities. When a property is sold or key members of a Homeowner's Association change, the Maintenance and Source Control Manual shall be transferred to the new owner/Homeowner's Association Member. A log of maintenance activity that indicates what actions were taken shall also be kept and be available for inspection by the County. For public facilities, a copy of the manual shall be retained in the appropriate department.

The manual must be prepared in an 8.5 x 11 inch format and must comply with the recording standards of the Pierce County Auditor. The manual must be prepared by a professional engineer and must be written to be understandable by the typical property owner and/or person responsible for maintenance.

For both private and public facilities, it is important to work with maintenance personnel early and throughout the design process. During discussions with maintenance personnel, describe the maintenance procedures that will be performed on the site BMPs. This will help ensure that future maintenance work and potential access needs are clearly understood.

The Maintenance and Source Control Manual must include the following components:

Cover Page

The Maintenance and Source Control Manual must have a cover page. The cover page must include the project name; engineer's name, address, telephone number, and email address; date of preparation of the manual (and any updates); project parcel numbers; and applicable county permit numbers.

Map

A map of the project area must be included in the manual. The extent of the map should be inclusive of all the drainage facilities that are a part of the Drainage Control Plan for the project. The intent of the map is to show the boundaries of the maintenance responsibilities that the Maintenance and Source Control Manual addresses. The map is not intended to provide a high level of detail nor is it intended to call out each structure or BMP. The map shall provide road names of the existing roads that the project connects to as well as any proposed roads. The map can be one or multiple pages.

Maintenance and Source Control Manual Section 1 – Project Description

Provide a brief description of the development project, including project type (plat, short plat, commercial center, industrial, etc.) and size (acres, number of lots, lineal feet of road, square feet of building, etc.). Describe the stormwater BMPs and conveyance systems, and how these systems are designed to manage the volume, rate, and quality of stormwater runoff from the project.

Maintenance and Source Control Manual Section 2 – Maintenance Importance and Intent

Include the following statement in this section:

"The importance of maintenance for the proper functioning of stormwater control facilities cannot be

over-emphasized. A substantial portion of failures (clogging of filters, resuspension of sediments, loss of storage capacity, etc.) are due to inadequate maintenance. Stormwater BMP maintenance is essential to ensure that BMPs function as intended throughout their full life cycle.

The fundamental goals of maintenance activities are to insure the entire flow regime and treatment train designed for this site continue to fully function. For this site these include: (engineer can delete non applicable BMPs listed below):

- Maintain designed stormwater infiltration capacity
- Maintain designed stormwater detention/retention volume
- Maintain ability of storm facility to attenuate flow rates
- Maintain ability to safely convey design stormwater flows
- Maintain ability to treat stormwater runoff quality
- Preserve soil and plant health, as well as stormwater flow contact with plant and soil systems
- Clearly identify systems so they can be protected
- Keep maintenance costs low
- Prevent large-scale or expensive stormwater system failures
- Prevent water quality violations or damage to downstream properties.

The intent of this section and manual is to pass on to the responsible party(s) all the information critical to understand the design of the system, risks and considerations for proper use, suggestions for maintenance frequencies, and cost so that realistic budgets can be established."

Maintenance and Source Control Manual Section 3 – Responsible Parties

Stormwater facilities range in size and complexity. Entities responsible for maintenance should be appropriately matched to the tasks required to ensure long-term performance. For example, an individual homeowner may be able to reasonably maintain a rain garden, permeable driveway, infiltration trench, or other small facility. However, larger facilities are often maintained through private parties, shared maintenance covenants with the County, or by County ownership.

This section of the Maintenance and Source Control Manual must identify the party (or parties) responsible for maintenance and operation of all stormwater structures and BMPs requiring maintenance.

Maintenance and Source Control Manual Section 4 – Facilities Requiring Maintenance

Provide a detailed list of all stormwater structures and BMPs requiring maintenance. For situations where there are split maintenance responsibilities (e.g., private/public), provide a breakdown of the entity responsible for each structure and BMP.

Maintenance and Source Control Manual Section 5 – Maintenance Instructions

This section shall begin with the following statement, unless otherwise approved by the County:

"The parties responsible for maintenance must review and apply the maintenance requirements contained herein. These maintenance instructions outline conditions for determining if maintenance actions are required, as identified through inspection. However, they are not intended to be measures of the facility's required condition at all times between inspections. Exceedance of these conditions at any time between inspections or maintenance activity does not automatically constitute a violation of these

standards. However, based upon inspection observations, the inspection and maintenance presented in the checklists shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action. For facilities not owned and maintained by the County, a log of maintenance activity that indicates what actions were taken must be kept on site and be available for inspection by the County."

In addition, include a narrative description of the purpose, function, and maintenance requirements for all stormwater structures and BMPs requiring maintenance. See Pierce County Planning and Public Works' website for example language that can be used for this content. Following the narrative description(s), include detailed maintenance checklists for all stormwater structures and BMPs requiring maintenance. Appendix I-A includes maintenance checklists for all stormwater facilities and BMPs included in this Stormwater Management and Site Development Manual. The Maintenance and Source Control Manual shall include only those checklist items that are pertinent to the structures and BMPs proposed for your project. Do not include all of the checklists provided in Appendix I-A. Note that the maintenance checklists (and narrative descriptions) can be included as an attachment to the Maintenance and Source Control Manual, so long as they are clearly referenced in this section.

If the project is a surface mine, this section shall identify the measures (temporary swales, temporary berms, etc.) that will be implemented over the life of the mining activity to control stormwater runoff in accordance with the approved Drainage Control Plan.

Maintenance and Source Control Manual Section 6 – Vegetation Maintenance

The effectiveness of many stormwater facilities will depend on the plants included in the facility design, and their proper maintenance. A listing and location of plant species and their requirements for maintenance shall be included in this section. This includes bioretention and rain garden planting, newly planted and retained trees claimed as flow reduction credits, as well as vegetation retention and restoration areas. Maintenance requirements must address issues including but not limited to pest and disease management practices, pruning requirements, irrigation requirements, fertilization requirements, etc.

Maintenance and Source Control Manual Section 7 – Pollution Source Control Measures

Pollution source control is the application of pollution prevention practices on a developed site to reduce contamination of stormwater runoff at its source. BMPs and resource management systems are designed to reduce the amount of contaminants used and potentially discharged to the environment. This section of the Maintenance and Source Control Manual shall contain language regarding pollution source controls that are specifically applicable to the site. Additional information on required and suggested source control measures is provided in Volume IV.

Maintenance and Source Control Manual Section 8 – Annual Cost of Maintenance

Provide an estimate of the expected annual cost of maintenance, including identification of the number of catch basins, control structures, linear feet of pipe, etc. Contact the County for additional guidance if needed.

3.3.7 Drainage Control Plan – Establishment of Maintenance Covenant

A maintenance covenant is required for each site/lot that contains stormwater management BMPs that will be maintained by a private entity such as an individual, corporation, or homeowner's association. The maintenance covenant must be created on a county-approved form (obtainable from Pierce County Planning and Public Works' website. Any attachments shall meet the recording

requirements of the Pierce County Auditor. The covenant shall be recorded at the Pierce County Auditor's office at the expense of the applicant, and shall be tied to the parcel numbers that the project is built on. All covenants must be recorded prior to final construction approval for the proposed project.

The covenant shall include the following:

1. A legal description of the property
2. Assessor parcel numbers
3. Project name
4. Project application/permit #
5. Parties responsible (including contact information) for maintenance and implementation of pollution source control measures
6. Language stating that the covenant shall run with the land and be binding on all successors and assigns
7. A requirement that the responsible parties maintain the stormwater facilities in accordance with the attached project Maintenance and Source Control Manual
8. A requirement that the responsible parties implement pollution source control measures in the attached Maintenance and Source Control Manual
9. A requirement that the responsible parties keep and maintain a log of maintenance activity that indicates what actions were taken, and that the log be made available for inspection by the County
10. Language that prohibits unauthorized modifications, unless approved by the County
11. Language that provides for a county approval process and allows modification to the covenant, or to the Maintenance and Source Control Manual
12. Language that provides for a county process (remedies) for situations where the responsible party fails to perform the required maintenance or fails to implement the pollution source control measures
13. Language that provides access authority to the County for purposes of inspection, maintenance, and repair
14. Language that provides for reimbursement to the County by the responsible party in the event that the County incurs costs related to maintenance or repair
15. The location of the approved Drainage Control Plan
16. The Maintenance and Source Control Manual as an attachment.

Chapter 4. BMP and Facility Selection Process for Permanent Stormwater Control Plans

4.1 Purpose

The purpose of this chapter is to provide guidance for selecting permanent BMPs and facilities for new development and redevelopment sites (including retrofitting of redevelopment sites).

Pierce County's pollution control strategy is to emphasize pollution prevention first, through the application of source control BMPs. Then the application of appropriate onsite, treatment, and flow control facilities fulfills the statutory obligation to provide AKART, or "all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the State of Washington." (RCW 90.48.010)

The remainder of this chapter presents seven steps in selecting BMPs, treatment facilities, and flow control facilities.

4.2 BMP and Facility Selection Process

Step I: Determine and Read the Applicable Minimum Requirements

Section 2.3 establishes project size thresholds for the application of minimum requirements to new development and redevelopment projects. Figures 2.1 and 2.2 provide the same thresholds in a flow chart format. Calculate total new hard surfaces, replaced hard surfaces, and converted vegetation areas to determine which minimum requirements apply to the project.

Step II: Select Source Control BMPs

Refer to Volume IV. If the project involves construction of areas or facilities to conduct any of the activities described in Volume IV, Chapter 2, the required structural source control BMPs described in that volume must be constructed as part of the project. In addition, residential (Volume IV, Chapter 3) or the planned business enterprise (Volume IV, Chapter 4) that will occupy the site need to review the required operational source control BMPs described. Structural source control BMPs should be identified on all applicable plans submitted for county review and approval.

The project may have additional source control responsibilities as a result of area-specific pollution control plans (e.g., watershed or basin plans, water cleanup plans, groundwater management plans, lakes management plans), ordinances, and regulations.

Step III: Determine Threshold Discharge Areas and Applicable Requirements for Treatment, Flow Control, and Wetlands Protection

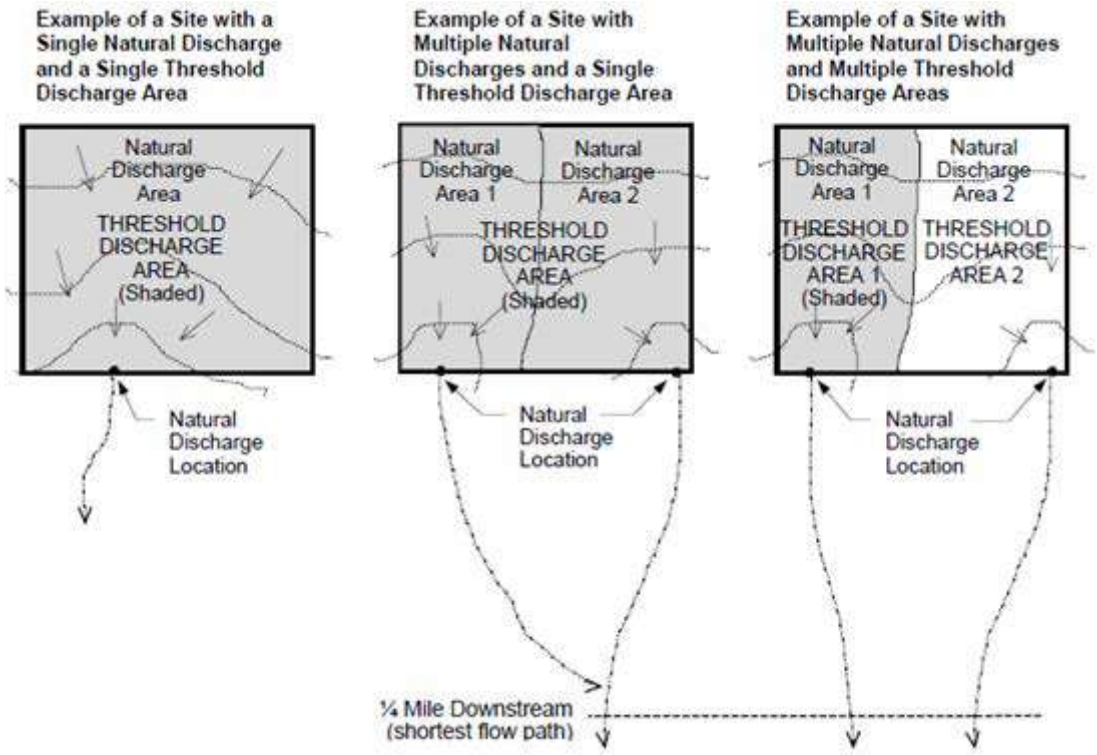
Minimum Requirement #6: Runoff Treatment and Minimum Requirement #7: Flow Control have specific thresholds that determine their applicability (see Sections 2.4.6 and 2.4.7). Minimum Requirement #8: Wetlands Protection uses the same size thresholds as those used in #6 and #7. Those thresholds determine whether certain areas (called "threshold discharge areas") of a project must use treatment and flow control facilities, designed by a professional engineer, or whether just Minimum Requirement #5: Onsite Stormwater Management BMPs can be applied instead (see Section 2.4.5).

Step 1: Review the definitions in the Glossary to become acquainted with the following terms: effective impervious surface, impervious surface, hard surface, pollution-generating impervious surface (PGIS), pollution-generating hard surface, pollution-generating pervious surface (PGPS), and converted vegetation areas.

Step 2: Outline the threshold discharge areas for your project site.

Threshold Discharge Area – An onsite area draining to a single natural discharge location or multiple natural discharge locations that combine within one-quarter mile downstream (as determined by the shortest flow path). The examples in Figure 4.1 below illustrate this definition. The purpose of this definition is to clarify how the thresholds of this manual are applied to project sites with multiple discharge points.

Figure 4.1 - Threshold Discharge Areas



Step 3: Determine the amount of pollution-generating hard surfaces (including pollution-generating permeable pavements) and pollution-generating pervious surfaces (not including permeable pavements) in each threshold discharge area. Compare those totals to the project thresholds in Section 2.4.6 (Table 2.1) to determine where treatment facilities are necessary. Note that onsite stormwater management BMPs (Minimum Requirement #5) are always applicable.

Step 4: Compute the totals for effective impervious surface and converted vegetation areas in each threshold discharge area. Compare those totals to the project thresholds in Section 2.4.7 to determine if flow control facilities (Minimum Requirement #7 and #8) are needed. If neither threshold for flow control facilities is exceeded, proceed to Step 5. If one of the thresholds is exceeded, proceed to Step IV below.

Step 5: For each threshold discharge area, use an Ecology approved continuous runoff model to determine whether there is an increase of 0.15 cfs in the 100-year return frequency flow using

15-minute time steps. This requires a comparison to the 100-year return frequency flow predicted for the existing (pre-project; not the historic) land cover condition of the same area. If the above threshold is exceeded, flow control – Minimum Requirements #7 and #8 – is potentially required. See the "Applicability" sections of those minimum requirements. Note that onsite stormwater management BMPs (Minimum Requirement #5) are always applicable.

This task requires properly representing the hard surfaces and the converted vegetation areas in the runoff model. Hard surfaces include impervious surfaces, permeable pavements, and vegetated roofs. Impervious surface area totals are entered directly. Additional modeling guidance is found in the BMP design criteria in Volumes III and VI.

Step IV: Select Flow Control BMPs and Facilities

A determination should have already been made whether Minimum Requirement #7, and/or Minimum Requirement #8 apply to the project site. Onsite stormwater management BMPs must be applied in accordance with Minimum Requirement #5. In addition, flow control facilities must be provided for discharges from those threshold discharge areas that exceed the thresholds outlined in Section 2.4.7. Use an approved continuous simulation runoff model and the details in Volume III, Chapter 3 to size and design the facilities.

The following describes a selection process for those facilities.

Step 1: Determine whether you can infiltrate.

Review Appendix I-C – Underground Injection Control (UIC) Program Guidelines to determine if the proposed infiltration BMP is considered a UIC well. If so, Appendix I-C requirements apply to the selected BMP.

There are two possible options for infiltration.

The first option is to infiltrate through rapidly draining soils that do not meet the site characterization and site suitability criteria for providing water quality treatment (see Volume V, Section 6.3). In this case, any runoff from pollutant generating surfaces must first be treated in accordance with Minimum Requirement #6 prior to discharge to the flow control infiltration facility (and ultimately to the ground via infiltration). The treatment facility could be located off-line with a capacity to treat the water quality design flow rate or volume (see Volume V, Chapter 4) to the applicable performance goal (see Volume V, Chapter 3). Volumes or flow rates in excess of the water quality design volume or flow rate would bypass untreated into the infiltration basin. The infiltration facility must provide adequate volume such that the flow duration standard of Minimum Requirement #7, or the wetland protection requirements of Minimum Requirement #8, will be achieved. See Volume III, Chapter 3 for design criteria for infiltration facilities intended to provide flow control without treatment.

The second option is to infiltrate through soils that meet the site characterization and site suitability criteria for water quality treatment outlined in Volume V, Section 6.3. The facility would be designed to meet the requirements for both treatment and flow control. Because such a facility would have to be located on-line it would be quite large in order to achieve the flow duration standard of Minimum Requirement #7. Therefore this option will, in most cases, be cost and space prohibitive.

If infiltration facilities for flow control are planned, the flow control requirement has been met. Proceed to Step V. If infiltration facilities are not planned, proceed to Step 2.

Step 2: Use an approved continuous simulation runoff model to size a detention facility.

Refer to Volume III, Chapter 2 for an overview of the use of continuous simulation models for flow control facility sizing. Additional information may be available from the model developers, depending on the specific model being used.

Note that the more the site is left undisturbed, and the less impervious surfaces are created, the smaller the detention/flow control facility. Greater the use of onsite stormwater management BMPs can lead to a smaller detention facility when supported by engineering.

Step V: Select Treatment Facilities

Please refer to Chapter 2 of Volume V of this manual for step-by-step guidance to selection of treatment facilities.

- Step 1: Determine the receiving waters and pollutants of concern based on offsite analysis
- Step 2: Determine whether the facility will be county owned or privately owned
- Step 3: Determine if an oil control facility/device is required
- Step 4: Determine if infiltration for pollutant removal is practicable
- Step 5: Determine if control of phosphorous is required
- Step 6: Determine if enhanced treatment is required
- Step 7: Select a basic treatment facility unless previously selected treatments also meet basic treatment standards.

Step VI: Review Selection of BMPs and Facilities

The list of onsite, treatment, flow control, and source control BMPs should be reviewed. The site designer may want to re-evaluate site layout and design to reduce the need for stormwater facilities or the size of the facilities by reducing the amount of impervious surfaces created and increasing the areas to be left undisturbed. This step presents another opportunity to maximize the use of onsite stormwater management BMPs and LID approaches to reduce stormwater facility needs.

Step VII: Complete Development of Permanent Stormwater Control Plans and Submittals

The design and location of the BMPs and facilities on the site must be determined using the detailed guidance in Volumes III through VI. Maintenance requirements for each treatment and flow control facility are also required as part of the Maintenance and Source Control Manual submittal. Please refer to Chapter 3 for guidance on the contents of required stormwater site plans and submittals, which may include: Construction SWPPP, Abbreviated Plans, or Drainage Control Plans.

Volume I References

Azous, A.L. and Horner R.R., "Wetlands and Urbanization, Implications for the Future," Final Report of the Puget Sound Wetlands and Stormwater Management Research Program, 1997.

Low Impact Development Manual for Puget Sound, WSU Puyallup Research and Extension Center, and the Puget Sound Partnership, 2012.

Low Impact Development Operation and Maintenance Manual, Washington State Department of Ecology, Prepared by Herrera Environmental Consultants, Inc. and the Washington Stormwater Center, 2013.

Puget Sound Water Quality Management Plan, Puget Sound Water Quality Authority, 1987, 1989, 1991, 1994.

Soil Survey of Pierce County Area, Washington, 1979, Soil Conservation Service, United States Department of Agriculture (USDA), 1979.

Appendix I-A – Example Maintenance Checklists

This appendix includes detailed maintenance checklists for all stormwater facilities and BMPs. In addition to the information presented here, the description of each BMP in Volumes III and V includes a brief section on facility maintenance. The tables presented in this appendix should be used to complete the requirements for Section 5 – Maintenance Instructions for the project Maintenance and Source Control Manual submittal. See Section 3.3.6 of Volume I for additional details on the Maintenance and Source Control Manual submittal requirements. Project owners (or other individuals assigned maintenance responsibility) must review and apply the maintenance requirements included in the applicable checklists for all stormwater structures and BMPs present on their site.

Maintenance personnel should bring copies of the applicable maintenance checklists (provided in their Maintenance and Source Control Manual) to the site during routine inspections, check off the problems that were assessed during each inspection, and include comments on problems found and actions taken. These inspection records must be kept in the maintenance files (i.e., as part of the required maintenance log).

Listing of Maintenance Checklists:

#1 – Maintenance Checklist for Detention Ponds: 3
#2 – Maintenance Checklist for Infiltration Basins and Trenches: 6
#3 – Maintenance Checklist for Closed Detention Systems (Tanks/Vaults): 9
#4 – Maintenance Checklist for Control Structure/Flow Restrictor: 10
#5 – Maintenance Checklist for Catch Basins: 11
#6 – Maintenance Checklist for Debris Barriers (e.g., Trash Racks): 13
#7 – Maintenance Checklist for Energy Dissipaters: 14
#8 – Maintenance Checklist for Basic and Compost-Amended Biofiltration Swales: 16
#9 – Maintenance Checklist for Wet and Continuous Inflow Biofiltration Swales: 18
#10 – Maintenance Checklist for Filter Strips (Basic and CAVFS): 19
#11 – Maintenance Checklist for Wet Ponds: 20
#12 – Maintenance Checklist for Wet Vaults: 21
#13 – Maintenance Checklist for Sand Filters (aboveground/open): 22
#14 – Maintenance Checklist for Sand Filters (below ground/enclosed): 23
#15 – Maintenance Checklist for Manufactured Media Filters. 25
#16 – Maintenance Checklist for Baffle Oil/Water Separators (American Petroleum Institute [API] Type): 27
#17 – Maintenance Checklist for Coalescing Plate Oil/Water Separators: 28
#18 – Maintenance Checklist for Treatment Wetlands: 29
#19 – Maintenance Checklist for Fencing/Shrubbery Screen/Other Landscaping: 32
#20 – Maintenance Checklist for Grounds (Landscaping): 33
#21 – Maintenance Checklist for Gates: 34
#22 – Maintenance Checklist for Conveyance Systems (Pipes and Ditches): 35
#23 – Maintenance Checklist for Media Filter Drain. 36
#24 – Maintenance Checklist for Vortechs Stormwater Treatment System 38
#25 – Maintenance Checklist for Stormceptor System. 39
#26 – Maintenance Checklist for Filterra. 40
#27 – Maintenance Checklist for CDS Media Filtration System (MFS) ®. 41
#28 – Maintenance Checklist for Aqua Shield Aqua-Swirl. 43
#29 – Maintenance Checklist for Bioretention (Cells, Swales, and Planter Boxes): 44
#30 – Maintenance Checklist for Cisterns: 49
#31 – Maintenance Checklist for Vegetated Roof: 50
#32 – Maintenance Checklist for Permeable Pavement: 54
#33 – Maintenance Checklist for Downspout, Sheet Flow, and Concentrated Dispersion Systems: 56
#34 – Maintenance Checklist for Rain Gardens: 58
#35 – Maintenance Checklist for Trees: 60
#36 – Maintenance Checklist for Downspout Full Infiltration Systems: 61
#37 – Maintenance Checklist for Dead-End Sump Vaults: 62

#1 – Maintenance Checklist for Detention Ponds

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Any trash and debris which exceed five cubic feet per 1,000 square feet. If less than threshold, all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
General	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined in the Pierce County Noxious Weeds List. (Apply requirements of adopted integrated pest management policies for the use of herbicides.)	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Noxious and nuisance vegetation removed according to applicable regulations. *(Coordinate with Tacoma-Pierce County Health Department.) Complete eradication of noxious weeds may not be possible. Compliance with state or local eradication policies required.*
General	Contaminants and Pollution	Any evidence of contaminants such as oil, gasoline, concrete slurries, or paint.	No contaminants or pollutants present. *(Coordinate source control, removal, and/or cleanup with Pierce County Surface Water Management 253-798-2725 and/or Dept. of Ecology Spill Response 800-424-8802.)*
General	Rodent Holes	If the facility is constructed with a dam or berm, look for rodent holes or any evidence of water piping through the dam or berm.	Rodents removed and dam or berm repaired. *(Coordinate with Tacoma-Pierce County Health Department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)*
General	Beaver Dams	Beaver dam results in an adverse change in the functioning of the facility.	Facility is returned to design function. *(Contact WDFW Region 6 to identify the appropriate Nuisance Wildlife Control Operator.)*
General	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. *Apply insecticides in compliance with adopted integrated pest management policies.*
General	Tree Growth and Dense Vegetation	Tree growth and dense vegetation impedes inspection, maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements).	Trees and vegetation do not hinder inspection or maintenance activities.
General	Hazard Trees	If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements).	Hazard trees removed.
General	Performance	Check crest gauge against design expectations (see Maintenance and Source Control Manual).	Reading recorded. County notified if not meeting design performance.

#1 – Maintenance Checklist for Detention Ponds

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Crest Gauge	Crest Gauge Missing/ Broken	Crest gauge is not functioning properly, has been vandalized, or is missing.	Repair/replace.
Side Slopes of Pond	Erosion	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
Side Slopes of Pond	Erosion	Any erosion observed on a compacted berm embankment.	Slopes stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. *If erosion is occurring on compacted berms, a professional engineer should be consulted to resolve source of erosion.*
Storage Area	Sediment	Accumulated sediment that exceeds 10 percent of the designed pond depth unless otherwise specified or affects facility inlets or outlets.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion. *(If sediment contamination is a potential problem, sediment should be tested regularly to determine leaching potential prior to disposal.)*
Storage Area	Liner (If Applicable)	Liner is visible and has more than three 0.25 inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation.	Dike is built back to the design elevation. *If settlement is significant, a professional engineer should be consulted to determine the cause of the settlement.*
Pond Berms Over 4 ft in height (Dikes)	Tree Growth	Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees on berms removed. *If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A professional engineer should be consulted for proper berm/spillway restoration.*
Pond Berms (Dikes)	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue.	Piping eliminated. Erosion potential eliminated. *Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.*

#1 – Maintenance Checklist for Detention Ponds

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Emergency Overflow/ Spillway	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.	Trees on emergency spillway removed. *If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A professional engineer should be consulted for proper berm/spillway restoration.*
Emergency Overflow/ Spillway	Rock Missing	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of outflow path of spillway.	Rocks and pad depth restored to design standards. (Riprap on inside slopes need not be replaced.)
Emergency Overflow/ Spillway	Erosion	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. *If erosion is occurring on compacted berms a professional engineer should be consulted to resolve source of erosion.*

If you are unsure whether a problem exists, contact a professional engineer.

#2 – Maintenance Checklist for Infiltration Basins and Trenches

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Any trash and debris which exceed five cubic feet per 1,000 square feet. If less than threshold, all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
General	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined in the Pierce County Noxious Weeds List. (Apply requirements of adopted integrated pest management policies for the use of herbicides.)	No danger of poisonous vegetation where maintenance personnel or the public might normally be. *(Coordinate with Tacoma-Pierce County Health Department) Complete eradication of noxious weeds may not be possible. Compliance with state or local eradication policies required.*
General	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants.	No contaminants or pollutants present. *(Coordinate removal/cleanup with Pierce County Surface Water Management 253-798-2725 and/or Dept. of Ecology Spill Response 800-424-8802.)*
General	Rodent Holes	If the facility is constructed with a dam or berm, look for rodent holes or any evidence of water piping through the dam or berm.	Rodents removed and dam or berm repaired. *(Coordinate with Tacoma-Pierce County Health Department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)*
General	Beaver Dams	Beaver dam results in an adverse change in the functioning of the facility.	Facility returned to design function. *(Contact WDFW Region 6 to identify the appropriate Nuisance Wildlife Control Operator)*
General	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. *Apply insecticides in compliance with adopted integrated pest management policies.*
General	Performance	Check crest gauge against design expectations (see Maintenance and Source Control Manual).	Crest gauge results reflect design performance expectations. Reading recorded. County notified if not meeting design performance.
Crest Gauge	Crest Gauge Missing/ Broken	Crest gauge is not functioning properly, has been vandalized, or is missing.	Crest gauge present and functioning. Repair/replace crest gauge if missing or broken.

#2 – Maintenance Checklist for Infiltration Basins and Trenches

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Storage Area	Water Not Infiltrating	Water ponding in infiltration basin after rainfall ceases and appropriate time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90 percent of its designed capabilities. If 2 inches or more sediment is present, remove).	Facility infiltrates as designed. Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than one-half full.	Filter bag less than one-half full. Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Water flows through filter. Replace gravel in rock filter if needed.
Trenches	Observation Well (Use Surface of Trench if Well is Not Present)	Water ponds at surface during storm events. Less than 90 percent of design infiltration rate.	Remove and replace/clean rock and geomembrane.
Ponds	Vegetation	Exceeds 18 inches.	Grass or groundcover mowed to a height no greater than 6 inches.
Ponds	Vegetation	Bare spots.	No bare spots. Revegetate and stabilize immediately.
Side Slopes of Pond	Erosion	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. *If erosion is occurring on compacted slope, a professional engineer should be consulted to resolve source of erosion.*
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works.	Dike is built back to the design elevation. If settlement is significant, a professional engineer should be consulted to determine the cause of the settlement.
Pond Berms (Dikes)	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue.	No water flow through pond berm. Piping eliminated. Erosion potential eliminated. *Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.*

#2 – Maintenance Checklist for Infiltration Basins and Trenches

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Hazard Trees	If dead, diseased, or dying trees are identified.	Hazard trees removed. *(Use a certified Arborist to determine health of tree or removal requirements).*
General	Tree Growth and Dense Vegetation	Tree growth and dense vegetation which impedes inspection, maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements).	Trees and vegetation do not hinder inspection or maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood).
Pond Berms (Dikes)	Tree Growth	Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees on berms removed. *If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A professional engineer should be consulted for proper berm/spillway restoration.*
Emergency Overflow/ Spillway	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.	Trees on emergency spillways removed. *If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A professional engineer should be consulted for proper berm/spillway restoration.*
Emergency Overflow/ Spillway	Rock Missing	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of outflow path of spillway.	Rocks and pad depth restored to design standards. (Riprap on inside slopes need not be replaced.)
Emergency Overflow/ Spillway	Erosion	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. *If erosion is occurring on compacted berms a professional engineer should be consulted to resolve source of erosion.*
Presettling Ponds and Vaults	Facility or sump filled with Sediment and/or Debris	6 inches or designed sediment trap depth of sediment.	No sediment present in presettling pond or vault. Sediment is removed.
Drain Rock	Water Ponding	If water enters the facility from the surface, inspect to see if water is ponding at the surface during storm events. If buried drain rock, observe drawdown through observation port or cleanout.	No water ponding on surface during storm events. *Clear piping through facility when ponding occurs. Replace rock material/ sand reservoirs as necessary. Tilling of subgrade below reservoir may be necessary (for trenches) prior to backfill.*

If you are unsure whether a problem exists, contact a professional engineer.

#3 – Maintenance Checklist for Closed Detention Systems (Tanks/Vaults)

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Storage Area	Plugged Air Vents	One-half of the cross-section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning. Remove blockage or replace air vent if damaged.
Storage Area	Debris and Sediment	Accumulated sediment depth exceeds 10 percent of the diameter of the storage area for one-half length of storage vault or any point depth exceeds 15 percent of diameter.	All sediment and debris removed from storage area.
Storage Area	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability.)	All joint between tank/pipe sections are sealed.
Storage Area	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10 percent of its design shape. (Review required by engineer to determine structural stability.)	Tank/pipe repaired or replaced to design.
Storage Area	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound.	Vault replaced or repaired to design specifications and is structurally sound.
Storage Area	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	No cracks more than one-fourth inch wide at the joint of the inlet/ outlet pipe. No water or soil entering vault through joints or walls.
Crest Gauge	Crest Gauge Missing/ Broken	Crest gauge is not functioning properly, has been vandalized, or is missing.	Crest gauge present and functioning. *Repair/replace crest gauge if missing or broken.*
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole access cover/ lid is in place and secure.
Manhole	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than one-half inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
Manhole	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.

#3 – Maintenance Checklist for Closed Detention Systems (Tanks/Vaults)

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Manhole	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.

If you are unsure whether a problem exists, contact a professional engineer.

Tanks and vaults are a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#4 – Maintenance Checklist for Control Structure/Flow Restrictor

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25 percent of sump depth or 1 foot below orifice plate.	No trash and debris blocking or potentially blocking control structure orifice.
General	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
General	Structural Damage	Structure is not in upright position (allow up to 10 percent from plumb).	Structure in correct position.
General	Structural Damage	Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
General	Structural Damage	Any holes–other than designed holes–in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
Cleanout Gate	Damaged or Missing	Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
Cleanout Gate	Damaged or Missing	Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
Cleanout Gate	Damaged or Missing	Gate is rusted over 50 percent of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
Orifice Plate	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole access cover/ lid is in place and secure.
Manhole	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than one-half inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
Manhole	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.

#4 – Maintenance Checklist for Control Structure/Flow Restrictor

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Manhole	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.

If you are unsure whether a problem exists, contact a professional engineer.

Control structures are usually considered a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#5 – Maintenance Checklist for Catch Basins

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	"Dump no pollutants" (or similar) stencil or stamp not visible	Stencil or stamp should be visible and easily read.	Warning signs (e.g., "Dump No Waste-Drains to Stream" or "Only rain down the drain"/ "Puget Sound starts here") painted or embossed on or adjacent to all storm drain inlets.
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inlet capacity by more than 10 percent.	No trash or debris located immediately in front of catch basin or on grate opening.
General	Trash and Debris	Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
General	Trash and Debris	Trash or debris in any inlet or outlet pipe blocking more than one-third of its height.	Inlet and outlet pipes free of trash or debris.
General	Trash and Debris	Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
General	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin.
General	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than one-fourth inch.	No holes and cracks in the top slab allowing material to run into the basin.
General	Structure Damage to Frame and/or Top Slab	Frame not sitting flush on top slab, i.e., separation of more than three-fourth inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
General	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.

#5 – Maintenance Checklist for Catch Basins

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Fractures or Cracks in Basin Walls/ Bottom	Grout fillet has separated or cracked wider than one-half-inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
General	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
General	Vegetation	Vegetation growing across and blocking more than 10 percent of the basin opening.	No vegetation blocking opening to basin.
General	Vegetation	Vegetation growing in inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart.	No vegetation or root growth present.
General	Contamination and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants.	No contaminants or pollutants present. *(Coordinate removal/cleanup with Pierce County Surface Water Management 253-798-2725 and/or Dept. of Ecology Spill Response 800-424-8802.)*
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is in place and secured.
Catch Basin Cover	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than one-half-inch of thread.	Mechanism opens with proper tools.
Catch Basin Cover	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Grates	Grate Opening Unsafe	Grate with opening wider than seven-eighths of an inch.	Grate opening meets design standards.
Grates	Trash and Debris	Trash and debris that is blocking more than 20 percent of grate surface inletting capacity.	Grate free of trash and debris.
Grates	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

If you are unsure whether a problem exists, contact a professional engineer.

#6 – Maintenance Checklist for Debris Barriers (e.g., Trash Racks):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20 percent of the openings in the barrier.	Barrier cleared to receive design flow capacity.
General	Damaged/ Missing Bars	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than three-fourth inch.
General	Damaged/ Missing Bars	Bars are missing or entire barrier missing.	Bars in place according to design.
General	Damaged/ Missing Bars	Bars are loose and rust is causing 50 percent deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
General	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe.	Barrier firmly attached to pipe.

If you are unsure whether a problem exists, contact a professional engineer.

#7 – Maintenance Checklist for Energy Dissipaters:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
Rock Pad	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20 percent of the design depth.	Pipe cleaned/flushed so that it matches design.
Dispersion Trench	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Water discharges from feature by sheet flow. Trench redesigned or rebuilt to standards.
Dispersion Trench	Perforations Plugged	Over one-half of perforations in pipe are plugged with debris and sediment.	Perforations freely discharge flow. Perforated pipe cleaned or replaced.
Dispersion Trench	Water Flows Out Top of "Distributor" Catch Basin	Water flows out of distributor catch basin during any storm less than the design storm or is causing or appears likely to cause damage.	No flow discharges from distributor catch basin. Facility rebuilt or redesigned to standards.
Dispersion Trench	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/ Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to one-half of original size or any concentrated worn spot exceeding 1 square foot which would make structure unsound.	Structure in no danger of failing. Structure replaced to design standards if needed.
Manhole/ Chamber	Trash and Debris	Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
Manhole/ Chamber	Trash and Debris	Trash or debris in any inlet or outlet pipe blocking more than one-third of its height.	Inlet and outlet pipes free of trash or debris.
Manhole/ Chamber	Trash and Debris	Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.

#7 – Maintenance Checklist for Energy Dissipaters:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Manhole/ Chamber	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin.
Manhole/ Chamber	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 0.25 inch.	No holes and cracks in top slab allowing material to run into the basin.
Manhole/ Chamber	Structure Damage to Frame and/or Top Slab	Frame not sitting flush on top slab, i.e., separation of more than three-fourth inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
Manhole/ Chamber	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
Manhole/ Chamber	Fractures or Cracks in Basin Walls/ Bottom	Grout fillet has separated or cracked wider than 0.5 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
Manhole/ Chamber	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
Manhole/ Chamber	Contamination and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants.	No contaminants or pollutants present. *(Coordinate removal/cleanup with Pierce County Surface Water Management 253-798-2725 and/or Dept. of Ecology Spill Response 800-424-8802.)*
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed.
Catch Basin Cover	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than one-half-inch of thread.	Mechanism opens with proper tools.
Catch Basin Cover	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.

If you are unsure whether a problem exists, contact a professional engineer.

#8 – Maintenance Checklist for Basic and Compost-Amended Biofiltration Swales:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches or inhibits vegetation growth in 10 percent or more of swale.	No sediment deposits in treatment area of the biofiltration swale. Remove sediment deposits on grass treatment area of the swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
General	Standing Water	When water stands in the swale between storms and does not drain freely.	Swale drains freely and no standing water in swale between storms. *Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.*
General	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Spreader leveled and cleaned and flow spread evenly over entire swale width.
General	Constant Base Flow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Base flow removed from swale by a low-flow pea-gravel drain the length of the swale, or by-passed around the swale.
General	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10 percent of the swale bottom.	Swale has no bare spots and grass is thick and healthy. *If grass growth is poor, determine and address the cause. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.*
General	Vegetation	When the grass becomes excessively tall (greater than 10 inches); when nuisance weeds and other vegetation starts to take over.	Vegetation mowed or nuisance vegetation removed so that flow not impeded. *Grass mowed to a height of 3 to 4 inches. No grass clippings left in swale.*
General	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	Over-hanging limbs trimmed back and brushy vegetation on adjacent slopes removed.

#8 – Maintenance Checklist for Basic and Compost-Amended Biofiltration Swales:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Inlet and outlet areas clear of sediment and debris. Material clogging or blocking the inlet/ outlet area removed.
General	Trash and Debris Accumulation	Trash and debris accumulated in the bioswale.	Leaves, litter, and oily materials removed as needed. Curb cuts and level spreaders cleaned as needed.
General	Erosion/ Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	No eroded or scoured areas in biofiltration swale. Cause of erosion or scour addressed. *For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.*

If you are unsure whether a problem exists, contact a professional engineer.

#9 – Maintenance Checklist for Wet and Continuous Inflow Biofiltration Swales:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Sediment Accumulation	Sediment depth exceeds 2 inches in 10 percent of the swale treatment area.	No sediment deposits in treatment area.
General	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Water depth of 4 inches throughout swale for most of wet season. Build up or repair outlet berm so that water is retained in the wet swale.
General	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Wetland vegetation fully covers bottom of swale. Cause of lack of vigor of vegetation addressed. Replant as needed. *No cattails or nuisance vegetation present. For excessive cattail growth, cut cattail shoots back and compost offsite. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.*
General	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Inlet and outlet areas clear of sediment and debris.
General	Trash and Debris Accumulation	Any trash and debris which exceed one cubic foot per 1,000 square feet. If less than threshold, all trash and debris will be removed as part of next scheduled maintenance.	No trash and debris present. Any trash and debris removed from wet swale.
General	Erosion/ Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	No eroded or scoured areas in biofiltration swale. *Cause of erosion or scour addressed, Design flows checked to assure swale is large enough to handle flows. Excess flows are bypassed or swale enlarged. Eroded areas replanted with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.*

If you are unsure whether a problem exists, contact a professional engineer.

#10 – Maintenance Checklist for Filter Strips (Basic and CAVFS):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	No sediment deposits in treatment areas. Slope re-leveled to be even and pass flows evenly through strip.
General	Vegetation	When the grass becomes excessively tall (greater than 10 inches); when nuisance weeds and other vegetation starts to take over.	Grass is healthy and nuisance vegetation controlled such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
General	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	No trash or debris present. Any trash and debris removed from filter.
General	Erosion/ Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	No eroded or scoured areas, cause of erosion or scour addressed. *For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel (basic filter strip) or a 50/50 mixture of crushed gravel and compost (CAVFS). The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re- seeded. For smaller bare areas, overseed when bare spots are evident.*
General	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Flows are spread evenly over entire filter width. Spreader is level and clean.

If you are unsure whether a problem exists, contact a professional engineer.

#11 – Maintenance Checklist for Wet Ponds:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Water level	First cell is empty, does not hold water.	Water retained in first cell for most of the year. *Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.*
	Trash and Debris	Accumulation that exceeds one cubic foot per 1,000 square feet of pond area.	No trash or debris on site. Any trash and debris removed from pond.
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6 inches, usually in the first cell.	Sediment removed from pond bottom. *(If sediment contamination is a potential problem, sediment should be tested regularly to determine leaching potential prior to disposal.)*
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil- absorbent pads or vactor truck. Source of oil located and corrected. *If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.*
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom that exceeds 6 inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/ Berm	Any part of these components that has settled 4 inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

If you are unsure whether a problem exists, contact a professional engineer.

#12 – Maintenance Checklist for Wet Vaults:

Drainage System Feature	Problem	Conditions to Check For	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	No trash or debris present. Any trash and debris removed from vault.
General	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6 inches.	No sediment in vault. *(If sediment contamination is a potential problem, sediment should be tested regularly to determine leaching potential prior to disposal.)*
General	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
General	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
General	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified percentage of the vault surface area must provide ventilation to the vault interior (see design specifications).
Vault Structure	Damage – Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
Vault Structure	Damage – Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than one-fourth inch at the joint of the inlet/outlet pipe.
Vault Structure	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
Access Ladder	Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements.

If you are unsure whether a problem exists, contact a professional engineer.

A vault is a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#13 – Maintenance Checklist for Sand Filters (aboveground/open):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Above ground (open sand filter)	Sediment and Silt Accumulation On Top Layer	Sediment and silt depth exceeds one-half inch over 10 percent of surface area of sand filter.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section. Silt scraped off during dry periods using steel rakes or other devices. Surface layer of the media striated.
Above ground (open sand filter)	Trash and Debris Accumulations	Trash and debris accumulated on sand filter bed.	No trash or debris present. Any trash and debris removed from sand filter bed.
Above ground (open sand filter)	Sediment/ Debris in Cleanouts	When the cleanouts become full or partially plugged with sediment and/or debris.	No sediment or debris present. Any sediment and debris removed from cleanouts and/or drainpipes.
Above ground (open sand filter)	Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, flow through the overflow pipes occurs frequently, or hydraulic conductivity is less than 1 inch per hour.	Sand filter infiltrates as designed. Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging and influent suspended solids loads (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material). *Other options include removal of thatch, aerating the filter surface, tilling the filter surface, replacing the top 4 inches of filter media, and inspecting geotextiles for clogging.*
Above ground (open sand filter)	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities. (Consider 4-8 hour drawdown tests).	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
Above ground (open sand filter)	Short Circuiting	Drawdown greater than 12 inches per hour. When flows become concentrated over one section of the sand filter rather than dispersed. (Consider 4-8 hour drawdown tests).	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area. No leaks in the cleanouts or underdrains.
Above ground (open sand filter)	Erosion Damage to Slopes	Erosion over 2 inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
Above ground (open sand filter)	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.

#13 – Maintenance Checklist for Sand Filters (aboveground/open):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Above ground (open sand filter)	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter. Rills and gullies on the surface of the filter can indicate improper function of the inlet flow spreader.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
Above ground (open sand filter)	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20 percent or any other failure to the piping.	Pipe repaired or replaced.

If you are unsure whether a problem exists, contact a professional engineer.

#14 – Maintenance Checklist for Sand Filters (below ground/enclosed):			
Drainage System Feature	**Problem**	**Conditions to Check For**	**Results Expected When Maintenance is Performed**
Below Ground Vault	Sediment and Silt Accumulation on Top Layer	Sediment and silt depth exceeds one-half inch.	No sediment deposits on grass layer of sand filter that would impede permeability of the filter section. Silt scraped off during dry periods using steel rakes or other devices. Surface layer of the media striated.
Below Ground Vault	Sediment Accumulation in Presettling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6 inches.	No sediment deposits in first chamber of vault.
Below Ground Vault	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	No trash or debris present. Any trash and debris removed from vault and inlet/outlet piping.
Below Ground Vault	Sediment in Underdrain Pipes/ Cleanouts	When underdrain pipes, cleanouts become full of sediment and/or debris.	No sediment or debris present. Any sediment and debris removed from cleanouts and/or underdrain pipes.

#14 – Maintenance Checklist for Sand Filters (below ground/enclosed):			
Drainage System Feature	**Problem**	**Conditions to Check For**	**Results Expected When Maintenance is Performed**
Below Ground Vault	Clogged Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, and/ or flow through the overflow pipes occurs frequently, and/ or hydraulic conductivity is less than 1 inch per hour.	Sand filter infiltrates as designed. Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging and influent suspended solids loads (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material). *Other options include removal of thatch, aerating the filter surface, tilling the filter surface, replacing the top 4 inches of filter media, and inspecting geotextiles for clogging.*
Below Ground Vault	Short Circuiting	Drawdown greater than 12 inches per hour. When seepage/ flow occurs along the vault walls and corners. Sand eroding near inflow area. (Consider 4-8 hour drawdown tests.)	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion. No leaks in the cleanouts or underdrains.
Below Ground Vault	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
Below Ground Vault	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
Below Ground Vault	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified percentage of the vault surface area must provide ventilation to the vault interior (see design specifications).
Below Ground Vault	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
Below Ground Vault	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half inch or evidence of soil particles entering the structure through the cracks, or maintenance/ inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.

#14 – Maintenance Checklist for Sand Filters (below ground/enclosed):			
Drainage System Feature	**Problem**	**Conditions to Check For**	**Results Expected When Maintenance is Performed**
Below Ground Vault	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than one-fourth inch at the joint of the inlet/outlet pipe.
Below Ground Vault	Baffles/ Internal Walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/ inspection person.	Baffles repaired or replaced to specifications.
Below Ground Vault	Access Ladder	Damaged ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

If you are unsure whether a problem exists, contact a professional engineer.

A below ground enclosed sand filter is a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#15 – Maintenance Checklist for Manufactured Media Filters.			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Media filter vault	Sediment Accumulation on Top of Filter Cartridges	Sediment accumulation exceeds 0.25 inches on top of cartridges.	No sediment deposits on top of cartridges. Sediment on cartridges likely indicates that cartridges are plugged and require maintenance.
Media filter vault	Sediment Accumulation in Vault	Sediment accumulation in vault exceeds 6 inches. Look for other indicators of clogged cartridges or overflow.	No sediment accumulation in vault. *Sediment in vault should be removed. Cartridges should be checked and replaced or serviced as needed.*
Media filter vault	Trash and Floatable Debris Accumulation	Trash and floatable debris accumulation in vault.	No trash or other floatable debris in filter vault.
Media filter vault	Filter Cartridges Submerged	Filter vault does not drain within 24 hours following storm. Look for evidence of submergence due to backwater or excessive hydrocarbon loading.	Filter media checked and replaced if needed. *If cartridges are plugged with oil additional treatment or source control BMP may be needed.*
Forebay	Sediment Accumulation	Sediment accumulation exceeds 6 inches or one-third of the available sump.	Sediment accumulation less than 6 inches.

#15 – Maintenance Checklist for Manufactured Media Filters.

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Forebay	Trash and Floatable Debris Accumulation	Trash and/or floatable debris accumulation.	No trash or other floatable debris accumulation in forebay. Trash and/or floatable debris should be removed during inspections. *Significant oil accumulation may indicate the need for additional treatment or source control.*
Underdrain Pipes/ Cleanouts	Sediment in Underdrain Pipes/ Cleanouts	Accumulated sediment that exceeds 20 percent of the diameter.	No sediment or debris in underdrain pipes or cleanouts. Sediment and debris removed.
Below ground vault	Access cover Damaged/ Not working	One maintenance person cannot remove lid after applying 80 pounds of lift, corrosion of deformation of cover.	Cover repaired to proper working specifications or replaced.
Below ground vault	Damaged Pipes	Any part of the pipes are crushed or damaged due to corrosion and/or settlement.	Pipe repaired or replaced.
Below ground vault	Vault Structure Has Cracks in Wall, Bottom, and Damage to Frame and/or Top Slab.	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault repaired or replaced so that vaults meets design specifications and is structurally sound.
Below ground vault	Vault Structure has Cracks in Wall, Bottom, and Damage to Frame and/or Top Slab.	Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 0.25 inch at the joint of inlet/outlet pipe.
Below ground vault	Baffles	Baffles corroding, cracking, warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.
Below ground vault	Ladder Rungs Unsafe	Maintenance person judges that ladder is unsafe due to missing rungs, misalignment, rust, or cracks. Ladder must be fixed or secured immediately.	Ladder meets design standards and allows maintenance persons safe access.
Below Ground Cartridge Type	Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
Below Ground Cartridge Type	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

Also check Department of Ecology website and manufacturer guidelines for updates to O&M requirements.

If you are unsure whether a problem exists, contact a professional engineer.

A vault is a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#16 – Maintenance Checklist for Baffle Oil/Water Separators (American Petroleum Institute [API] Type):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Effluent Water Quality	Inspection of Discharge Water for Obvious Signs of Poor Water Quality	Floating oil in excess of 1 inch in first chamber, any oil in other chambers or effluent, or other contaminants of any type in any chamber.	No contaminants present other than a surface oil film. Effluent discharge from vault should be clear without thick visible sheen.
Structure	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6 inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
General	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
General	Oil Accumulation	Oil accumulations that exceed 1 inch, at the surface of the water or 6 inches of sludge in the sump.	No visible oil depth on water. Extract oil/sludge from vault by vactoring. *Disposal in accordance with state and local rules and regulations.*
Structure	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
Structure	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
Structure	Vault Structure Damage Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance person judges that structure is unsound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
Structure	Vault Structure Damage Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch at the joint of any inlet/ outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/outlet pipe.
Structure	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.

#16 – Maintenance Checklist for Baffle Oil/Water Separators (American Petroleum Institute [API] Type):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Structure	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

If you are unsure whether a problem exists, contact a professional engineer.

An oil/water separator vault is a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#17 – Maintenance Checklist for Coalescing Plate Oil/Water Separators:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Effluent Water Quality	Inspection of Discharge Water for Obvious Signs of Poor Water Quality	Floating oil in excess of 1 inch in first chamber, any oil in other chambers or effluent, or other contaminants of any type in any chamber.	No contaminants present other than surface oil film. Effluent discharge from vault should be clear with no thick visible sheen.
Structure	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6 inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
General	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
General	Oil Accumulation	Oil accumulation that exceeds 1 inch at the water surface.	No visible oil depth on water and coalescing plates clear of oil. *Oil is extracted from vault using vactoring methods. Dispose of in accordance with state and local rules and regulations.* *Coalescing plates are cleaned by thoroughly rinsing and flushing. Direct wash-down effluent to the sanitary sewer system where permitted. Should be no visible oil depth on water.*
Structure	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
Structure	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.

#17 – Maintenance Checklist for Coalescing Plate Oil/Water Separators:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Structure	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
Structure	Vault Structure Damage – Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
Structure	Vault Structure Damage – Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/outlet pipe.
Structure	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

If you are unsure whether a problem exists, contact a professional engineer.

An oil/water separator vault is a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#18 – Maintenance Checklist for Treatment Wetlands:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
General	Trash and Debris	Any trash and debris accumulations which exceed five cubic feet per 1,000 square feet. If there is less than the threshold, remove all trash and debris as part of the next scheduled maintenance.	Trash and debris cleared from site.

#18 – Maintenance Checklist for Treatment Wetlands:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
General	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined in the Pierce County Noxious Weeds List. (Apply requirements of adopted integrated vegetation management (IVM) policies for the use of herbicides.)	No danger of poisonous vegetation where maintenance personnel or the public might have contact. *(Coordinate with Pierce County Noxious Weed Coordinator.) Complete eradication of noxious weeds may not be possible, however compliance with state or local eradication policies are required.*
General	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil- absorbent pads or vactor truck. Source of oil located and corrected. *If chronic low levels of oil persist, plant emergent wetland plants such as Juncus effusus (soft rush) which can assist filtering small concentrations of oil.*
General	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material or damaged.	No clogging or blockage in the inlet and outlet piping.
General	Rodent Holes	If the facility is constructed with a dam or berm, look for rodent holes or any evidence of water piping through the dam or berm.	Rodents removed and dam or berm repaired. *(Coordinate with Tacoma-Pierce County Health Department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)*
General	Beaver Dams	Beaver dam results in an adverse change in the functioning of the facility.	Facility is fully functioning. *Evaluate using beaver deceiver and leveler devices. If beaver removal is necessary, contact WDFW Region 6 to coordinate with a Nuisance Wildlife Control Operator.*
General	Tree Growth and Hazard Trees	Tree growth that impedes maintenance access.	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., firewood or construction).
General	Tree Growth and Hazard Trees	If dead, diseased, or dying trees are identified, use a certified Arborist to determine the health of tree and whether removal is required.	Hazard trees removed.
General	Liner	Liner is visible and has more than three 0.25 inch holes in it.	Liner is repaired or replaced. Liner is fully covered.
Forebay	Sediment Accumulation	Sediment accumulation in forebay exceeds the design depth of the sediment zone plus 6 inches.	Accumulated sediment is removed from forebay bottom to the design depth of the sediment zone.

#18 – Maintenance Checklist for Treatment Wetlands:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Side Slopes of Wetland	Erosion	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes stabilized using appropriate erosion control measure(s) such as rock reinforcement, planting of grass, or additional compaction.
Side Slopes of Wetland	Erosion	Any erosion observed on a compacted berm embankment.	*If erosion is occurring on compacted berms a professional engineer should be consulted to resolve source of erosion*.
Wetland Cell	Wetland Vegetation	20 percent or more of the constructed wetland area has dead or dying vegetation, as measured by stem counts relative to the design plant coverage.	Plants in wetland cell surviving and not interfering with wetland function. Dead or dying vegetation is replaced by like species, unless recommended otherwise by the Wetlands Consultant and approved by the County. *(Watering, physical support, mulching, and weed removal may be required on a regular basis especially during the first 3 years.)*
Wetland Cell	Wetland Vegetation	Percent vegetated cover of constructed wetland bottom area, excluding exotic and invasive species, is less than 50 percent after 2 years.	Exotic/invasive species removed. Additional plantings may be required.
Wetland Cell	Wetland Vegetation	Decaying vegetation produces foul odors.	Decaying vegetation is removed, preferably in late summer.
Wetland Cell	Wetland Vegetation	Wetland vegetation is blocking flow paths causing flow back-up and flooding.	Areas of blocking vegetation are cut back sufficient to allow design flows and prevent flooding.
Wetland Cell	Wetland Vegetation	Water quality monitoring indicates that wetland vegetation is contributing phosphorus and metals to downstream waters rather than sequestering them.	Water quality monitoring indicates improved water quality. To maximize removal of wetland pollutants, wetland vegetation must be periodically harvested, particularly with respect to phosphorus and metals removal. Harvesting should occur by mid-summer before plants begin to transfer phosphorus from the aboveground foliage to subsurface roots, or begin to lose metals that desorb during plant die off. Every 3 to 5 years the entire plant mass including roots should be harvested because the below ground biomass constitutes a significant reservoir (as much as half) of the nutrients and metals that are removed from stormwater by plants.

#18 – Maintenance Checklist for Treatment Wetlands:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Wetland Cell	Sediment Accumulation	Sediment accumulation inhibits growth of wetland plants or reduces wetland volume (greater than 1 foot of sediment accumulation).	Wetland dredged to remove sediment accumulation.
Wetland Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works.	Dike restored to the design elevation. *A professional engineer should be consulted to determine the source of the settlement*.
Wetland Berms (Dikes)	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue.	Piping eliminated. Erosion potential eliminated. *(Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repairs.)*
Wetland Berms Over 4 ft in height (Dikes)	Tree Growth	Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees on berms removed. *If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A professional engineer should be consulted for proper berm/spillway restoration.*
Emergency Overflow/ Spillway	Obstruction	Tree growth or other blockage on emergency spillways may cause failure of the berm due to uncontrolled overtopping.	Obstruction on emergency spillway removed. *A professional engineer should be consulted for proper berm/spillway restoration.*
Emergency Overflow/ Spillway	Rock Missing	Only one layer of rock exists above native soil in an area five square feet or larger, or any exposure of native soil at the top of outflow path of spillway.	Rocks and pad depth are restored to design standards. (Riprap on inside slopes need not be replaced.)
Emergency Overflow/ Spillway	Erosion	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. *If erosion is occurring on compacted berms a professional engineer should be consulted to resolve source of erosion.*

If you are unsure whether a problem exists, contact a professional engineer.

#19 – Maintenance Checklist for Fencing/Shrubbery Screen/Other Landscaping:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
General	Missing or Broken Parts/Dead Shrubbery	Any defect in the fence or screen that permits easy entry to a facility.	Fence is mended or shrubs replaced to form a solid barrier to entry.
General	Erosion	Erosion has resulted in an opening under a fence that allows entry by people or pets.	Soil under fence replaced so that no opening exceeds 4 inches in height.
General	Unruly Vegetation	Shrubbery is growing out of control or is infested with weeds. Any evidence of noxious weeds as defined in the Pierce County Noxious Weeds List.	Shrubbery is trimmed and weeded to provide appealing aesthetics. Do not use chemicals to control weeds.
Fences	Damaged Parts	Posts out of plumb more than 6 inches.	Posts plumb to within 1.5 inches of plumb.
Fences	Damaged Parts	Top rails bent more than 6 inches.	Top rail free of bends greater than 1 inch.
Fences	Damaged Parts	Any part of fence (including posts, top rails, and fabric) more than 1 foot out of design alignment.	Fence is aligned and meets design standards.
Fences	Damaged Parts	Missing or loose tension wire.	Tension wire in place and holding fabric.
Fences	Damaged Parts	Missing or loose barbed wire that is sagging more than 2.5 inches between posts.	Barbed wire in place with less than 0.75 inch sag between posts.
Fences	Damaged Parts	Extension arm missing, broken, or bent out of shape more than 1.5 inches.	Extension arm in place with no bends larger than 0.75 inch.
Fences	Deteriorated Paint or Protective Coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.	Structurally adequate posts or parts with a uniform protective coating.
Fences	Openings in Fabric	Openings in fabric are such that an 8-inch diameter ball could fit through.	No openings in fabric.

#20 – Maintenance Checklist for Grounds (Landscaping):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
General	Weeds (nonpoisonous)	Weeds growing in more than 20 percent of the landscaped area (trees and shrubs only). Any evidence of noxious weeds as defined in the Pierce County Noxious Weeds List.	Weeds present in less than 5 percent of the landscaped area.

#20 – Maintenance Checklist for Grounds (Landscaping):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Insect Hazard	Any presence of poison ivy or other poisonous vegetation or insect nests.	No poisonous vegetation or insect nests present in landscaped area.
General	Trash or Litter	See Detention Ponds (Checklist #1).	See Detention Ponds (Checklist #1).
General	Erosion of Ground Surface	Noticeable rills are seen in landscaped areas.	Causes of erosion are identified and steps taken to slow down/ spread out the water. Eroded areas are filled, contoured, and seeded.
Trees and shrubs	Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25 percent of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
Trees and shrubs	Damage	Trees or shrubs that have been blown down or knocked over.	Tree replanted, inspected for injury to stem or roots. Replace if severely damaged.
Trees and shrubs	Damage	Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Stakes and rubber-coated ties placed around young trees/ shrubs for support.

#21 – Maintenance Checklist for Gates:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Damaged or Missing Components	Gate is broken, jammed, or missing.	Pond has a functioning gate to allow entry of people and maintenance equipment such as mowers and backhoe. If a lock is used, make sure the County field staff have a key.
General	Damaged or Missing Components	Broken or missing hinges such that gate cannot be easily opened and closed by one maintenance person.	Hinges intact and lubed. Gate is working freely.
General	Damaged or Missing Components	Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	Gate is aligned and vertical.
General	Damaged or Missing Components	Missing stretcher bands, and ties.	Stretcher bar, bands, and ties in place.

#22 – Maintenance Checklist for Conveyance Systems (Pipes and Ditches):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Pipes	Sediment & Debris	Accumulated sediment that exceeds 20 percent of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
Pipes	Vegetation	Vegetation that reduces free movement of water though pipes.	Vegetation does not impede free movement of water through pipes. *Prohibit use of sand and sealant application and protect from construction runoff.*
Pipes	Damaged (Rusted, Bent or Crushed)	Protective coating is damaged: rust is causing more than 50 percent deterioration to any part of pipe.	Pipe repaired or replaced.
Pipes	Damaged (Rusted, Bent or Crushed)	Any dent that significantly impedes flow (i.e. decreases the cross section area of pipe by more than 20 percent).	Pipe repaired or replaced.
Pipes	Damaged (Rusted, Bent or Crushed)	Pipe has major cracks or tears allowing groundwater leakage.	Pipe repaired or replaced.
Open Ditches	Trash & Debris	Dumping of yard wastes such as grass clippings and branches. Unsightly accumulation of non-degradable materials such as glass, plastic, metal, foam, and coated paper.	No trash or debris present. Trash and debris removed and disposed of as prescribed by the County.
Open Ditches	Sediment Buildup	Accumulated sediment that exceeds 20 percent of the design depth.	Ditch cleaned of all sediment and debris so that it matches design.
Open Ditches	Vegetation	Vegetation (e.g. weedy shrubs or saplings) that reduces free movements of water through ditches.	Water flows freely though ditches. Grassy vegetation should be left alone.
Open Ditches	Erosion Damage to Slopes	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	No erosion damage present. Slopes stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
Open Ditches	Erosion Damage to Slopes	Any erosion observed on a compacted berm embankment.	*If erosion is occurring on compacted berms a professional engineer should be consulted to resolve source of erosion.*
Open Ditches	Rock Lining Out of Place or Missing (If Applicable)	Native soil is exposed beneath the rock lining.	Rocks replaced to design standards.

If you are unsure whether a problem exists, contact a professional engineer.

#23 – Maintenance Checklist for Media Filter Drain.			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
No Vegetation Zone adjacent to pavement	Erosion, Scour, or Vehicular Damage	No vegetation zone uneven or clogged so that flows are not uniformly distributed.	Area leveled and cleaned so that flows are spread evenly.
No Vegetation Zone adjacent to pavement	Sediment Accumulation on Edge of Pavement	Flows no longer sheet flowing off of roadway. Sediment accumulation on pavement edge exceeds top of pavement elevation.	No sediment accumulation on pavement edge that impedes sheet flow. Sediment deposits removed such that flows can sheet flow off of roadway.
Vegetated Filter	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Sediment deposits removed, slope is re-leveled so that flows pass evenly through Ecology Embankment.
Vegetated Filter	Excessive Vegetation or Undesirable Species	When the grass becomes excessively tall; when nuisance weeds and other vegetation starts to take over or shades out desirable vegetation growth characteristics. Any evidence of noxious weeds as defined in the Pierce County Noxious Weeds List..	Grass mowed and nuisance vegetation controlled such that flow not impeded. *Grass should be mowed to a height that encourages dense even herbaceous growth.*
Vegetated Filter	Erosion, Scour, or Vehicular Damage	Eroded or scoured areas due to flow channelization, high flows or vehicular damage.	No eroded or scoured areas. *For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with suitable topsoil. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident.*
Media Bed	Erosion, Scour, or Vehicular Damage	Eroded or scoured areas due to flow channelization, high flows or vehicular damage.	No eroded or scoured areas. *For ruts or areas less than 12 inches wide, repair the damaged area by filling with suitable media. If bare areas are large, generally greater than 12 inches wide, the media bed should be re-graded.*
Media Bed	Sediment Accumulation on Media Bed	Sediment depth inhibits free infiltration of water.	Sediment accumulation does not impeded infiltration. Sediment deposits removed and slope is re-leveled so that flows pass freely through Media Bed.
Underdrains	Sediment	Depth of sediment within perforated pipe exceeds 0.5 inch.	Depth of sediment within perforated pipe does not exceed 0.5 inch. Flush underdrains through access ports and collect flushed sediment.

#23 – Maintenance Checklist for Media Filter Drain.			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
General	Trash and Debris Accumulation	Any trash and debris accumulations which exceed one cubic foot per 1,000 square feet. If there is less than the threshold, remove all trash and debris as part of the next scheduled maintenance.	No trash or debris present. Remove trash and debris from media filter.
General	Flows are Bypassing Ecology Embankment	Evidence of significant flows downslope (rills, sediment, vegetation damage, etc.) of media filter drain.	Facility functions as designed. Sediment deposits removed and slope is re-leveled so that flows pass evenly through media filter drain. If media filter drain is completely clogged, it may require a more extensive repair or replacement.
General	Media Filter Drain Mix Replacement	Water is seen on surface of the media filter drain mix from storms that are less than the 91st percentile 24-hour rain event (approx. 1.25" in 24 hours). Maintenance also needed on a 10-year cycle and during a preservation project.	No water ponded on surface after design storm. *Excavate and replace all of the media filter drain mix contained within the media filter drain.*

See also the latest version of the WSDOT Highway Runoff Manual for additional maintenance information.

If you are unsure whether a problem exists, contact a professional engineer.

#24 – Maintenance Checklist for Vortechs Stormwater Treatment System			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
General	Sediment Accumulation	Sediment depth is within 6 inches of dry weather water surface elevation.	Accumulated sediment should be removed.
General	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
General	Oil Accumulation	Oil accumulation that exceeds 1 inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
Structure	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
Structure	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.

Structure	Vault Structure Damage – Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/ inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
Structure	Vault Structure Damage – Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/outlet pipe.

Designers must also review the most current manufacturer guidelines for any updates or additions to the following O&M requirements.

If you are unsure whether a problem exists, contact a professional engineer.

A vault is a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#25 – Maintenance Checklist for Stormceptor System.			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Settling chamber	Excessive Sediment Accumulation	Capacities vary depending on model number[1].	Sediments removed.
Settling chamber	Trash and Floatable Debris Accumulation	Excessive trash and floatable debris accumulation.	Minimal trash or other floatable debris.
Settling chamber	Excessive Oil Accumulation	Oil exceeds 6 inches in depth or evidence of a spill.	Oil cleaned out.
Manhole Cover	Cover Damaged/ Not Working	One maintenance person cannot remove lid after applying 80 pounds of lift, corrosion of deformation of cover.	Cover repaired to proper working specifications or replaced.
Disk Insert	Disk Insert Inlet/ Outlet Obstructed	Inlet or outlet piping obstructed.	Disk insert inlet/outlet free from obstructions.
Structure	Structure has Cracks in wall, Bottom, and Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault repaired or replaced so that vaults meets design specifications and is structurally sound.
Structure	Structure has Cracks at the Joint of any Inlet/ Outlet Pipe	Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 0.25 inch at the joint of inlet/outlet pipe.

Designers must also review the most current manufacturer guidelines for any updates or additions to the following O&M requirements.

If you are unsure whether a problem exists, contact a professional engineer or the manufacturer's representative.

[1]model number and sediment depth capacities:

Sediment Depths Indicating Required Servicing

Model	Sediment Depth
STC 450i	8"
STC 900	8″
STC 1200	8″
STC 1800	8"
STC 2400	8″
STC 3600	8″
STC 4800	8″
STC 6000	8″
STC 7200	8″
STC 11000	8″
STC 13000	8″

Model	Sediment Depth
STC 16000	8″

#26 – Maintenance Checklist for Filterra.

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Inlet	Excessive Sediment or Trash Accumulation	Accumulated sediments or trash impair free flow of water into Filterra system.	Inlet free of obstructions and allows free distributed flow of water into Filterra system. Sediments and/or trash removed.
Mulch Cover	Trash and Floatable Debris Accumulation	Excessive trash and/or debris accumulation.	Minimal trash or other debris on mulch cover. Trash and debris removed and mulch cover raked level.
Mulch Cover	Ponding of Water on Mulch Cover	Ponding in unit could be indicative of clogging due to excessive fine sediment accumulation or spill of petroleum oils.	Stormwater drains freely and evenly through mulch cover. *Recommend contact manufacturer and replace mulch or soil if necessary.*
Vegetation	Plants not Growing or in Poor Condition	Soil/ mulch too wet, evidence of spill. Incorrect plant selection. Pest infestation. Vandalism to plants.	Plants healthy and pest free. *Contact manufacturer for advice.*
Vegetation	Excessive Plant Growth	Excessive plant growth inhibits facility function or becomes a hazard for pedestrian and vehicular circulation and safety.	Plants trimmed/pruned in accordance with manufacturer's recommendations to maintain appropriate plant density and aesthetics. Appropriate plants are present.
Structure	Structure has Cracks in Wall, Bottom, and Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the structure is not structurally sound.	Structure sealed and structurally sound.
Structure	Structure has Cracks at the Joint of any Inlet/ Outlet Pipe	Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Structure repaired so that no cracks exist wider than 0.25 inch at the joint of inlet/outlet pipe.

Designers must also review the most current manufacturer guidelines for any updates or additions to the following O&M requirements.

If you are unsure whether a problem exists, contact a professional engineer or the manufacturer's representative.

#27 – Maintenance Checklist for CDS Media Filtration System (MFS) ®.			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Media filter vault	Sediment Accumulation on Top of Filter Cartridges	Sediment accumulation exceeds 0.5 inch on top of cartridges.	Minimal sediment deposits on top of cartridges. Excess sediment on cartridges likely indicates that cartridges are plugged and require maintenance.
Media filter vault	Sediment Accumulation in Vault	Sediment accumulation in vault exceeds 6 inches.	Sediment in vault removed.
Media filter vault	Trash and Floatable Debris Accumulation	Excessive trash and floatable debris accumulation in vault.	Minimal trash or other floatable debris in filter vault.
Media filter cartridges	Filter Cartridges Full	Filter cartridge media appears dark. Check should be performed on a dry day. Requires entry to vault[1].	Filter media checked and replaced if needed. If cartridges are plugged with oil, additional treatment or source control BMP may be needed.
Media filter cartridges	Filter Cartridges Full	Area around cartridges has standing water and cartridges are submerged 24 hours after a storm.	Filter media checked and replaced if needed. If cartridges are plugged with oil, additional treatment or source control BMP may be needed.
Media filter cartridges	Filter Cartridges Full	Water flowing over the head control box during light storm events and more than 1 inch of floatables has accumulated in the cartridge vent pipe.	Filter media checked and replaced if needed. If cartridges are plugged with oil, additional treatment or source control BMP may be needed.
Access Cover	Access Cover Damaged/ Not Working	One maintenance person cannot remove lid after applying 80 pounds of lift, corrosion of deformation of cover.	Cover repaired to proper working specifications or replaced.
Collector manifold	Damaged Piping	Any part of the pipes are crushed or damaged due to corrosion and/or settlement.	Pipe repaired or replaced.
Vault	Vault Structure has Cracks in Wall, Bottom, and Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/ inspection personnel determine that the vault is not structurally sound.	Vault repaired or replaced so that vault meets design specifications and is structurally sound.
Vault	Structure has Cracks at the Joint of any Inlet/ Outlet Pipe	Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist at the joint of inlet/outlet pipe.
Baffles	Baffles	Baffles corroding, cracking, warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.

#27 – Maintenance Checklist for CDS Media Filtration System (MFS) ®.			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Access Ladder	Ladder Rungs Unsafe	Maintenance person judges that ladder is unsafe due to missing rungs, misalignment, rust, or cracks. Ladder must be fixed or secured immediately.	Ladder meets design standards and allows maintenance persons safe access.

Designers must also review the most current manufacturer guidelines for any updates or additions to the following O&M requirements.

If you are unsure whether a problem exists, contact a professional engineer.

[1]Comments:

1. CDS MFS system vault is a confined space. Visual inspections should be performed aboveground. If entry is required it should be performed by qualified personnel.
2. Default maintenance is annual.
3. Configuration options include precast or cast in place concrete vaults or precast manhole structures.

#28 – Maintenance Checklist for Aqua Shield Aqua-Swirl.			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Sediment Storage area	Excessive Sediment Accumulation	Sediment accumulation within 36 inches of water surface.	Sediment removed.
Aqua Swirl Chamber	Trash and Floatable Debris Accumulation	Excessive trash and floatable debris accumulation swirl chamber.	Minimal trash or other floatable debris.
Manhole Cover	Cover Damaged/ Not Working	One maintenance person cannot remove lid after applying 80 pounds of lift, corrosion of deformation of cover.	Cover repaired to proper working specifications or replaced.
Structure	Vault Structure has Cracks in Wall, Bottom, and Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault repaired or replaced so that vault meets design specifications and is structurally sound.
Structure	Vault Structure has Cracks at the Joint of any Inlet/ Outlet Pipe	Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 0.25 inch at the joint of inlet/outlet pipe.

#28 – Maintenance Checklist for Aqua Shield Aqua-Swirl.			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Baffles	Baffles	Baffles corroding, cracking, warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.

Designers must also review the most current manufacturer guidelines for any updates or additions to the following O&M requirements.

If you are unsure whether a problem exists, contact a professional engineer or the manufacturer's representative.

#29 – Maintenance Checklist for Bioretention (Cells, Swales, and Planter Boxes):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
General	Trash	Trash and debris present.	No trash and debris present.
Concrete Sidewalls	Cracks or Failure in Concrete Planter Reservoir	Cracks wider than 0.5 inch or maintenance/inspection personnel determine that the planter is not structurally sound.	Concrete repaired or replaced.
Rockery Sidewalls	Instable Rockery	Rock walls are insecure.	Rockery sidewalls are stable (may require consultation with professional engineer, particularly for walls 4 feet or greater in height).
Earthen Side Slopes and Berms	Failure in Earthen Reservoir (Embankments, Dikes, Berms, and Side Slopes)	Erosion (gullies/rills) greater than 2 inches around inlets, outlet, and along side slopes.	Source of erosion eliminated and damaged area stabilized (regrade, rock, vegetation, erosion control blanket). For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures are in place until permanent repairs can be made.
Earthen Side Slopes and Berms	Failure in Earthen Reservoir (Embankments, Dikes, Berms, and Side Slopes)	Erosion of sides causes slope to become a hazard.	The hazard is eliminated and slopes are stabilized.
Earthen Side Slopes and Berms	Failure in Earthen Reservoir Embankments, Dikes, Berms, and Side Slopes)	Settlement greater than 3 inches (relative to undisturbed sections of berm).	The design height is restored with additional mulch.

#29 – Maintenance Checklist for Bioretention (Cells, Swales, and Planter Boxes):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Earthen Side Slopes and Berms	Failure in Earthen Reservoir (Embankments, Dikes, Berms, and Side Slopes)	Downstream face of berm or embankment wet, seeps or leaks evident.	Holes are plugged and berm is compacted. May require consultation with professional engineer, particularly for larger berms.
Earthen Side Slopes and Berms	Failure in Earthen Reservoir (Embankments, Dikes, Berms, and Side Slopes)	Any evidence of rodent holes or water piping around holes if facility acts as dam or berm.	Rodents (see "Pests: Insects/ Rodents") removed or destroyed and berm repaired/ compacted.
Ponding Area	Sediment or Debris Accumulation	Accumulation of sediment or debris to extent that infiltration rate is reduced (see "Ponded water") or surface storage capacity significantly impacted.	Sediment cleaned out to restore facility shape and depth. Damaged vegetation is replaced and mulched. Source of sediment identified and controlled (if feasible).
Ponding Area	Leaf Accumulation	Accumulated leaves in facility.	No leaves clogging outlet structure or impeding water flow.
Ponding Area	Basin Inlet via Surface Flow	Soil is exposed or signs of erosion are visible.	Erosion sources repaired and controlled.
Curb Cut Inlet	Sediment or Debris Accumulation	Sediment, vegetation, or debris partially or fully blocking inlet structure.	Curb cut is clear of debris. Source of the blockage is identified and action is taken to prevent future blockages.
Splash Block Inlet	Water Not Properly Directed to Facility	Water is not being directed properly to the facility and away from the inlet structure.	Blocks are reconfigured to direct water to facility and away from structure.
Splash Block Inlet	Erosion	Water disrupts soil media.	Splash block is reconfigure/ repaired.
Inlet/outlet pipe	Damaged Pipe	Pipe is damaged.	Pipe is repaired/replaced. No cracks more than 0.25 inched wide at the joint of inlet/outlet pipes exist.
Inlet/outlet pipe	Clogged Pipe	Pipe is clogged.	Pipe is clear of roots or debris. Source of the blockage is identified and action is taken to prevent future blockages.
Inlets/outlet and access pathways	Blocked Access	Maintain access for inspections.	Vegetation is cleared within 1 foot of inlets and outlets. Access pathways are maintained.
Ponding Area	Erosion	Water disrupts soil media.	No eroded or scoured areas in bioretention area. Cause of erosion or scour addressed. A cover of rock or cobbles or other erosion protection measure maintained (e.g., matting) to protect the ground where concentrated water enters or exits the facility (e.g., a pipe, curb cut or swale).

#29 – Maintenance Checklist for Bioretention (Cells, Swales, and Planter Boxes):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Trash Rack	Trash or Debris Accumulation	Trash or debris present on trash rack.	No trash or debris on trash rack. Clean and dispose trash.
Trash Rack	Damaged Trash Rack	Bar screen damaged or missing.	Barrier repaired or replaced to design standards.
Check Dams and Weirs	Sediment or Debris Accumulation	Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, weir, or orifice.	Blockage is cleared. Identify the source of the blockage and take actions to prevent future blockages.
Check Dams and Weirs	Erosion	Erosion and/or undercutting is present.	No eroded or undercut areas in bioretention area. Cause of erosion or undercutting addressed. Check dam or weir is repaired.
Check Dams and Weirs	Unlevel Top of Weir	Grade board or top of weir damaged or not level.	Weir restored to level position.
Flow Spreader	Sediment Accumulation	Sediment blocks 35 percent or more of ports/notches or, sediment fills 35 percent or more of sediment trap.	Sediment removed and disposed of.
Flow Spreader	Damaged or Unlevel Grade Board/Baffle	Grade board/baffle damaged or not level.	Board/baffle removed and reinstalled to level position.
Overflow/ emergency spillway	Sediment or Debris Accumulation	Overflow spillway is partially or fully plugged with sediment or debris.	No sediment or debris in overflow.
Overflow/ emergency spillway	Erosion	Native soil is exposed or other signs of erosion damage are present.	Erosion repaired and surface of spillway stabilized.
Overflow/ emergency spillway	Missing Spillway Armament	Spillway armament is missing.	Armament replaced.
Underdrain	Blocked Underdrain	Plant roots, sediment or debris reducing capacity of underdrain. Prolonged surface ponding (see “Bioretention Soil”).	Underdrains and orifice are free of sediment and debris.
Bioretention soil	Ponded Water	Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	Cause of ponded water is identified and addressed: 1. Leaf or debris buildup is removed 2. Underdrain is clear 3. Other water inputs (e.g., groundwater, illicit connections) investigated 4. Contributing area verified If steps #1–4 do not solve the problem, imported bioretention soil is replaced and replanted.

#29 – Maintenance Checklist for Bioretention (Cells, Swales, and Planter Boxes):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Bioretention soil	Protection of Soil	Maintenance requiring entrance into the facility footprint.	Maintenance is performed without compacting bioretention soil media.
Vegetation	Bottom Swale and Upland Slope Vegetation	Less than 75 percent of swale bottom is covered with healthy/ surviving vegetation.	Plants are healthy and pest free. Cause of poor vegetation growth addressed. Bioretention area is replanted as necessary to obtain 75 percent survival rate or greater. Plant selection is appropriate for site growing conditions.
Trees and shrubs	Causing Problems for Operation of Facility	Large trees and shrubs interfere with operation of the basin or access for maintenance.	Trees and shrubs do not hinder facility performance or maintenance activities. Prune or remove large trees and shrubs.
Trees and shrubs	Dead Trees and Shrubs	Standing dead vegetation is present.	Trees and shrubs do not hinder facility performance or maintenance activities. Dead vegetation is removed and cause of dead vegetation is addressed. Specific plants with high mortality rate are replaced with more appropriate species.
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)	Safety Issues	Vegetation causes some visibility (line of sight) or driver safety issues.	Appropriate height for sight clearance is maintained. Regular pruning maintains visual sight lines for safety or clearance along a walk or drive. Tree or shrub is removed or transplanted if presenting a continual safety hazard.
Emergent Vegetation	Conveyance Blocked	Vegetation compromises conveyance.	Sedges and rushes are clear of dead foliage.
Mulch	Lack of Mulch	Bare spots (without much cover) are present or mulch covers less than 2 inches.	Facility has a maximum 3-inch layer of an appropriate type of mulch and mulch is kept away from woody stems.
Vegetation	Accumulation of Clippings	Grass or other vegetation clippings accumulate to 2 inches or greater in depth.	Clippings removed.
Noxious Weeds	Presence of Noxious Weeds	Listed noxious vegetation is present. See Pierce County Noxious Weeds List.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality.

#29 – Maintenance Checklist for Bioretention (Cells, Swales, and Planter Boxes):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Vegetation	Weeds	Weeds are present (unless on edge and providing erosion control).	Weed material removed and disposed of. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality.
Excessive Vegetation	Adjacent Facilities Compromised	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil.	Vegetation does not impede function of adjacent facilities or pose as safety hazard. Groundcovers and shrubs trimmed at facility edge. Excessive leaf litter is removed.
Excessive Vegetation	Causes Facility to Not Function Properly	Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety.	Pruning and/or thinning vegetation maintains proper plant density and aesthetics. Plants that are weak, broken, or not true to form are removed or replaced in-kind. Appropriate plants are present.
Irrigation (if any)	NA	Irrigation system present.	Manufacturer's instructions for O&M are met.
Plant watering	Plant Establishment	Plant establishment period (1-3 years).	Plants are watered as necessary during periods of no rain to ensure plant establishment.
Summer Watering (after establishment)	Drought Period	Longer term period (3+ years).	Plants are watered as necessary during drought conditions and trees are watered up to five years after planting.
Spill Prevention and Response	Spill Prevention	Storage or use of potential contaminants in the vicinity of facility.	Spill prevention measures are implemented whenever handling or storing potential contaminants.
Spill Prevention and Response	Spill Response	Any evidence of contaminants such as oil, gasoline, concrete slurries, paint, etc.	Spills are cleaned up as soon as possible to prevent contamination of stormwater. No contaminants or pollutants present. (Coordinate source control, removal, and/or cleanup with Pierce County Surface Water Management 253-798-2725 and/or Dept. of Ecology Spill Response 800-424-8802.)
Safety	Safety (Slopes)	Erosion of sides causes slope to exceed 1:3 or otherwise becomes a hazard.	Actions taken to eliminate the hazard.
Safety	Safety (Hydraulic Structures)	Hydraulic structures (pipes, culverts, vaults, etc.) become a hazard to children playing in and around the facility.	Actions taken to eliminate the hazard (such as covering and securing any openings).

#29 – Maintenance Checklist for Bioretention (Cells, Swales, and Planter Boxes):			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Aesthetics	Aesthetics	Damage/vandalism/debris accumulation.	Facility restored to original aesthetic conditions.
Aesthetics	Edging	Grass is starting to encroach on swale.	Edging repaired.
Pest Control	Pests: Insects/ Rodents	Pest of concern is present and impacting facility function.	Pests removed or destroyed and facility returned to original functionality. Do not use pesticides or *Bacillus thuringiensis israelensis (Bti)*.
Pest Control	Mosquitoes	Standing water remains in the basin for more than three days following storms.	All inlets, overflows and other openings are protected with mosquito screens. No mosquito infestation present.

If you are unsure whether a problem exists, contact a professional engineer.

#30 – Maintenance Checklist for Cisterns:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Roof	Debris Accumulation in Cistern	Debris has accumulated.	No debris in cistern.
Gutter	Debris Accumulation in Gutter	Debris has accumulated.	No debris in cistern or gutters.
Screens at the top of downspout and cistern inlet	Debris Accumulation in Cistern	Screen has deteriorated.	Screen is in place and functions as designed.
Screens at the top of downspout and cistern inlet	Debris Accumulation in Cistern	None. Preventative maintenance.	No debris in cistern or accumulated on screen.
Low flow orifice	Cistern Overflows Are Too Frequent	Debris or other obstruction of orifice.	Low flow orifice is clean.
Overflow pipe	Overflow Pipe	Pipe is damaged.	Overflow pipe is watertight and does not leak. Repair/replace.
Overflow pipe	Overflow Pipe	Pipe is clogged.	Debris removed. Overflow pipe can convey overflow to point of discharge.
Cistern	Accumulated Debris And/or Sediment	More than 6 inches of accumulation in bottom of cistern.	Accumulated debris and/or sediment removed.

#30 – Maintenance Checklist for Cisterns:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Training and Documentation	NA	Training / written guidance is required for proper O&M.	Property owners and tenants are provided with proper training and a copy of the Maintenance and Source Control Manual.
Access and Safety	NA	Access to cistern required for maintenance or cleaning.	Any opening that could allow the entry of people is marked: "DANGER—CONFINED SPACE".
Pest Control	Mosquito Infestation	Standing water remains for more than three days following storms.	All inlets, overflows, and other openings are protected with mosquito screens. No mosquito infestation present.

If you are unsure whether a problem exists, contact a professional engineer.

#31 – Maintenance Checklist for Vegetated Roof:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Soil / Growth Medium	Water is Not Infiltrating Properly	Water does not permeate growth media (runs off soil surface).	Facility infiltrates as designed. Aerate or replace media until stormwater infiltrates freely through growth media.
Soil / Growth Medium	Water is Not Infiltrating Properly	Growth medium thickness is less than design thickness (due to erosion and plant uptake).	Facility infiltrates as designed. Supplement growth medium to design thickness.
Soil / Growth Medium	Water is Not Infiltrating Properly	Fallen leaves or debris are present.	No leaves or debris present.
Soil / Growth Medium	Erosion/Scouring	Areas of potential erosion are visible.	Steps taken to repair or prevent erosion. Fill, hand tamp, or lightly compact, and stabilize with additional soil substrate/growth medium and additional plants.
Erosion Control Measures	Erosion/Scouring	Mat or other erosion control is damaged or depleted during plant establishment period.	Erosion control measures repaired/replaced until 90 percent vegetation coverage attained. Avoid application of mulch on extensive vegetated roofs.
System Structural Components	Deteriorating Flashing, Gravel Stops, Utilities, or Other Structures on Roof	Flashing, utilities or other structures on roof are deteriorating (can serve as source of metal pollution in vegetated roof runoff).	Structural components inspected for deterioration or failure. Repair/replace as necessary.

#31 – Maintenance Checklist for Vegetated Roof:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Roof Drain	Sediment, Vegetation, or Debris Accumulation	Sediment, vegetation, or debris blocks 20 percent or more of inlet structure.	Blockages cleared. Problems that led to blockage identified and corrected.
Roof Drain	Damaged Inlet Pipe	Inlet pipe is in poor condition.	Repaired/replaced.
Roof Drain	Clogged Inlet Pipe	Pipe is clogged.	Roots or debris removed.
Vegetation	Plant Coverage	Healthy vegetative coverage falls below 90 percent (unless design specifications stipulate less than 90 percent coverage).	Bare areas planted with vegetation If necessary, install erosion control measures until percent coverage goal is attained.
Vegetation (sedums)	NA	Extensive roof with low density sedum population.	Sedums are mulch mowed, creating cuttings from existing plants to encourage colonization.
Vegetation	Presence of Noxious Weeds	Listed noxious vegetation is present. See Pierce County Noxious Weeds List..	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Noxious and nuisance vegetation removed according to applicable regulations. By law, class A & B noxious weeds must be removed, bagged, and disposed as garbage immediately. Reasonable attempts must be made to remove and dispose of class C noxious weeds. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality. *(Coordinate with Tacoma-Pierce County Health Department.) Complete eradication of noxious weeds may not be possible. Compliance with state or local eradication policies required.*
Vegetation	Presence of Weeds	Weeds are present.	Weed material removed and disposed of, with roots manually removed with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality.

#31 – Maintenance Checklist for Vegetated Roof:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Vegetation (extensive vegetated roof)	Under Fertilization	Poor plant establishment and possible nutrient deficiency in growth medium.	Organic debris allowed to replenish and maintain long-term nutrient balance and growth medium structure. Conduct annual soil test 2-3 weeks prior to the spring growth flush to assess need for fertilizer. Utilize test results to adjust fertilizer type and quantity appropriately. Minimum amount slow-release fertilizer necessary to achieve successful plant establishment is applied. Apply fertilizer only after acquiring required approval from facility owner and operator. Note that extensive vegetated roofs are designed to require zero to minimal fertilization after establishment (excess fertilization can contribute to nutrient export).
Vegetation (intensive vegetated roof)	Under Fertilization	Fertilization may be necessary during establishment period or for plant health and survivability after establishment.	Annual soil test conducted 2-3 weeks prior to the spring growth flush to assess need for fertilizer. Utilize test results to adjust fertilizer type and quantity appropriately. Apply minimum amount slow-release fertilizer necessary to achieve successful plant establishment. Apply fertilizer only after acquiring required approval from facility owner and operator. Intensive vegetated roofs may require more fertilization than extensive vegetated roofs.
Vegetation (trees and shrubs on an intensive vegetated roof)	NA	Pruning as needed.	All pruning of mature trees performed by or under the direct guidance of an ISA certified arborist.
Irrigation system (if any)	NA	Irrigation system is not working or routine maintenance is needed.	Manufacturer's instructions for O&M have been followed.
Vegetation (extensive vegetated roof)	NA	Summer watering – Plant establishment period (1-2 years).	Watered weekly during periods of no rain to ensure plant establishment (30 to 50 gallons per 100 square feet).

#31 – Maintenance Checklist for Vegetated Roof:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Vegetation (extensive vegetated roof)	NA	Summer watering – Longer term period (2+ years).	Watered during drought conditions or more often if necessary to maintain plant cover (30 to 50 gallons per 100 square feet).
Vegetation (intensive vegetated roof)	NA	Plant establishment period (1-2 years).	Watered deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist. Use soaker hoses or spot water with a shower type wand when irrigation system not present.
Vegetation (intensive vegetated roof)	NA	Longer term period (2+ years).	Watered during drought conditions or more often if necessary to maintain plant cover.
Spill Prevention and Response	NA	Storage or use of potential contaminants in the vicinity of facility.	Spill prevention measures exercised whenever handling or storing potential contaminants.
Spill Prevention and Response	Release of Pollutants.	Any evidence of contaminants such as oil, gasoline, concrete slurries, paint, etc.	Spills are cleaned up as soon as possible to prevent contamination of stormwater. No contaminants or pollutants present. *(Coordinate source control, removal, and/or cleanup with Pierce County Surface Water Management 253-798-2725 and/or Dept. of Ecology Spill Response 800-424-8802.)*
Training and Documentation	NA	Training / written guidance is required for proper O&M.	Property owners and tenants provided with proper training and a copy of the Maintenance and Source Control Manual.
Safety	NA	Insufficient egress / ingress routes and fall protection.	Egress and ingress routes maintained to design standards and fire codes. Ensure appropriate fall protection.
Aesthetics	Poor Aesthetics	Damage/vandalism/ debris accumulation.	Facility restored to original aesthetic conditions.
Pest Control	Mosquitoes	Standing water remains for more than three days following storms.	Standing water removed. Cause of the standing water identified, and appropriate actions taken to address the problem (e.g., aerate or replace medium, unplug drainage).

If you are unsure whether a problem exists, contact a professional engineer.

#32 – Maintenance Checklist for Permeable Pavement:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Facility – General Requirements	Unstable Adjacent Area	Runoff from adjacent pervious areas deposits soil, mulch, or sediment on pavement.	No deposited soil or other materials on permeable pavement or other adjacent surfacing. All exposed soils that may erode to pavement surface mulched and/or planted.
Facility – General Requirements	Wearing Course Covered by Adjacent Vegetation	Vegetation growing beyond facility edge onto sidewalks, paths, and street edge.	Vegetation does not impede function of adjacent facilities or pose as safety hazard. Groundcovers and shrubs trimmed to avoid overreaching the sidewalks, paths and street edge.
Porous asphalt or pervious cement concrete	NA	None. Maintenance to prevent clogging with fine sediment.	Conventional street sweepers equipped with vacuums, water, and brushes or pressure washer used to restore permeability. Vacuum or pressure wash the pavement two to three times annually.
Porous asphalt or pervious cement concrete	NA	None. Maintenance to prevent clogging with fine sediment.	Use of sand and sealant application prohibited. Protect from construction runoff.
Porous asphalt or pervious cement concrete	Cracks	Major cracks or trip hazards.	Potholes or small cracks filled with patching mixes. Large cracks and settlement addressed by cutting and replacing the pavement section.
Porous asphalt or pervious cement concrete	NA	Utility cuts.	Any damage or change due to utility cuts replaced in kind.
All Pavement Types	Leaf and Debris Accumulation	Fallen leaves or debris.	Removed/disposed.
Interlocking concrete paver blocks	Missing or Damaged Paver Block	Interlocking paver block missing or damaged.	Individual damaged paver blocks removed and replaced or repaired per manufacturer's recommendations.
Interlocking concrete paver blocks	Settlement	Settlement of surface. When deviation from original grade impedes function.	Original grade re-established. May require resetting.
All pavement types	All Pavement Types	Sediment or debris accumulation between paver blocks, on surface of pavement, or in grid voids.	Sediment at surface does not inhibit infiltration. Remove/ dispose of sediment.
Interlocking concrete paver blocks	Void material is missing or low	Loss of aggregate material between paver blocks.	Refill per manufacturer's recommendations.

#32 – Maintenance Checklist for Permeable Pavement:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Open-celled paving grid with gravel	Loss of Aggregate Material in Paving Grid	Loss of aggregate material in grid.	Aggregate gravel level maintained at the same level as the plastic rings or no more than 0.25 inch above the top of rings. Refill per manufacturer's recommendations.
Open-celled paving grid with grass	Lack of Grass Coverage	Loss of soil and/or grass material in grid.	Refill and/or replant per manufacturer's recommendations. Growing medium restored, facility aerated and reseeded or planted, and vegetated area amended as needed.
Inlet/outlet pipe	Pipe is Damaged	Pipe is damaged.	Pipe is repaired/replaced.
Inlet/outlet pipe	Pipe is Clogged	Pipe is clogged.	Roots or debris is removed.
Inlet/outlet pipe	Erosion	Native soil exposed or other signs of erosion damage present.	No eroded or scoured areas Cause of erosion or scour is addressed.
Underdrain pipe	Blocked Underdrain	Plant roots, sediment or debris reducing capacity of underdrain (may cause prolonged drawdown period).	Underdrains and orifice free of sediment and debris. Jet clean or rotary cut debris/roots from underdrain(s). If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Spill Prevention and Response	NA	Storage or use of potential contaminants in the vicinity of facility.	Spill prevention measures exercised whenever handling or storing potential contaminants.
Spill Prevention and Response	Release of Pollutants	Any evidence of contaminants such as oil, gasoline, concrete slurries, paint, etc.	Spills are cleaned up as soon as possible to prevent contamination of stormwater. No contaminants or pollutants present. (Coordinate source control, removal, and/or cleanup with Pierce County Surface Water Management 253-798-2725 and/or Dept. of Ecology Spill Response 800-424-8802.)

If you are unsure whether a problem exists, contact a professional engineer.

#33 – Maintenance Checklist for Downspout, Sheet Flow, and Concentrated Dispersion Systems:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Splash block	Water Directed Toward Building	Water is being directed towards building structure.	Water directed away from building structure.
Splash block	Water Causing Erosion	Water disrupts soil media.	Blocks are reconfigured/ repaired and media is restored.
Transition zone	Erosion	Adjacent soil erosion; uneven surface creating concentrated flow discharge; or less than 2 foot of width.	No eroded or scoured areas. Cause of erosion or scour is addressed.
Dispersion trench	Concentrated Flow	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" from edge of trench; intent is to prevent erosion damage).	No debris on trench surface. Notched grade board or other distributor type is aligned to prevent erosion. Trench is rebuilt to standards, if necessary.
Surface of trench	Accumulated Debris	Accumulated trash, debris, or sediment on drain rock surface impedes sheet flow from facility.	Trash or debris is removed/disposed in accordance with local solid waste requirements.
Surface of trench	Vegetation Impeding Flow	Vegetation/moss present on drain rock surface impedes sheet flow from facility.	Freely draining drain rock surface.
Pipe(s) to trench	Accumulated Debris in Drains	Accumulation of trash, debris, or sediment in roof drains, gutters, driveway drains, area drains, etc.	No trash or debris in roof drains, gutters, driveway drains, or area drains.
Pipe(s) to trench	Accumulated Debris in Inlet Pipe	Pipe from sump to trench or drywell has accumulated sediment or is plugged.	No sediment or debris in inlet/outlet pipe screen or inlet/outlet pipe.
Pipe(s) to trench	Damaged Pipes	Cracked, collapsed, broken, or misaligned drain pipes.	No cracks more than 0.25-inch wide at the joint of the inlet/outlet pipe.
Sump	Accumulated Sediment	Sediment in the sump.	Sump contains no sediment.
Access lid	Hard to Open	Cannot be easily opened.	Access lid is repaired or replaced.
Access lid	Buried	Buried.	Access lid functions as designed (refer to record drawings for design intent).
Access lid	Missing Cover	Cover missing.	Cover is replaced.
Rock pad	Inadequate Rock Cover	Only one layer of rock exists above native soil in area 6 square feet or larger, or any exposure of native soil.	Rock pad is repaired/replaced to meet design standards.
Rock pad	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad is repaired/replaced to meet design standards.
Dispersal Area	Erosion	Erosion (gullies/ rills) greater than 2 inches deep in dispersal area.	No eroded or scoured areas. Cause of erosion or scour is addressed.

#33 – Maintenance Checklist for Downspout, Sheet Flow, and Concentrated Dispersion Systems:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Dispersal Area	Accumulated Sediment	Accumulated sediment or debris to extent that blocks or channelizes flow path.	No excess sediment or debris in dispersal area. Sediment source is addressed (if feasible).
Ponded water	Ponded Water	Standing surface water in dispersion area remains for more than 3 days after the end of a storm event.	System freely drains and there is no standing water in dispersion area between storms. The cause of the standing water (e.g., grade depressions, compacted soil) is addressed.
Vegetation	Plant Survival	Dispersal area vegetation in establishment period (1-2 years, or additional 3rd year) during extreme dry weather).	Vegetation is healthy and watered weekly during periods of no rain to ensure plant establishment.
Vegetation	Lack of Vegetation Allowing Erosion	Poor vegetation cover such that erosion is occurring.	Vegetation is healthy and watered. No eroded or scoured areas are present. Cause of erosion or scour is addressed. Plant species are appropriate for the soil and moisture conditions.
Vegetation	Vegetation Blocking Flow	Vegetation inhibits dispersed flow along flow path.	Vegetation is trimmed, weeded, or replanted to restore dispersed flow path.
Vegetation	Presence of Noxious Weeds	Any noxious or nuisance vegetation which may constitute a hazard to county personnel or the public. See Pierce County Noxious Weeds List.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where county personnel or the public might normally be.
Pest Control	Mosquito Infestation	Standing water remains for more than three days following storms.	All inlets, overflows and other openings are protected with mosquito screens. No mosquito infestation present.
Rodents	Presence of Rodents	Rodent holes or mounds disturb dispersion flow paths.	Rodents removed or destroyed, holes are filled, and flow path is revegetated.

If you are unsure whether a problem exists, contact a professional engineer.

#34 – Maintenance Checklist for Rain Gardens:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Facility – General Requirements	Mosquitoes	Standing water remains for more than three days following storms.	All inlets, overflows and other openings are protected with mosquito screens. No mosquito infestation present. Rain garden drains freely and there is no standing water between storms. Cause of the standing water is addressed (see "Ponded water").
Footprint area	Trash	Trash and debris present.	No trash or debris present.
Footprint area	Debris Accumulation	Accumulated leaves in facility.	No leaves clogging outlet structure or impeding water flow.
Earthen side slopes and berms	Erosion	Persistent soil erosion on slopes.	No eroded or scoured areas. Cause of erosion or scour is addressed.
Rockery sidewalls	Unstable Rockery	Rockery side walls are insecure.	Rockery sidewalls are stable (may require consultation with engineer, particularly for walls 4 feet or greater in height).
Rain garden bottom area	Sediment Accumulation	Visible sediment deposition in the rain garden that reduces drawdown time of water in the rain garden.	No sediment accumulation in rain garden, Source of sediment addressed.
Mulch	Lack of Mulch	Bare spots (without mulch cover) are present or mulch depth less than 2 inches.	Facility has a minimum 2- to 3-inch layer of an appropriate type of mulch and is kept away from woody stems.
Splash block inlet	Water Not Properly Directed to Rain Garden	Water is not being directed properly to the rain garden and away from the inlet structure. Water splashes adjacent buildings.	Blocks are reconfigured to direct water to rain garden and away from structure.
Pipe inlet/outlet	Erosion	Rock or cobble is removed or missing and concentrated flows are contacting soil.	No eroded or scoured areas. Cause of erosion or scour is addressed. Cover of rock or cobbles protects the ground where concentrated water flows into the rain garden from a pipe or swale.
Pipe inlet/outlet	Accumulated Debris	Accumulated leaves, sediment, debris or vegetation at curb cuts, inlet or outlet pipe.	Blockage is cleared.
Pipe inlet/outlet	Damaged Pipe	Pipe is damaged	Pipe is repaired/replaced.
Pipe inlet/outlet	Clogged Pipe	Pipe is clogged.	Pipe is clear of roots and debris.
Access	Blocked Access	Maintain access for inspections.	Vegetation is cleared or transplanted within 1 foot of inlets and outlets.
Ponded water	Ponded Water	Excessive ponding water: Ponded water remains in the rain garden more than 48 hours after the end of a storm.	Rain garden drains freely and there is no standing water in the rain garden between storms. Leaf litter/ debris/sediment is removed.

#34 – Maintenance Checklist for Rain Gardens:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Overflow	Blocked Overflow	Capacity reduced by sediment or debris.	No sediment or debris in overflow.
Vegetation	Blocking Site Distances and Sidewalks	Vegetation inhibits sight distances and sidewalks.	Sidewalks and sight distances along roadways and sidewalks are kept clear.
Vegetation	Vegetation Blocking Pipes	Vegetation is crowding inlets and outlets.	Inlets and outlets in the rain garden are clear of vegetation.
Vegetation	Unhealthy Vegetation	Yellowing: possible Nitrogen (N) deficiency Poor growth: possible Phosphorous (P) deficiency. Poor flowering, spotting or curled leaves, or weak roots or stems: possible Potassium (K) deficiency.	Plants are healthy and appropriate for site conditions.
Vegetation	Weeds	Presence of weeds.	Weeds are removed (manual methods preferred) and mulch is applied.
Summer watering (years 1-3)	Plant Establishment	Tree, shrubs and groundcovers in first three years of establishment period.	Plants are watered during plant establishment period (years 1-3).
Summer watering (after establishment)	Drought Conditions	Vegetation requires supplemental water.	Plants are watered during drought conditions or more often if necessary during post-establishment period (after 3 years).

If you are unsure whether a problem exists, contact a professional engineer.

#35 – Maintenance Checklist for Trees:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance Is Performed**
Tree	Excess or unhealthy growth	Health of tree at risk, or tree in conflict with other infrastructure.	Tree pruned according to industry standards to promote tree health and longevity.
Tree	NA	Young tree (i.e., within first three years).	Tree provided with supplemental irrigation and fertilization (as needed) during first three growing seasons.
Tree	NA	Evidence of pest activity affecting tree health.	Pest management activities implemented to reduce or eliminate pest activity, and to restore tree health.
Tree	Dead or Declining	Dead, damaged or declining.	Tree is replaced per planting plan or acceptable substitute.
Tree	Dead or Declining	Dead, damaged or declining.	Tree is replaced per planting plan or acceptable substitute.

#36 – Maintenance Checklist for Downspout Full Infiltration Systems:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Rock trench/ well	Inflow disruption	Accumulated trash, debris, or sediment on drain rock surface impeding sheet flow into facility.	Sheet flow re-established. Material removed and disposed of in accordance with applicable solid waste requirements.
Rock trench/ well	Inflow disruption	Vegetation/moss present on drain rock surface impeding sheet flow into facility.	Material removed and sheet flow re-established.
Rock trench/ well	Inflow disruption	Water ponding at surface, or standing water in subgrade observation port.	Inflow to facility is consistent and no ponding is observed. Inlet piping is clear and/or rock or sand reservoirs have been replaced.
Inlet/ outlet pipe conveyance	Conveyance blockage	Accumulation of trash, debris, or sediment in roof drains, gutters, driveways drains, area drains, etc.	Conveyance systems are clear of debris and free-flowing.
Inlet/ outlet pipe conveyance	Conveyance blockage	Pipes to or from sump, trench, or drywell have accumulated sediment or is plugged.	Pipe systems are clear of debris and free-flowing.
Inlet/ outlet pipe conveyance	Conveyance damage	Pipes to or from sump, trench, or drywell is cracked, broken, or misaligned.	Pipe systems are undamaged and free-flowing.
Roof downspout	Splash pad malfunction	Splash pad missing or damaged.	Splash pad installed and functioning correctly
Storage sump	Sediment in sump	Excess sediment accumulate in sump.	Material removed and disposed of in accordance with applicable solid waste requirements.
Storage sump	Access lid problems	Access lid cannot be opened or is missing.	Access lid is functioning as designed. Refer to record drawings to confirm type, function, and required components.

#37 – Maintenance Checklist for Dead-End Sump Vaults:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet (includes floatables and non-floatables).	No trash or debris present. Any trash and debris removed from dead-end sump vault.
General	Sediment/ Liquid Accumulation in Vault	Sediment/liquid accumulation in vault exceeds the half the depth of the vault.	No sediment/liquid in dead-end sump vault. (If sediment contamination is a potential problem, sediment should be tested regularly to determine leaching potential prior to disposal.)
General	Damaged Pipe	Inlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.

#37 – Maintenance Checklist for Dead-End Sump Vaults:			
Drainage System Feature	**Defect or Problem**	**Condition When Maintenance Is Needed**	**Results Expected When Maintenance is Performed**
General	Access Cover Damaged/Not Working	Cover cannot be opened or removed, by one person. Corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
Vault Structure	Damage – Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
Vault Structure	Damage – Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/outlet pipe.

If you are unsure whether a problem exists, contact a professional engineer.

A vault is a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

Appendix I-B – Wetland Protection Guidelines

B.1 Scope and Principles for Wetland Protection

B.1.1 Purpose

This appendix provides guidelines intended to prevent diminishment of the function and values of wetlands by avoiding alterations to the structural, hydrologic, and water quality characteristics of existing wetlands to the extent feasible during new development, redevelopment, and stormwater management projects.

New development, redevelopment, and stormwater management projects may decrease the functions and values of wetlands by:

- Increasing the amount of water flow discharged to a wetland
- Decreasing the amount of water flow discharged to a wetland
- Increasing the amount of pollutants discharged to a wetland.

This can happen even if the wetland is not physically altered for development or stormwater management purposes.

B.1.2 Wetland Rating System

A wetland identified as a receiving water of a project needs to be rated using the Washington State Wetland Rating System for Western Washington: 2014 Update (Hruby, 2014) to determine its category and habitat score.

Wetlands in Washington State differ widely in their functions and values. The Washington State Wetland Rating System categorizes wetlands into four categories (I, II, III and IV) based on their sensitivity to disturbance, their rarity, our ability to replace them, and the functions they provide. Category I is the highest rated wetland and the most sensitive to disturbance and Category IV wetlands are the lowest rated, based on relatively low functions and values.

This Appendix uses categories and habitat scores for wetlands to determine the level of protection necessary to reduce the risk of loss of wetland functions and values.

The rating system does not replace a full assessment of wetland functions that may be necessary if wetlands are impacted and mitigation permits are required.

For more information on the wetlands rating system, go to the Washington State Department of Ecology wetland rating systems webpage.

B.1.3 Regulatory Authority

Wetlands are Waters of the State as defined under Chapter 90.48 RCW, Surface Waters of the State under Chapter 173-201A WAC, and may be Waters of the U.S. according to the 2015 Clean Water Rule and regulated under the Clean Water Act. This Appendix does not include guidance for wetland delineation, assessment, permitting, or restoration.

Every development project should follow the requirements of the State Environmental Policy Act. Proponents should contact Pierce County Planning and Public Works and any other agency that deals with wetland protection. Other state and federal agencies may also have jurisdiction over projects affecting wetlands such as the Washington State Departments of Ecology, Natural

Resources, and Fish & Wildlife; the U.S. Environmental Protection Agency; and the U.S. Army Corps of Engineers.

B.1.4 Wetland Protection Levels

The level of protection required for existing wetlands is based on the wetland category, habitat score, and the wetland characteristics.

The levels of wetland protection outlined in this Appendix include:

- I-B.2 General Protection
- I-B.3 Protection from Pollutants
- I-B.4 Wetland Hydroperiod Protection

B.1.5 Informational Needs

The following information is needed to assess the impacts and risks to wetlands and to determine the necessary protection level.

1. Size, boundary, and characteristics of the proposed project site, wetland contributing drainage area, and the wetland and its buffer.
2. Following Ecology's *Wetland Rating System for Western Washington: 2014 Update* (Hruby, 2014) determine:
    a. Wetland type.
    b. Wetland category.
    c. Wetland habitat score.
3. Presence of rare, endangered, threatened, or sensitive species.
4. Presence of breeding populations of native amphibian species.
5. Use of an Ecology approved continuous simulation model.
6. If the TDA Thresholds for Minimum Requirement #7: Flow Control are triggered, the project proponent may also need:
    a. Legal Access to wetland,
    b. Wetland field monitoring data (See I-B.5 Wetland Hydroperiod Data Collection and Evaluation Procedures).

B.2 General Protection

All wetlands (Categories I, II, III, and IV) must receive the following general protection:

1. Consult regulations issued under federal and state laws that regulate the discharge of pollutants to surface waters, including the Construction Stormwater General NPDES Permit.
2. Maintain the wetland buffer required by local and/or state regulations.
3. Retain areas of native vegetation connecting the wetland and its buffer with nearby wetlands and other contiguous areas of native vegetation.
4. Avoid compaction of soil and introduction of invasive plant or animal species in the wetland and its buffer.

5. Take measures to avoid general physical impacts (e.g., littering and vegetation destruction). Examples are protecting existing buffer zones; discouraging access, especially by vehicles, by planting outside the wetland and encouragement of stewardship and signage by landowners.
6. Any stormwater management practices, such as Runoff Treatment or Flow Control BMP implementation, must be done outside of the wetland buffer boundary, except limited circumstances where the wetland and/or buffer may be used for additional Runoff Treatment and/or Flow Control of stormwater (See I-B.6 Compensatory Mitigation of Wetlands).
7. Discharge from a BMP or project site should be dispersed using a method to diffuse the flow before entering the wetland buffer.
8. Consider fences to restrict human access, but make sure it doesn't interfere with wildlife movement. They should be used when wildlife passage is not a major issue and the potential for intrusive impacts is high. When wildlife movement and intrusion are both issues, the circumstances will have to be weighed to decide about fencing. Check with Pierce County Planning and Public Works and/or state agencies to determine if fencing would be allowed.

B.3 Protection from Pollutants

All wetlands (Categories I, II, III and IV) must receive the following protection from pollutants:

1. Provide Construction Stormwater BMPs as directed in Minimum Requirement #2: Construction Stormwater Pollution Prevention Plan (SWPPP) to prevent sediment and other pollutants from entering the wetland.
2. Provide Source Control BMPs as directed in Minimum Requirement #3: Source Control of Pollution. Refer to Volume IV for requirements.
3. Provide Onsite Stormwater Management and use LID principles as much as practicable for the site, as directed in Minimum Requirement #5: Onsite Stormwater Management. LID principles and practices will help meet other wetland hydroperiod protection criteria and provide additional habitat.
4. Provide Runoff Treatment BMPs as directed in Minimum Requirement #6: Runoff Treatment to treat runoff prior to entering the wetland and its buffer.

   Note: If the thresholds for Minimum Requirement #6: Runoff Treatment are not met for a TDA, then it is not required to provide Runoff Treatment BMPs for that TDA to comply with Minimum Requirement #8: Wetlands Protection.

If the wetland is a special characteristic wetland (such as mature or old growth forest wetlands, bogs, estuarine wetlands, wetlands of high conservation value, coastal lagoons, and interdunal wetlands), implement Runoff Treatment BMPs with the most advanced ability to control nutrient loads. Consider using Runoff Treatment BMPs with infiltration and active biological filtration.

B.4 Wetland Hydroperiod Protection

Protection of many wetland functions and values depends on maintaining the existing wetland's hydroperiod. This means maintaining the annual fluctuations in water depth and its timing as closely as possible. If a project triggers the requirements for Flow Control BMPs per the TDA

Thresholds in Minimum Requirement #7: Flow Control, the project must apply the following Wetland Hydroperiod Protection.

The Wetland Hydroperiod Protection is separated into two methods, Methods 1 and 2, that are dependent on the wetland category and whether the project proponent has legal access to the wetland.

The first method prefers a minimum one year of monitoring followed by continuous simulation modeling of the wetland stage (called Method 1). Method 1 shall be applied to the wetlands listed below:

- Category I or II depressional or riverine impounding (including special characteristics Category I or II) wetlands that the project proponent owns, or the project proponent has legal access to – for purposes of conducting monitoring in the wetland.

Method 1 considers wetland specific information and field data; therefore, it allows more detailed evaluation of effects of stormwater on wetland functions. In cases where the project proponent neither owns nor has legal access to the Category I or II wetlands receiving stormwater from a proposed project, Method 2 shall be used.

Method 2 uses a site discharge volume model to evaluate hydrologic changes in a wetland with no additional wetland monitoring requirement. Method 2 shall be applied to the wetlands listed below:

- Category I or II wetlands that are offsite or the project proponent doesn't have legal access to conduct monitoring in the wetland.
- Category I or II riverine, slope or lake-fringe wetlands.
- Category III and IV wetlands with a habitat score greater than 5.
- Category III and IV interdunal special characteristic wetlands.
- Category III and IV wetlands that provide habitat for rare, threatened, endangered or sensitive species.
- Category III and IV wetlands that contain a breeding population of any native amphibian species.
    - If the wetland has permanent or seasonal ponding or inundation, assume it has a breeding population of native amphibians.
    - For seasonal ponding, if the wetland has surface ponding after May 1 of a normal water year or drier, assume it has a breeding population of native amphibians.
    - See the Wetland Rating System for guidance on identifying field indicators.
    - Recent aerial images of surface water in the wetland during normal water year or drier year can also indicate presence of permanent or seasonal ponding.

B.4.1 Method 1: 1-yr Wetland Monitoring and Wetland Stage Modeling

Method 1 criteria and analysis is based on the presumption that a wetland has limited Water Level Fluctuation (WLF) and water holding capacity. The risk to the wetland will be minimal if the frequency and duration of WLF in the wetland and the WLF timing post-project remain as similar to pre-project levels as possible. Therefore, the criteria sets limits on the frequency and duration of stage excursions (greater WLF than the pre-project level), as well as on overall WLF

after development. The criteria were developed based on studies in *Wetlands and Urbanization, Implications for the Future* (Azous and Horner, 1997).

One water year of field monitoring will characterize the existing WLF and water holding capacity of the wetland, and it will be used to calculate the allowable WLF by the proposed development.

A hydrologic assessment to measure or estimate elements of the hydroperiod under pre-project and post-project conditions should be performed with the aid of a qualified scientist or wetland specialist.

Criteria for Method 1: The project proponent must meet the following six Method 1 criteria in order to comply with the Wetland Hydroperiod Protection Requirements.

Criteria 1. Mean Monthly WLF Limit:

1. If the pre-project (monitored) mean monthly WLF for a given calendar month is < 15cm (0.49 ft, 5.91 inches), the post-project mean WLF of the wetland for that calendar month may increase to no more than 20 cm (0.66 ft, 7.87 inches).
2. If the pre-project (monitored) mean monthly WLF for a given calendar month is ≥ 15 cm (0.49 ft, 5.91 inches), the post-project mean monthly WLF of the wetland for that calendar month may increase by up to, but no more than, 5 cm (0.16 ft, 1.97 inches).
3. Without one year of monitoring data, assume the pre-project mean monthly WLF for any month is ≥ 15 cm (0.49 ft, 5.91 inches), and the post-project mean monthly WLF of the wetland for that calendar month may increase by up to, but no more than, 5 cm (0.16 ft, 1.97 inches).

Criteria 2. Mean Annual WLF Limit:

1. If the pre-project (monitored) mean annual WLF is < 15cm (0.49 ft), the post-project mean annual WLF of the wetland may increase to no more than 20 cm (0.66 ft, 7.87 inches).
2. If the pre-project (monitored) mean annual WLF is ≥ 15 cm (0.49 ft, 5.91 inches), the post-project mean annual WLF of the wetland may increase by up to, but no more than, 5 cm (0.16 ft, 1.97 inches).
3. Without one year of monitoring data, assume the pre-project mean annual WLF is ≥ 15 cm (0.49 ft, 5.91 inches), and the post-project mean annual WLF of the wetland may increase by up to, but no more than, 5 cm (0.16 ft, 1.97 inches).

Criteria 3. Frequency of Stage Excursions

1. The frequency of stage excursions of 15 cm (0.49 ft, 5.91 inches) above or below the pre-project stage must not exceed an annual average of six.

Criteria 4. Durations of Stage Excursions

1. The duration of stage excursions of 15 cm (0.49 ft, 5.91 inches) above or below the pre-project stage must not exceed three days per excursion.
   AND
   For a Wetland that Provides Habitat for Native Amphibians: The stage excursions above or below the pre-project stage must not exceed 8 cm (0.26 ft, 3.15 inches) for more than one day in any 30-day period between January 1 and May 31. The hydroperiod limits characterize wetlands inhabited by breeding native amphibians and apply to breeding zones during the period of January 1 through May 31. If these limits are exceeded, amphibian breeding success is likely to decline.

OR
For a Peat Wetland: The duration of stage excursions in the post-project scenario cannot be above the pre-project stage for more than one day in any year and applies to all zones over the entire year. If this limit is exceeded, characteristic bog or fen wetland vegetation is likely to decline.

Criteria 5. Total Dry Period Change

1. The total dry period (when pools dry down to the soil surface everywhere in the wetland) must not increase or decrease by more than two weeks in any year between the pre- and post-project scenarios.

Criteria 6. Perennial to Ephemeral or Seasonal Avoidance

1. Alterations to watershed and wetland hydrology that may cause perennial wetlands to become ephemeral or seasonal post-project must be avoided.
2. If modeled wetland stage indicates the wetland is perennial, the dry period at the post-project scenario should not exceed one day in any year.

Additional guidance, as well as an excel template to assist with the calculations to verify compliance with Method 1 is provided in I-B.5 Wetland Hydroperiod Data Collection and Evaluation Procedures.

B.4.2 Method 2: Site Discharging Modeling

An alternative way to predict the risk to the wetland hydroperiod from stormwater discharges is to assess the changes in total volume of flows into a wetland that result from the development project. The size of the wetland and its capacity are not known or needed to utilize Method 2. The risk to wetland functions will be assumed to increase as the total discharge volumes from the site into the wetland diverge from the preproject conditions. The risk will be decreased if the divergence is smaller.

As stormwater generated at the project site passes through the wetland buffer, total discharge volumes from the site to the wetland are to be calculated at the outflow of the wetland buffer. The existing or required length and area of wetland buffer per local and/or state regulations around the wetland should be included as an element in the model under both pre-project (existing) and post-project scenarios.

Criteria for Method 2: The project proponent must ensure they are meeting both of the following Method 2 criteria in order to comply with Wetland Hydroperiod Protection.

Criteria 1. Mean Daily Total Discharge Volumes from the Site

Total volume of water into a wetland on daily basis should not be more than 20 percent higher or lower than the pre-project volumes.

- Calculate the average of the total discharge volumes from the site for each day over the period of precipitation record in the approved model for pre- and post-project scenarios. There will be 365 (366 for a leap year) average daily values for the pre-project scenario and 365 (366 for a leap year) for the post-project. No day can exceed 20 percent change in volume.

Criteria 2. Mean Monthly Total Discharge Volumes from the Site

Total volume of water into a wetland on a monthly basis should not be more than 15 percent

higher or lower than the pre-project volumes.

- Calculate the average of the monthly total discharge volumes from the site for each calendar month over the period of precipitation record in the approved model for pre- and post-project scenarios. No month can exceed 15 percent change in volume.

The guidance for implementing Method 2 and assessing the criteria above in the respective model is provided in section I-B.5 Wetland Hydroperiod Data Collection and Evaluation Procedures.

Limitations

Method 2 may not result in complete protection of wetland functions and values as these criteria are based on risk to the resource rather than an actual understanding of the impacts. When applicable, Ecology recommends application of the Wetland Hydroperiod Protection with wetland-specific monitoring as described in Method 1.

B.5 Wetland Hydroperiod Data Collection and Evaluation Procedures

Consider the following strategies to minimize impacts on the wetland hydroperiod and to meet the criteria. The list is in order of preference:

- Increasing the retention of natural pervious cover.
- Reducing the level of development.
- Reducing the total amount of impervious surfaces.
- Increasing infiltration using onsite LID techniques.
- Increasing or maintaining larger wetland buffer zones.
- Increasing infiltration and/or storage capacity of Flow Control BMPs.

B.5.1 Method 1

Field Monitoring and Data Collection

Field monitoring data of the wetland must be collected to determine the existing pre-project hydroperiod, which will then be compared to model outputs to verify compliance with the Hydroperiod Protection Criteria. Without one year of hydroperiod monitoring, the minimum allowable WLF change can be used (see Criteria for Method 1 in I-B.4 Wetland Hydroperiod Protection and Steps to Verify Compliance with the Method 1 Hydroperiod Protection Criteria below).

An Ecology-approved, continuous simulation model will be needed for data analysis. Relevant historic monitoring information can also inform the pre-project condition of the wetland. The following lists describe the minimum required wetland specific information in order to implement the Method 1 Wetland Hydroperiod Protection guidance:

1. Contour Data or Water Storage Capacity:

   Bathymetry, or wetland contours, is indicative of the water storage capacity of the wetland that will be used in the model simulation.

   If possible, the bathymetry of the wetland should be surveyed. LIDAR data or GIS analysis may also be used to provide approximate wetland contours.

   In the absence of bathymetry data, approximate the bathymetry using the permanent

ponding area and assume the storage will occur on top of that area. This resulting storage area will be lower than the actual area, providing a more protective model.

2. Hydroperiod Monitoring:

   Collect at least one year (if applicable) of water levels (instantaneous water stage and crest stage) using a crest stage gage or continuous water level loggers in the wetland. Water levels should be collected at least monthly over a year.

   Average base stage = (Instantaneous stage at the beginning of interval + Instantaneous stage at the end of interval)/2.

3. Flow Monitoring:

   The goal of this monitoring is to construct a relationship in the model to simulate how flows will be released from the wetland for each given stage. A simplified monitoring approach may be appropriate for a simple wetland flow regime. For instance, where a well-defined outlet controls the outflows from a wetland, instantaneous monitoring of the outflow for the typical range of flows may be sufficient. In this simple case, a velocity and cross-section and stage monitoring at the outlet can be sufficient to create the relationship for the model. These measurements may be performed in conjunction with the hydroperiod monitoring described above. Additional field visits timed with precipitation and or dry periods may be necessary to ensure the outflow relationship covers the range of modeled flows.

   Ecology acknowledges it can be challenging to determine the location(s) of flows to and from wetlands. In some cases, there will be a clear channel that is the source of the inflows and outflows, while in others the water may disperse over a wide area. An alternative would be to gather nearly continuous (every 15 minute) rainfall data along with wetland stage data (hydroperiod monitoring) and adjust the storage and discharge rate within the model using these data. If the flow data or estimation in the model are not available, assume there is no surface outflow for the wetland (closed depression).

   Chapter 8 of Wetlands and Urbanization, Implications for the Future (Azous and Horner, 1997) indicates a complete wetland water balance includes precipitation, evapotranspiration, surface inflow, surface outflow, groundwater exchange, and change in wetland storage using a tipping-bucket gage and continuous flow measurements. The wetland assessment as part of this Method 1 needs to consider the more protective approach to develop that relationship. A scientist (e.g., wetland scientist or hydrologist) may determine the groundwater flow is a significant characteristic of the outflow of the system. In this case, the project proponent may need to determine the groundwater regime of the system.

Model Construction and Simulation

The project proponent should develop a Stage-Storage Discharge (SSD) table that represents the volume of water that ponds in the wetland and the flow rate of water that discharges from the wetland at a given stage.

Having a reliable SSD table that represents the wetland is essential to evaluate the effects of development in the model. Wetland bathymetry and contour data by field measurement or using equations to represent the volume-area-depth relations of wetlands and wetland flow monitoring data are critical to develop the SSD table for the wetland.

In the absence of actual wetland flow monitoring data, it may be possible to develop the SSD

table for the wetland by combining the model simulated flows with the field data obtained on the wetland WLF (hydroperiod monitoring) data. This would require an iterative modeling process. The modeling iterations would involve manually changing the discharge rates in the SSD table until the resulting simulated WLF approach WLF from the field monitoring data. The project proponent or modeler shall provide the details of how this estimated in its hydrologic assessment report so that it can be reviewed by the County.

With an SSD table, the following are necessary for the model simulation to evaluate the discharge of development in the model and determine compliance with the Method 1 Wetland Hydroperiod Protection criteria:

- Pre-project condition land uses and associated acreage for the entire contributing area that drains to the wetland.
- Post-project condition land uses and associated acreage for the entire contributing area that drains to the wetland.
- Percentage of developing project area compared to total acreage of contributing area that drains to the wetland.

Pre-Project Simulation

1. Identify existing impervious and pervious surfaces that discharge to the wetland and use the model elements to represent the land use and associated acreage for all hydrologically contributing areas to the wetland.
2. Add the wetland buffer using the lateral flow soil basin or include it as part of the contributing area land use.
3. Connect the runoff from the contributing basin(s) including interflow and groundwater to the SSD table that represents the wetland.
4. Set the outflow of the wetland as the Point of Compliance (POC).

Post-Project Simulation

1. Identify anticipated impervious and pervious surfaces that discharge to the wetland and use the model elements to represent the land use and associated acreage for all hydrologically contributing areas to the wetland.
2. Identify any Flow Control BMPs and use the appropriate model elements to represent these facilities.
3. Add the wetland buffer using the lateral flow soil basin or include it as part of the contributing area land use.
4. Connect the runoff from the contributing basin(s) (including the buffer) including interflow and groundwater to the same SSD table used in the pre-project scenario.
5. Connect flows from any Flow Control BMP elements through the downstream element(s) to SSD table that represents the wetland.
6. Connect any infiltration from Flow Control BMP elements to groundwater of SSD table (if applicable).
7. Set the outflow of the wetland as the POC.

The order of the steps above depends on the type of elements and their intended function and

could change to be more representative of the contributing flow pathways to the wetland.

Once the model simulations are done for post- and pre-project scenarios, export the SSD table stage data for the full period of record: daily, monthly, and yearly average, and Max and Min stage.

These model outputs, together with monitored WLF, are to be used to verify compliance with the Method 1 Hydroperiod Protection Criteria in I-B.4 Wetland Hydroperiod Protection.

Steps to Verify Compliance with the Method 1 Hydroperiod Protection Criteria

Ecology has provided an excel template to assist with the calculations in the steps below. The excel template may be downloaded from the interactive online version of the manual.

1) Calculate the Existing WLF of Wetland using Monitored Water Levels

Using the measurements of crest and instantaneous stage during a series of time intervals over a year, calculate WLF between measurements.

Calculate mean annual and mean monthly WLF as the arithmetic averages of a year and each month for which data are available.

Water level fluctuation (WLF) = Crest stage - Average base stage

2) Estimate the WLF by Continuous Simulation of Stages in the Model

Using modeled daily, monthly, and yearly stages (average, max and min) for the full period of record, calculate daily, monthly or annual WLF as follows:

WLF = Max stage - average stage

Calculate Allowable WLF change

Allowable WLF change by the proposed project is determined by two factors: Monitored WLF of the wetland, and the size of the proposed project relative to the wetland's contributing basin area.

Allowable WLF change for the proposed project is calculated as follows:

- If monitored WLF is < 15 cm (0.49 ft, 5.91 inches),
  - Allowable WLF change for the wetland (A) = 20 cm (0.66 ft, 7.87 inches) – monitored WLF
  - **Allowable WLF change for the proposed project** = A / percentage of development by proposed project in the contributing basin area.
- If monitored WLF for a given calendar month is ≥ 15 cm (0.49 ft, 5.91 inches),
  - Allowable WLF of the wetland (A) for that calendar month may increase by up to, but no more than, 5 cm (0.16 ft, 1.97 inches).
  - **Allowable WLF change for the proposed project** = 5 cm / percentage of development by proposed project in the contributing basin area.

For example, if the project develops 10 acres of a 100-acre basin (10 percent), the project can cause no more than 10 percent of total allowable WLF change in the wetland. If the total allowable WLF change for the wetland is 10 cm (0.32 ft, 3.94 inches), the allowable WLF change for the proposed site is 1.0 cm (0.032 ft, 0.394 inches).

4) Verify Compliance with the Criteria

Compare each modeled daily, monthly, or annual WLF with the calculated allowable WLF (factored

by percentage of development by proposed project in the contributing basin area). If any of the modeled WLF difference between pre-project and post-project scenarios exceeds the calculated allowable WLF change for the proposed project, it means the proposed project does not comply with Method 1 Wetland Hydroperiod Protection.

For criteria about durations and frequencies, assess individual modeled stage outputs to verify compliance.

B.5.2 Method 2

Model Construction and Simulation

When modeling, include the wetland buffer as the final element in both pre- and post-project scenarios, downstream of the project area including any Flow Control BMPs. The point of compliance (POC) should be assigned to capture the total (surface, interflow, and groundwater) volume leaving the wetland buffer for both the pre-project and post-project scenarios.

Pre-project simulation

1. Identify existing impervious and pervious surfaces that discharge to the wetland and use the model elements to represent these land areas.
2. Identify the wetland buffer area and use the lateral flow soil basin to represent the wetland buffer.
3. Connect the model elements to the wetland buffer ensuring impervious land areas are connected to surface flows and that for any other model elements all flows (surface, interflow, and groundwater) are connected.
4. Set the wetland buffer element as the most downstream element.
5. Set the POC at the outflow of the wetland buffer element including surface runoff, interflow, and groundwater.

Post-project simulation

1. Identify anticipated post-project impervious and pervious surfaces that discharge to the wetland and use the model elements to represent these land areas.
2. Identify any Flow Control BMPs and use the appropriate model elements to represent these facilities.
3. Identify the wetland buffer area and use the lateral flow soil basin to represent the wetland buffer.
4. Connect the model elements to the wetland buffer ensuring that impervious land areas are connected to surface flows and that for any other model elements all flows (surface, interflow, and groundwater) are connected.
5. Connect any Flow Control BMP elements to the wetland buffer ensuring surface flows are connected to surface water and any infiltration is connected to groundwater.
6. Set the wetland buffer element as the most downstream element.
7. Set the POC at the outflow of the wetland buffer element including surface runoff, interflow, and groundwater.

Once the model simulations are done for post and pre-project scenarios, verify compliance with

the Method 2 Hydroperiod Protection Criteria.

B.6 Compensatory Mitigation of Wetlands

It is always necessary to treat stormwater prior to discharge to a wetland and its buffer. Any required Runoff Treatment BMPs including the outlet structure must be provided outside of the wetland and its buffer boundaries. If outflow from a BMP or project site is concentrated, flow should be diffused prior to discharge into the buffer.

Compensatory Mitigation Required

When project proponents alter a wetland(s) as part of a Runoff Treatment and/or Flow Control BMP system, they must demonstrate they have done everything possible to avoid and minimize impacts. Remaining impacts to wetland area and/or functions must be compensated according to local, state, and federal regulations and guidelines. Check with the agencies responsible for issuing permits.

Compensatory Mitigation Not Required

Treated stormwater may be beneficial to wetlands that have been heavily disturbed by human activities and can improve wetland hydrologic functions. In these limited cases when all of the solid bullets below are met, hydrologic alteration of the wetland to meet the requirements of a Flow Control BMP/facility is allowed without compensatory mitigation. This alteration will be considered a hydrologic functional restoration activity.

- The wetland is rated Category III or IV.
- The wetland has a habitat score of 5 or less.
- The wetland does not provide habitat for rare, threatened, or endangered species.
- The wetland does not contain a breeding population of any native amphibians.
- The hydrologic functions of the wetland can be improved by modification. Generally, this means constraints exist within the wetland (or surrounding area) that have altered natural hydrologic processes. The constraints are described in Charts 4 & 5 in *Selecting Wetland Mitigation Sites Using a Watershed Approach* (Hruby et al., 2009).

  Proponents must identify and address at least one of the following common constraints to document improvement of hydrologic functions:

  - Surface water flows have been diverted away from the wetland by prior development. Surface/subsurface water flows could be directed to the site to augment hydrologic inputs.
  - Ditches that artificially drain water from the wetland could be filled or plugged to retain water.
  - Drain tiles that artificially drain water from the wetland could be broken or removed to retain water.
  - Artificially placed fill that decreases surface water storage capacity could be removed to increase surface water storage capacity.
  - Dikes or berms that prevent overbank flooding could be breached or removed.
  - Outlet culvert that is lower than the surrounding topographic depression could have its

invert elevation raised to increase surface water storage.

OR

- The wetland part of a priority restoration plan that achieves restoration goals identified in a Shoreline Master Program or other local or regional watershed plan.

- The wetland lies in the natural route of water and the discharge follows the natural routing.
- Successful demonstration that no net loss of wetland function and value occurs as a result of the structural or hydrologic modifications.
  - This includes the impacts from the machinery used for the construction. Heavy equipment can damage the soil structure of a wetland.
  - When the functions and values of a degraded wetland are improved by project alterations, the project proponent must specify which project activities would thus be self-mitigating.
  - Check with the agency(ies) issuing the permits for the modification(s) to determine which method(s) and/or analyses to use to determine no net loss of wetland functions and values.
  - Functions and values that are not replaced on site will have to be compensated for elsewhere.

B.7 Jurisdictional Planning for Wetland Protection from Stormwater

Ecology recommends that local jurisdictions plan and manage their resources to protect overall wetland functions and values, including their role in stormwater management.

Wetlands protection planning can help local jurisdictions to take advantage of the most options for managing stormwater from development projects. Policies for the protection of wetlands should aim to prevent or minimize impacts at their point of origin and be self-perpetuating, that is they do not require periodic infusions of capital or labor.

The Department of Ecology, Puget Sound Partnership, and other agencies are actively developing new tools for watershed planning that will address many of the steps outlined below. We suggest you review information that has already been developed for your region or jurisdiction. This may significantly reduce your efforts. A good place to start is the Washington Department of Ecology's Watershed Characterization Project website.

Information for Wetlands Protection Planning

1. A map of the contributing watershed to the wetlands, or other appropriate landscape unit (see I-B.8 Wetland Protection Definitions), and an estimate of its area.
2. Approximate precise wetland boundaries. Wetland boundaries may have been previously delineated by the jurisdiction or by a project proponents working in the vicinity. Boundaries should be delineated using the latest approved Federal Manuals. Refer to https://ecology.wa.gov/Water-Shorelines/Wetlands/Tools-resources/Delineation-resources for details. Use the best information available.
3. A definition of environmental and development goals for the landscape unit subject to planning and management.
4. Existing management and monitoring plans.

5. Existing and projected land uses in the landscape unit in the following categories, expressed as percentages of the total watershed area:
    - Commercial,
    - Industrial,
    - Multi-family residential,
    - Single-family residential,
    - Agricultural,
    - Various categories of undeveloped, and
    - Areas subject to active logging or construction.
6. Hydrologic network throughout the landscape unit.
7. Soil conditions, including soil types, infiltration rates, and elevation of water table as it changes seasonally, and the presence of any restrictive layers.
8. Groundwater recharge and discharge points.

Typical Steps in Wetlands Protection Planning

1. Define the landscape unit you will be using for your planning effort. See the definition of landscape unit in I-B.8 Wetland Protection Definitions.
2. Begin the plan for the landscape unit with attention to the following general principles:
    a. Formulate the plan based on clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
    b. Map and assess the suitability of different areas for urban uses.

       There are several tools available for identifying such areas. For more information visit the Washington Department of Ecology's website. When appropriate, the assessment can also highlight outstanding local or regional resources that the community determines should be protected. Examples include a fish spawning and rearing, scenic areas, recreational areas, threatened or endangered species habitat, and farmland.
3. Maximize natural water storage and infiltration opportunities within the landscape unit and outside of existing wetlands, especially:
    a. Promote the conservation of forest cover. Develop on deforested land. This affects the water flows in a basin less than building on land that requires removing forest cover. Loss of forest cover increases peak runoff requiring expensive structural solutions.
    b. Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Implement policies and regulations to discourage the clearing, filling, and channelization of these features. Use existing drainage networks in preference to pipes, culverts, and engineered ditches as long as the flows and volumes of water in them are not increased.
4. Establish and maintain buffers surrounding wetlands and in riparian zones as required by the Critical Area Ordinance (Title 18E) for the local jurisdiction. Also, maintain interconnections among wetlands and other natural habitats to allow for wildlife

movements (see Update on Wetland Buffers: The State of the Science, (Ecology 2013)).

5. Implement measures to avoid general impacts on wetlands and other water bodies (e.g., littering, vegetation destruction, and human and pet intrusion harmful to wildlife).
6. In wetlands that are relatively unaffected by human activities, plan so the quantity of stormwater flows match the pre-project hydroperiod and hydrodynamics. In wetlands where water flows have been disturbed, consider ways of reducing the existing changes to flows. This involves not only management of high volumes and rates of flow during the wet season, but also preventing water supply depletion during the dry season. The latter may require augmenting flows if urbanization reduces existing surface or ground water inflows. Refer to I-B.5 Wetland Hydroperiod Data Collection and Evaluation Procedures for details on implementing these guidelines.
7. Assess alternatives for controlling the quantities of runoff as follows:
    a. Analyze proposed development actions in terms of changes to quantity of runoff.
    b. For existing development or redevelopment, assess possible alternative solutions to adding flow controls by:
        - Protecting health, safety, and property from flooding by removing buildings from floodplains.
        - Preventing stream channel erosion by stabilizing the eroding bed and/or bank area with bioengineering techniques, preferably, by using structural reinforcements that are consistent with the protection of aquatic habitats and beneficial uses of the stream (refer to Chapter 173-201A WAC for the definition of beneficial uses).
    c. For new development or redevelopment, assess different regulatory alternatives or incentives for changing common practices in land use including: density controls, clearing limits, impervious surface limits, transfer of development rights, purchase of conservation areas, etc.
    d. If the alternatives considered in Steps (a-c) above cannot solve an existing or potential problem, perform an analysis of the contributing drainage catchment to assess possible alternative solutions that can be applied onsite or on a regional scale. The most appropriate solution or combination of alternatives should be selected with regard to the specific opportunities and constraints existing in the drainage catchment.

        For new development or redevelopment, onsite scale solutions that should be assessed include, in approximate order of preference:
        LID BMPs and LID principals.
        - Infiltration basins or trenches.
        - Detention ponds
        - Below-ground vault or tank storage.
        - Parking lot detention.

        Regional scale solutions that should be assessed for solving problems associated with new development, redevelopment or existing development include:
        - LID BMPs and LID principals.

- Infiltration basins or trenches.
- Detention ponds.
- Constructed wetlands.

e. Consider altering an existing wetland for controlling water quantities only if upland alternatives are inadequate to solve the existing or potential problem. Refer to the criteria in B.6 Compensatory Mitigation of Wetlands to evaluate if wetlands can be altered.

8. Place strong emphasis on water resource protection during construction of new development. Establish effective erosion control programs to reduce the sediment loading to receiving waters. No existing wetland or other water body should ever be used for the sedimentation of solids in construction-phase runoff.
9. Stimulate public awareness of and interest in wetlands and other water resources in order to encourage protective attitudes in the community. This program should include:
   a. Education regarding the use of fertilizers and pesticides, automobile maintenance, the care of animals and the importance of retaining buffers to prevent water pollution. Refer to Homeowners' Guide to Wetlands and Buffers (Ecology, 2014).
   b. Descriptive signboards adjacent to wetlands informing residents of the wetland type, its functions, the protective measures taken, etc.
   c. If beavers are present in a wetland, educate residents about their ecological role and value and take steps to avoid human interference with beavers.
10. Stimulate public awareness of and interest in wetlands and other water resources in order to encourage protective attitudes in the community. This program should include:
    a. Perform pre-project baseline sampling by collecting water quality grab samples in an open water pool of the wetland for at least one year, allocated through the year as follows:
       - November 1 – March 31: 4 samples
       - April 1 – May 31: 1 sample
       - June 1 – August 31: 2 samples
       - September 1 – October 31: 1 sample

       If the wetland is dry during any period, reallocate the sample(s) scheduled then to another time when the wetland is no longer dry.
    b. The monitoring program should use the analytical methods approved by the U.S. Environmental Protection Agency and listed at 40 CFR part 136 or approved by Department of Ecology with similar reporting limits.Considering the baseline results, set water quality goals to be maintained in the post-project period. Example goals are:
       - No increase in violations of the Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC). Repeat the sampling on the same schedule for at least once year after all development is complete. Compare the results to the set goals.

B.8 Wetland Protection Definitions

The following terms are applicable only to this Appendix.

Buffer

The area (either upland, open water, or another wetland) that surrounds a wetland or water-course and that reduces adverse impacts to the ecosystem functions and values from adjacent development.

Compensatory mitigation

The stage of the mitigation sequence where impacts to wetland functions are offset (i.e., compensated for) through creation (establishment), restoration (re-establishment, rehabilitation), or enhancement of other wetlands. Because regulatory requirements and policies tend to focus on compensatory mitigation, the term "mitigation" is often used to refer to compensation, which is just one part of the overall mitigation sequence.

Constructed wetland

A wetland intentionally created from a non-wetland site for the purpose of water treatment.

Degraded wetland

A wetland (community) whose functions and values have been reduced as a result of human activities. For example, a wetland in which the vegetation, soils, and/or hydrology have been adversely altered, resulting in lost or reduced functions and values; generally, implies topographic isolation; hydrologic alterations such as hydroperiod alteration (increased or decreased quantity of water), diking, channelization, and/or outlet modification; soils alterations such as presence of fill, soil removal, and/or compaction; accumulation of toxicants in the biotic or abiotic components of the wetland; and/or low plant species richness with dominance by invasive weedy species.

Depressional wetland

Depressional wetlands occur in topographic depressions where the elevation of the surface within the wetland is lower than in the surrounding landscape. These wetlands often pond water at the surface but they can also be saturated without surface ponding.

Ephemeral wetland

Wetlands that temporarily hold water in the spring and early summer or after heavy rains. Periodically, these wetlands dry up, often in mid to late summer.

Estuarine wetland

Wetlands where salt tolerant plant species are dominant and the water regime is influenced by tidal action. The wetlands are usually partially enclosed by land with open, or partially obstructed access to open saline water. Salinity is greater than 0.5 ppt.

Hydrodynamics

The science involving the energy and forces acting on water or other liquids and the resulting impact on the motion of the liquid.

Hydroperiod

The seasonal occurrence of flooding and/or soil saturation; it encompasses the depth, frequency, duration, and seasonal pattern of inundation.

Invasive species

Nonnative organisms whose introduction causes or is likely to cause economic or environmental harm or harm to humans, animal or plant health.

Landscape unit

An area of land that has a specified boundary used for planning purposes that defines an area of interrelated physical, chemical, and biological processes. A watershed or drainage basin is a common type of landscape unit. A groundwater aquifer is another type of landscape unit.

Lake Fringe Wetlands

Lake Fringe wetlands are on the water side of the Ordinary High Water Mark (OHWM) of lakes where the area of open water next to a vegetated wetland is larger than 20 ac (8 ha), and more than 6.6 ft deep (2 m) over 30 percent of the open water areas.

Modification, Modified (wetland)

A wetland whose physical, hydrological, or water quality characteristics have been purposefully altered for a management purpose, such as by dredging, filling, forebay construction, and inlet or outlet control.

Peat Wetland

Unique, irreplaceable bogs and fens that can exhibit water pH in a wide range from highly acidic to alkaline, including fens typified by Sphagnum species, Rhododendron groenlandicum (Labrador tea), Drosera rotundifolia (sundew), and Vaccinium oxycoccos (bog cranberry); marl fens; estuarine peat deposits; and other moss peat systems with relatively diverse, undisturbed flora and fauna. Bog is the common name for peat systems having the Sphagnum association described, but this term applies strictly only to systems that receive water income from precipitation exclusively.

Perennial Wetland

Wetlands where at least a portion of their area has permanent surface water (i.e., flooded or inundated throughout the year), in a normal water year or wetter.

Polishing

Additional treatment of a waste stream that has already received one or more stages of treatment by other means.

Rare, threatened, endangered, or sensitive species

Plant or animal species that are relatively uncommon regionally, are nearing endangered status, or whose existence is in jeopardy and is usually restricted to highly specific habitats. Threatened, endangered or sensitive species are listed by federal or state authorities, whereas rare species are unofficial species of concern that fit the above definitions.

Regional

An action (here, for stormwater management purposes) that involves more than one discrete property.

Rehabilitation

The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural or historic hydrologic functions and processes of a degraded wetland.

Rehabilitation results in a gain in wetland function but does not result in a gain in wetland area.

Riverine impounding wetland

Riverine impounded wetlands retain surface water significantly longer than the duration of the flood event. Riverine impounded wetlands tend to hold water for more than a week after a flood event. These wetlands are found in a topographic depression on the valley floor, or in areas where natural or human made barriers to downstream flow occur.

Riverine wetlands

Riverine wetlands occur in valleys associated with stream or river channels. They lie in the active floodplain of a river, and have important hydrologic links to the water dynamics of the river or stream. The distinguishing characteristic of riverine wetlands in Washington is that they are frequently flooded by overbank flow from the stream or river.

Seasonal wetland

A wetland that has water above the soil surface for a period of time (usually between two months to less than one year) during and/or after the wettest season but in typical years dries to or below the soil surface in warmer, drier weather.

Sloped Wetlands

Slope wetlands occur on slopes where groundwater surfaces and begins running along the surface, or immediately below the surface. Water in these wetlands flows only in one direction (down the slope) and the gradient is steep enough that the water is not impounded. The downhill side of the wetland is always the point of lowest elevation in the wetland.

Stage excursion

A post-project departure, either higher or lower, from the water depth existing under a given set of conditions in the predevelopment state.

Water Level Fluctuation (WLF)

This is a defining characteristic of a wetland. Water level fluctuation (WLF) during a monitoring interval is as follows:

Average base stage = (Instantaneous stage at beginning of interval + Instantaneous stage at end of interval)/2

Wetland functions

The ecological (physical, chemical, and biological) processes or attributes of a wetland. Functions are often defined in terms of the processes that provide value to society, but they can also be defined based on processes that are not value based. Wetland functions include food chain support, provision of ecosystem diversity and fish and wildlife habitat, flood flow alteration, groundwater recharge and discharge, water quality improvement, and soil stabilization.

Wetland structure

The physical components of a wetland, both the abiotic (physical and chemical) and biotic (living).

Wetland values

Wetland processes or attributes that are valuable or beneficial to society (also see Wetland functions). Wetland values include support of commercial and sport fish and wildlife species, protection of life and property from flooding, recreation, education, and aesthetic enhancement

of human communities.

Wetlands

Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention BMPs, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands. (Waterbodies not included in the definition of wetlands as well as those mentioned in the definition are still waters of the state.)

Appendix I-C –Underground Injection Control (UIC) Program Guidelines

C.1 Introduction to UIC Wells

This appendix defines site suitability, treatment requirements, and design criteria for discharges of stormwater to Underground Injection Control (UIC) wells. The requirements of this appendix may be superseded by the Industrial Stormwater General Permit for those permitted sites. See C.19 UIC Program Guidelines – Definitions and Volume I, Section 1.7.12 Underground Injection Control – UIC Program for the UIC well definition and a list of examples.

All UIC wells receiving stormwater, except those located on tribal lands and UIC wells at single-family homes (or duplexes) receiving only residential roof runoff or used to control basement flooding, must be registered with the state of Washington. The majority of UIC wells receiving stormwater runoff can be authorized by the UIC program without requiring individual permits, provided the non-endangerment standard is met by fulfilling the requirements detailed throughout this appendix. Sub-surface infiltration (UIC wells) may be used to provide flow control for stormwater runoff under any of the following conditions:

- Pollutant concentrations expected to reach groundwater will meet Washington State groundwater quality standards.
- Stormwater is treated according to the requirements of this section prior to reaching the aquifer.
- Flows are greater than the water quality design flow rate (see Volume V, Section 4.1 Design Volume and Flow).

The unsaturated geological material between the bottom of the UIC well and the top of an unconfined aquifer, herein called the vadose zone, usually provides some level of treatment by removing contaminants by filtration, adsorption, and/or degradation. In some cases, the treatment provided by the vadose zone is suitable for protecting groundwater quality from contamination by stormwater runoff. In other cases, additional treatment may be required to protect groundwater quality. C.16 Determining Treatment Requirements and C.17 Classification of Vadose Zone Treatment Capacity describe these assessments and their applications.

This appendix does not address the following:

- UIC wells that receive fluids other than stormwater (precluding accidental spills and illicit discharges, which are addressed in Volume IV)
- The infiltration capacity of the vadose zone below the UIC well
- The ability of the UIC well to meet local operational requirements to infiltrate a certain volume of water in a given amount of time (see Volume I, Section 2.4.7 Minimum Requirement #7: Flow Control for more detail on flow control)

The UIC rule, WAC 173-218, requires a well assessment (see C.5 Well Assessment) for UIC wells that were constructed prior to February 3, 2006. The rule refers to these UIC wells as “existing” UIC wells.

The UIC program considers an infiltration trench where the design includes perforated pipe to be classified as a UIC well. Registration requirements do not apply to infiltration trenches without perforated pipes. Infiltration trenches designed, constructed, operated, and maintained according

to the specifications in Volume III, Section 3.6 and UIC registration with Ecology can be rule-authorized by the presumptive approach (see C.8 The Presumptive Approach).

C.2 Rule-Authorization or Permit

UIC wells must either be rule-authorized or covered by a state waste discharge permit to operate. If a UIC well is rule-authorized, an individual permit is not required. Rule-authorization can be rescinded if a UIC well no longer meets the non-endangerment standard, i.e., the discharge does not meet groundwater quality standards.

A UIC well may be rule-authorized when both of the following required actions are completed:

- Submit a registration form to Ecology (unless the UIC well is on tribal land, then registration is through U.S. Environmental Protection Agency (U.S. EPA), Region 10).
- Protect groundwater quality. The discharge from the UIC well must meet the non-endangerment standard.

C.3 Registration

Register UIC wells using Ecology's online registration process. For more information and details on the registration process, visit Ecology's web page for the UIC program.

All UIC wells must be registered except: UIC wells at single-family homes (or duplexes) receiving only residential roof runoff used to collect stormwater runoff from roof surfaces on an individual home (or duplex) or for basement flooding control.

C.3.1 New UIC Wells

Ecology considers UIC wells constructed on or after February 3, 2006, to be new wells. The registration provides Ecology with information to determine if the new UIC well meets the conditions to be rule-authorized:

- Applicants must submit the registration form 60 days prior to construction to allow a full review of the application by Ecology and other interested stakeholders.
- The UIC well must meet the non-endangerment standard, i.e., it complies with all the siting, design, and treatment requirements through either the presumptive approach (C.8 The Presumptive Approach) or the demonstrative approach (C.9 The Demonstrative Approach).

C.3.2 Existing UIC Wells

The UIC rule considers UIC wells constructed prior to February 3, 2006, as "existing". Existing wells used to manage stormwater runoff do not have to meet the new UIC well treatment requirements; however, registration is required if the UIC well is not already registered, and the owners must also complete a well assessment (C.5 Well Assessment) to determine if an existing UIC well is a high threat to groundwater. See WAC 173-218-090(2) and Ecology's UIC web page for more details.

C.4 Meeting the Non-Endangerment Standard

According to WAC 173-218-080(3), UIC wells must be constructed, operated, and maintained in a manner that protects water quality.

C.4.1 New UIC Wells

Ecology determines if a new UIC well is either rule-authorized or needs a state waste discharge permit based on whether the UIC well meets the non-endangerment standard.

Designers may either use the presumptive or demonstrative approach described in C4.8 The Presumptive Approach and C4.9 The Demonstrative Approach to meet the non-endangerment standard. UIC wells installed according to the specifications throughout this appendix are not considered a high threat to groundwater.

C.4.2 Existing UIC Wells

To determine compliance with the UIC rule, owners of existing UIC wells must complete a well assessment to determine if an existing UIC well is a high threat to groundwater (C.5 Well Assessment). The owner of a UIC well that is a high threat to groundwater must retrofit the well to protect groundwater quality.

C.4.3 Requirements for Municipal UIC Wells

The UIC program rule is the regulatory authority for UIC wells in Washington. The UIC program rule applies to Class V wells that receive stormwater regardless of whether a UIC well is located in a municipality permitted under the Phase I or Phase II Municipal Stormwater National Pollutant Discharge Elimination System (NPDES) Permit for Western Washington (MS4 Permit).

The MS4 Permit does not authorize stormwater discharges to/from UIC wells unless the overflow or discharge from a UIC well drains to a NPDES municipal separate storm sewer system (MS4). In those cases, the MS4 Permit does authorize the discharge and the conditions of the MS4 Permit directly apply. For example, if a UIC well is designed to infiltrate the 10-year storm and route larger storms to the MS4, then the requirements of the MS4 Permit apply to the well.

To prevent redundancy between the NPDES and the UIC programs, the UIC program rule allows permitted MS4s that also own or operate Class V UIC wells to satisfy the UIC rule by the presumptive approach (C.8 The Presumptive Approach). MS4 permittees have the option of applying the Stormwater Management Programs (SWMPs) that comply with the MS4 Permit to the areas served by their municipal UIC wells pursuant to WAC 173-218-090(1)(c)(C) in the manner described below. Note that the MS4 Permit does not require jurisdictions to fulfill all the requirements of the UIC program.

Municipalities may fulfill the source control and operation and maintenance requirements for new and existing municipal UIC wells under the following conditions:

- All areas served by municipally owned and operated UIC wells must be included in a Stormwater Management Program (SWMP) that ensures appropriate siting, treatment, design, operation, and maintenance of new municipal UIC wells as well as source control activities (including targeted education and outreach) that are well-suited for the land uses in these areas.
    - MS4 permittees may have a combined SWMP that addresses UIC and NPDES permit requirements together, or they may have two separate SWMPs for the areas served respectively by their municipal UIC wells.
    - In areas not covered by the MS4 permit, municipalities may create a SWMP specifically for the areas served by the municipal UIC wells.
- To comply with the UIC rule, jurisdictions must implement all of the following activities and

include them in their SWMP:

- Register all UIC wells, including existing and new wells.
- Design, construct, operate, and maintain new UIC wells according to the specifications throughout this appendix.
- Operate and maintain existing wells according to the specifications throughout this appendix.

Municipalities choosing not to develop and implement the SWMP in areas served by existing Class V UIC wells must:

- Conduct a well assessment (C.5 Well Assessment) for each UIC well, and
- Create a Stormwater Site Plan (SSP) for the area served by each existing municipal UIC well. The SSP will include source control best management practices applicable to the activities present in the area and describe operation and maintenance procedures to keep the UIC well functioning properly to provide necessary treatment to protect groundwater.

All new municipal UIC wells must be sited, designed, constructed, managed, operated, and maintained according to the requirements throughout this appendix.

C.5 Well Assessment

The assessment of an existing UIC well evaluates the potential risks to groundwater from the use of the well and includes information such as:

- The land use and activities around the well (which affect the quality of discharge),
- The local geology,
- Depth of the groundwater table in relation to the UIC well, and
- Whether the UIC well is located in a groundwater protection area.

Use this information to assess whether the well is a high threat to groundwater quality, by applying the information in C.16 Determining Treatment Requirements and C.17 Classification of Vadose Zone Treatment Capacity. If an existing UIC well is located in a groundwater protection area and the assessment determines that sufficient best management practices are not provided under the current conditions, retrofitting is required to protect groundwater quality. Existing UIC wells in groundwater protection areas that receive prohibited discharges (C.12 Prohibitions) must either be decommissioned or the activities must be moved and separated from the areas served by the existing UIC well.

A UIC well that was in use prior to the project is considered an existing well only if it remains in place. The well may be retrofitted or reconstructed in place without being considered a new well. Otherwise, if an existing well is moved, it is considered a new well, and the UIC requirements pertaining to new UIC wells apply.

C.5.1 Evaluating High Threat to Groundwater

For existing UIC wells, Ecology considers any of the following a high threat to ground- water for which the UIC well must be retrofitted.

- Existing UIC wells receiving prohibited discharges (C.12 Prohibitions); these wells also require a separate groundwater discharge permit.

- Existing UIC wells receiving a high pollutant load where the vadose zone between the bottom of the UIC well and the top of the groundwater has no treatment capacity or the vadose zone conditions are unknown; retrofits must provide treatment prior to the discharge to the well.
- Existing UIC well structures completed below the groundwater table; retrofits must provide separation and, if needed (C.16 Determining Treatment Requirements and C.17 Classification of Vadose Zone Treatment Capacity), treatment. (If a UIC well has standing water when it has not received recent stormwater inflows, it is likely completed below the groundwater table. See WAC 173-218-090(1)(b) for separation requirements between the bottom of the UIC well and the top of the groundwater table.)
- Site-specific information indicates that a groundwater quality problem exists in the vicinity of the existing UIC well.

A UIC well retrofit means to reduce the pollutant load from a UIC well to meet the non-endangerment standard by applying source control activity and/or structural controls such as a treatment BMP or create separation between the base of the well and the top of the groundwater table, WAC 173-218-030.

C.6 Preservation and Maintenance Projects

A preservation or maintenance project is defined as preserving/protecting infrastructure by rehabilitating or replacing existing structures to maintain operational and structural integrity, and for the safe and efficient operation of the UIC well. Maintenance projects do not increase the traffic capacity of a roadway or parking area.

A UIC well that was in use prior to preservation or maintenance project is considered an existing well only if it remains in place. The well may be retrofitted or reconstructed in place without being considered a new well. Otherwise, if an existing UIC well is moved, it is considered a new well and the UIC requirements pertaining to new UIC wells apply.

C.7 Emergency Situations

In emergency situations, such as roadway flooding, a jurisdiction may install a UIC well that does not meet the requirements in this manual on a temporary basis. When weather permits, and within a year of the event, the jurisdiction must either fully decommission the well or ensure that the UIC well meets the requirements of the rule.

For example, excessive winter rainfall overwhelms the capacity of the existing drainage system along a road. The water drains onto the road and turns to ice. The jurisdiction installs a new UIC well to fix the immediate problem and, once the weather permits, implements the required runoff treatment BMPs.

C.8 The Presumptive Approach

New UIC wells that meet all of the requirements detailed throughout this appendix meet the presumptive approach to comply with the non-endangerment standard. Otherwise, the demonstrative approach (C.9 The Demonstrative Approach) is required.

The presumptive approach requires the implementation of BMPs in Volume V and/or Volume IV of this manual or an equivalent manual, adopted at the time of construction. The manual addresses the following issues:

- The potential pollutant loading expected in the stormwater runoff for the planned land use(s) (see C.17 Classification of Vadose Zone Treatment Capacity)
- Source control of pollutants, especially those that are difficult to remove from stormwater by filtration, settlement, or other treatment technologies (see Volume IV)
- Known treatment methods (see Volume V)
- The potential treatment capacity of the vadose zone (see C.16 Determining Treatment Requirements)
- Siting (see C.18 Site Suitability Criteria (SSC))
- Design (see C.10 Siting and Design of New UIC Wells and Volume III for Infiltration BMPs)
- Operation and Maintenance (O&M) (see Appendix I-A - Example Maintenance Checklists)

C.10 Siting and Design of New UIC Wells details the siting and design criteria to meet the presumptive approach for drywells designed to meet runoff treatment. Volume III details the design requirements for infiltration trenches and drywells.

The presumptive approach may not be used when none of the source control or treatment BMPs in the manual are expected to eliminate or reduce concentrations of the pollutant(s) of concern (WAC 173-218-090(1)(i)(D)) to meet the non-endangerment standard.

C.9 The Demonstrative Approach

New UIC wells must meet the demonstrative approach to meet the non-endangerment standard if the presumptive approach is not completely followed, or if for any reason a project proponent chooses not to directly apply all of the requirements of this manual (or an equivalent manual).

The documentation for the demonstrative approach is a site-specific analysis that demonstrates that the proposed discharge will comply with groundwater quality standards.

To be eligible for rule-authorization using the demonstrative approach, the following topic areas must be addressed and documented with the UIC well registration:

- Site-specific analysis of pollutant loading
- Site-specific analysis of the treatment capacity of the vadose zone, if used for treatment
- BMP selection process used
- Pollutant removal expected from the selected BMPs
- Technical basis supporting the performance claims for the selected BMPs
- Assessment of how the selected BMPs will comply with state groundwater quality standards and satisfy state all known, available, and reasonable methods of prevention, control, and treatment (AKART) requirements

C.10 Siting and Design Of New UIC Wells

The requirements in this section apply to UIC wells built on or after February 3, 2006.

C.10.1 Minimum Sitting Requirements for Rule-Authorization of New UIC Wells

The following Site Suitability Criteria (SSC) from C.18 Site Suitability Criteria (SCS) apply to all UIC

wells:

- SSC-1 Setback Criteria
- SSC-2 Groundwater Protection Areas
- SSC- 3 High Vehicle Traffic Areas
- SSC-5 Depth to Bedrock, Water Table, or Impermeable Layer
- SSC-7 Seepage Analysis and Control
- SSC-8 Cold Climate and Impact of Roadway Deicers

UIC wells may be used provide flow control for stormwater runoff where pollutant concentrations that reach groundwater will meet the Washington State groundwater quality standards in the following situations:

- For flows greater than the water quality design flow rate (see Volume V, Section 4.1 Design Volume and Flow); or
- Where stormwater is treated prior to discharge into the UIC well according to the requirements in C.16 Determining Treatment Requirements.

Furthermore, if SSC-4 Soil Infiltration Rate/Drawdown Time and SSC-6 Soil Physical and Chemical Suitability for Treatment are met, the site is considered to have a high treatment capacity, and the existing site soils may be used to provide runoff treatment for flows through the UIC well (see C.13 Source Control and Runoff Treatment Requirements).

Restrictions on Sitting UIC Wells

- Prohibited areas: A UIC well may not be sited in prohibited areas; see C.12 Prohibitions for the list of areas where stormwater discharges to UIC wells are prohibited.
- Soil contamination: UIC wells may not be sited where there are soil contaminants that could be transported to groundwater unless the site is remediated prior to construction.

Siting UIC Wells Near Drinking Water Wells

Because a UIC well could be a potential source of contamination, it must be sited ≥ 100 feet from a drinking water well, outside of the sanitary control area of a public drinking water system, and ≥ 200 feet from a spring used for drinking water supplies. The design must consider the distance between the UIC well and a drinking water well based on the direction and rate of groundwater flow, and the vulnerability of the drinking water supply well to potential contamination, which is influenced by the following factors:

- Depth/distance from the bottom of the UIC well to the drinking water well screened interval(s), and
- Presence or lack of confining layer(s) between the bottom of the UIC well and the aquifer interval(s) used as the water supply, and
- Characteristics of the geologic material between the bottom of the UIC well and the aquifer.

Groundwater Protection Areas

At a minimum, basic treatment to remove solids prior to discharge to the UIC well is required for UIC wells located:

- In a wellhead protection area where the drinking water well is categorized with a high-susceptibility rating by the Washington State Department of Health, and/or
- Where a confining layer is not present between the base of the UIC well and the top of the aquifer used as a drinking water source, except when a UIC well receives insignificant and or low pollutant load from stormwater (see Table C.3. Pollutant Loading Classifications for Solids, Metals, and Oil in Stormwater Runoff Directed to UIC Wells).

Refer to Title 18E Development Regulations – Critical Areas, Chapter 18E.50 Aquifer Recharge and Wellhead Protection Areas, for requirements and additional information that apply to development within groundwater protection areas, such as sole source aquifers, groundwater management areas, wellhead protection areas, and areas designated as Critical Aquifer Recharge Areas. To locate the wellhead areas and the associated water districts in each county, see the Washington State Department of Health (DOH) Source Water Assessment Program maps located at their web page.

C.10.2 Design and Construction Requirements for Rule-Authorization of New UIC Wells

In order to be rule-authorized under the presumptive approach, UIC wells must be designed and installed in accordance with this manual or an equivalent manual adopted at the time of construction. The following subsections include additional requirements for design and construction of UIC wells.

Prevention of Clogging During Construction

In order to prevent clogging, UIC wells must be protected from sediment in runoff generated during construction. See Volume II for construction BMPs to prevent other pollutants from entering the UIC well during the construction phase of a project.

Stormwater Infiltration Rate/Drawdown Time

In most cases, UIC wells are designed to completely drain ponded runoff within 48 to 72 hours after flow to the UIC well has stopped. If the UIC well is designed to meet a runoff treatment requirement, the long-term infiltration rate (see Appendix III- A - Methods for Determining Design Infiltration Rates) must be sufficient to accommodate the water quality design flow rate (see Volume V, Section 4.1 Design Volume and Flow).

Vertical Separation for Rule-Authorization Using the Presumptive Approach

WAC 173-218-090 requires that new Class V UIC wells used for stormwater management must not directly discharge into groundwater. A 5-foot separation between the bottom of the well and the top of the groundwater is required, unless a demonstrative approach confirms that a separation of 3 feet will meet the non-endangerment standard.

The required depth to groundwater/vertical separation between the base of the UIC well and the top of the groundwater table for rule-authorization using the presumptive approach depends on the treatment capacity of the unsaturated zone. C.16 Determining Treatment Requirements and C.17 Classification of Vadose Zone Treatment Capacity provide a method for determining the treatment requirements based on the treatment capacity of the vadose zone and the pollutant loading classification of the stormwater runoff directed to the UIC wells.

The minimum vertical separation is 5 feet between the base of a UIC well and the highest elevation between the seasonal high groundwater table, bedrock, hardpan, or other low-

permeability layer.

Vertical Separation When 5-Foot Minimum Separation Cannot be Met

If vertical separation required for the presumptive approach cannot be met:

- Rule-authorization can be obtained using the demonstrative approach (see C.9 The Demonstrative Approach), or
- A reduction in separation to as little as 3 feet can be considered under the presumptive approach provided:
  - The treatment requirements are otherwise met (see C.16 Determining Treatment Requirements and C.17 Classification of Vadose Zone Treatment Capacity), and:
  - The groundwater mounding analysis, the volumetric water holding capacity of the zone receiving the water, and the design of the overflow and/or bypass structures are judged by the design professional as adequate to prevent overtopping and meet the SSC specified in this section.

C.11 Operation and Maintenance of UIC Wells

The UIC rule requires that wells are operated and maintained to protect groundwater quality. Maintenance of UIC wells prevents clogging and contamination from materials that collect in the well over time. The following required preventive maintenance activities will help maintain UIC function:

- Treatment for solids removal or a catch basin with a down turned elbow upstream of discharge to the UIC well to promote the long-term infiltration capacity and reduce the need for maintaining the UIC wells, as well as reduce the long-term accumulation of contaminants in the vadose zone
- Frequent inspections and regular maintenance to improve the long-term performance of the UIC wells
- Periodic removal of debris and sediment from the drywell to reduce or eliminate the buildup of materials that could inhibit infiltration
- Checking for structural damage and repair as needed

See Appendix I-A - Example Maintenance Checklists for recommended maintenance criteria and inspection frequencies.

C.12 Prohibitions

UIC wells may not receive stormwater from the activities and conditions listed below:

- Vehicle maintenance, repair, and service
- Commercial or fleet vehicle washing
- Airport/airplane deicing
- Storage of treated lumber
- Generation, storage, transfer, treatment, or disposal of hazardous wastes
- Handling of radioactive materials
- Solid waste handling facilities, including compost and biosolid facilities, except for those that

recycle only glass, paper, plastic, or cardboard

- Concrete recycling facilities that generate, store, or handle crushed concrete
- Asphalt recycling facilities that generate, store, or handle crushed asphalt
- Industrial or commercial areas that have outdoor processing, handling, or storage of raw solid materials or finished products unless the facility has specific management plans for proper storage and spill prevention, control, and containment appropriate to the types of materials handled at the facility (see Volume IV for information on stormwater pollution prevention plans and source control)
- Contaminated sites when the stormwater would increase the mobility of the contaminants at the site. For example, a drywell could not be used upgradient of or over the contaminant plume at a leaking underground storage tank site. The stormwater could increase the movement of the contaminants.
- Process water from the production area of an animal feeding operation.
- Land use, activity, or infiltration determined to be a significant contributor of pollutants to waters of the State or a site release of hazardous substances from historical or current activities resulting in contamination of soil, groundwater, surface water, if the groundwater is in direct communication with surface water, or sediment, which is prohibited under the Model Toxics Control Act (Chapter 173-340 WAC) and Sediment Management Standards (Chapter 173-204 WAC).

Because of the potential to contaminate groundwater, a UIC well must be individually authorized under a waste discharge permit to receive stormwater from any areas subject to the activities listed above. Ecology does not consider conventional runoff treatment to be protective of groundwater in these situations. Stormwater from areas subject to the activities listed above must be handled onsite with a closed-loop system or discharged to the sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 7983013.

However, careful design of these project sites may allow UIC wells to handle some of the stormwater runoff that will be generated. Stormwater from any portions of the site or facility that do not come in contact with these activities (or the areas of the facility associated with these activities) are allowed to be discharged to a UIC well following the presumptive approach.

See WAC 173-218-040(5)(b) for a list of other prohibited UIC wells.

C.13 Source Control and Runoff Treatment Requirements

The UIC rule bases source control and runoff treatment requirements on the types and quantities of pollutants expected from the proposed land use contributing storm runoff to the UIC well.

The rule presumes a UIC well meets the non-endangerment standard and is rule-authorized if the designer follows the guidelines in this section based on the following:

- Application of source control BMPs to control loading of pollutants that are difficult to remove from stormwater by filtration, settlement, or other treatment technologies, and
- Appropriate treatment of runoff to remove pollutants, which may be achieved by either or both:
    - Application of treatment to remove pollutants before discharging stormwater into the UIC well

- Availability of appropriate vadose zone treatment capacity to remove the solid phase of pollutants in stormwater by filtration and adsorption (see C.16 Determining Treatment Requirements and C.17 Classification of Vadose Zone Treatment Capacity)

C13.1 Source Control

- Source control is necessary to protect groundwater from pathogens, pesticides, nitrates, road salts and other anti-icing and deicing chemicals, fuel additives, and many other pollutants in urban runoff, as well as accidental spills.
- The operational and structural source control BMPs that are also required to meet the non-endangerment standard for various land uses are described in Volume IV or other equivalent manuals. Targeted education and outreach may also be a necessary source control measure.
- Source control BMPs can significantly reduce clogging and pollutants, especially solids, and must be used at all project sites. Protect UIC wells during the construction phase to prevent sediment from entering the UIC well. Implement the BMPs in Volume II or in an equivalent manual. Where there are no existing runoff treatment BMPs to practically address a pollutant issue and where filtration by the vadose zone cannot provide adequate removal of pollutants, owners are required to use source control BMPs to meet the non-endangerment standard. Otherwise, the discharge to the UIC well is prohibited (WAC 173-218-090(1)(c)(i)(D)). See C.12 Prohibitions for prohibited discharges.
- Wherever practicable, reduce the exposure of stormwater to these contaminants by one or more of the following:
- Careful attention to the product label application rates
- Targeted product use to avoid contamination of stormwater runoff
- Careful management of the storage and use of products
- Separation of areas where products are used from contributing areas that discharges to a UIC well
- Spill response planning

Contact Pierce County Planning and Public Works to determine whether specific source control requirements apply to your project in addition to those methods described in this manual for the proposed land use.

C.13.2 Runoff Treatment

The BMPs chosen for the site must remove or reduce the target pollutants to levels that will comply with State groundwater quality standards when the discharge reaches the groundwater table or first comes into contact with an aquifer (see Chapter 173-200 WAC). Each BMP is designed to reduce or eliminate certain pollutants. See other sections in Volume V for specific runoff treatment BMP design criteria.

Removing solids from stormwater runoff before it is discharged to a UIC well helps preserve infiltration rates over the long term. UIC wells used for flow control are required to have solids removed prior to discharge. Treatment for solids removal (basic treatment) must be designed, constructed, operated, and maintained in accordance with this manual or an equivalent manual.

Designers may alternatively use the demonstrative approach (C.9 The Demonstrative Approach)

should they wish to install a BMP that is not included in this manual.

Some pollutants may require additional treatment beyond that provided by the approved BMPs described in other sections in Volume V. The text below discusses these pollutants.

Bacteria

Fecal coliform bacteria and other pathogens in stormwater come from many sources. Examples are manure fertilizers, pet waste, and animal feeding operations.

Runoff treatment BMPs are unreliable in removing fecal coliform bacteria and other pathogens from runoff. Because of this, UIC wells shall not receive direct stormwater discharges from areas or sites that generate high loadings of fecal coliform bacteria, such as animal feeding operations.

Alternatively, runoff from sites generating high loadings of bacteria and pathogens may be:

- Discharge to the sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 7983013; or
- Used for crop irrigation, as long as other applicable requirements are met; or
- Directed to a bioretention, biofiltration, or bioinfiltration BMP after the nutrient budget is addressed; or
- Diverted through stormwater treatment wetlands (see Volume V, Section 9.3.3 Stormwater Treatment Wetlands) prior to discharge to a UIC well.

Municipal UIC well owners must implement appropriate source control, targeted education and out-reach, and illicit discharge detection and elimination programs in areas served by their UIC wells to prevent pet wastes from contaminating stormwater and to control other sources of pathogens.

UIC wells in the vicinity of land application areas (i.e., along adjacent roadways) must be protected by appropriate buffers and berms to prevent manure-contaminated runoff from entering the UIC well. Best practices for setbacks, nutrient budgets, and timing of application must also be implemented.

Private UIC well owners must ensure that their UIC wells are appropriately protected from sources of bacterial contamination.

Soluble Pollutants, Pesticides, Fertilizer, and Nutrients

Many soluble pollutants that are commonly found in stormwater (including pesticides, fertilizers, road salts, and other chemical pollutants) are very difficult to remove from stormwater. Source controls applicable to the land use and activities at the site are required to reduce the contamination of stormwater from these chemicals.

Areas such as parks, playgrounds, golf courses, public ball fields, cemeteries, and urban landscape typically use pesticides and fertilizers for landscape management. Examples of other activities that generate high nutrient loads include commercial composting, commercial animal handling areas, nurseries, and land application areas.

Pesticides include a host of chemicals with varying chemical fate and transport characteristics. Some pesticides travel to groundwater more readily because they are more water soluble and less likely to “stick” or sorb to soil particles. These pesticides need treatment by a biological treatment method, such as a biofiltration swale or constructed wetland. UIC wells that receive stormwater with pesticides that use one of these biological treatment methods are rule-

authorized when they are registered, providing this technical guidance is followed.

If UIC owners wish to use a different treatment method for pesticides, they may apply to Ecology for rule-authorization using the demonstrative approach outlined in C.9 The Demonstrative Approach. Nonbiological treatment systems are ineffective at removing these pollutants from runoff. Instead, runoff from these types of landscaped areas should be directed to bioretention, biofiltration, or bioinfiltration systems or constructed wetlands prior to discharge to UIC wells. Stormwater with fertilizer or nutrients may be used to irrigate crops and/or landscaped areas in accordance with other applicable requirements.

Ecology encourages use of the following practices:

- Limited use of applied chemicals
- Site design to minimize runoff from the landscaped surface
- Development of a pesticide management plan

UIC wells in the vicinity of land application areas (i.e., along adjacent roadways) must be protected by appropriate buffers and berms to prevent manure-contaminated runoff from entering the UIC well. Best practices for setbacks, nutrient budgets, and timing of application must also be implemented.

Industrial Activities with Requirements to Monitor for Nitrate, Nitrite, Ammonia, or Phosphorus

The U.S. EPA lists industrial activities that have monitoring requirements for nitrate, nitrite, ammonia, or phosphorus. Runoff from sites where nitrate, nitrite, ammonia, or phosphorus come into contact with stormwater must be directed to one of the following:

- Bioretention, biofiltration, or bioinfiltration systems
- Constructed wetlands prior to discharge
- Sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 7983013
- Municipal drainage system that discharges to surface water, if allowed by Pierce County Planning and Public Works and following treatment for removal of solids

Facilities may complete a no exposure certification as part of Ecology's UIC well registration process for exemption from these requirements. In order to qualify, no outdoor processing, handling, or storage of raw solid materials or finished products may take place at the facility. Industrial facilities that qualify for no-exposure certification may use the Tables in C.17 Classification of Vadose Zone Treatment Capacity to determine treatment requirements.

Commercial Site Roofs with Ventilation for Commercial Indoor Pollutants

Roof runoff from commercial businesses with ventilation systems specifically designed to remove commercial indoor pollutants must be evaluated on a case-by-case basis to identify the pollutants of concern and the appropriate treatment requirements.

In general, this runoff may be classified as a "medium" pollutant loading source (see Table C.3. Pollutant Loading Classifications for Solids, Metals, and Oil in Stormwater Runoff Directed to UIC Wells), and the requirements of this section may be applied to discharges from these areas to UIC wells.

Commercial Site Outdoor Handling or Storage

Treatment for solids removal (basic treatment) is require at commercial sites with outdoor handling or storage of raw solid materials. Examples include gravel, sands, logs, salts, and compost.

Industrial Site Roofs

Roof runoff from industrial facilities must be evaluated on a case-by-case basis and should be treated according to the other Best Management Practice requirements for the facility.

Industrial Site Outdoor Handling or Storage

Owners at industrial sites where outdoor processing, handling, or storage of raw solid materials or finished products, including outdoor loading areas for these materials or products, takes place must provide solids removal (basic treatment). These are sites defined by the U.S. EPA (40 CFR 122.26 (b)(14)).

C.14 Spills and Illicit Discharges

Appropriate spill control, prevention and response measures for various land uses are described in Volume IV. The spill control requirements in Volume IV apply to all stormwater discharges to UIC wells. Any spills that pose a threat to groundwater quality should be reported to Ecology. Petroleum spills that enter a UIC well must be reported to Ecology.

C.15 Deep UIC Wells

UIC wells that extend below an upper confining layer and discharge into the underlying vadose zone are designated by Ecology as deep UIC wells. This includes drywells where drilling extends through a surficial till layer into the vadose zone below. Pierce County Planning and Public Works may impose additional limits on the total depth of these UIC wells based on specific hydrologic conditions and other considerations.

Ecology recommends that project proponents explore alternative approaches to stormwater management before deciding to use a deep UIC well. Projects using deep UIC wells must provide the following:

- A hydrogeologic study that details the following, to determine if contamination could occur:
  - Consideration of potential changes to the aquifer.
  - Infiltration testing to determine mounding affects.
  - Identification of the direction and rate of groundwater flow.
  - Evaluation of the treatment capacity of the vadose zone (see C.16 Determining Treatment Requirements and C.17 Classification of Vadose Zone Treatment Capacity).
  - Determination as to whether the proposed deep UIC well is located within a groundwater protection area (GWPA) such as a wellhead protection area.
  - If a deep UIC well is located within a GWPA, assessment of the vulnerability of the drinking water supply source as follows:
    - Evaluate whether the introduction of stormwater will affect the quality of the groundwater at the water supply well.
    - Describe the following hydrogeologic factors that may influence the vulnerability of

a groundwater supply source:

- Depth of the drinking water well screened interval in relation to the deep UIC well infiltration depth, and
- Presence or lack of a confining layer between the land surface and the aquifer interval, and
- Type of material between the land surface and the aquifer, and between the bottom of the deep UIC well and the aquifer.

- An operation and maintenance manual for the deep UIC wells and treatment structures that includes a schedule for their implementation.
- A list of source control BMPs that will be implemented to minimize solids entering the deep UIC well.
- Description of any additional special runoff treatment needs and site operation requirements.
- A minimum of basic treatment for all discharges to drywells to remove suspended sediments, and to prevent sediment entering the well structure and vadose zone.
- A minimum 15-foot separation between the base of the drywell and the surface of the seasonal high groundwater table.
- Stabilization of the site prior to the drywells going on line to prevent sediment entering the drywells.
- A landscape management plan.
- Sealing of any impermeable layers that are penetrated during drilling, to prevent aquifer interconnection if a perched aquifer or other saturated stratum is penetrated.

A surface seal should also be included in the final completion of a deep drywell.

Ecology recommends hiring a Washington licensed well driller for construction of deep UICs. However, most UIC wells are not regulated by the Well Construction Act.

In the design phase of a deep UIC drywell proposal, the project proponent should notify the drinking water supply purveyor when the proposed UIC well will be located in a wellhead protection area, Critical Aquifer Recharge Area, or a Sole Source Aquifer.

Submittal of a State Waste Discharge Permit application may be required and will be determined on a site-by-site basis following the evaluation of the UIC permit application. Ecology will notify the project proponent if this is the case.

C.16 Determining Treatment Requirements

For all stormwater discharges to UIC wells, some form of treatment is required. Treatment may be provided by the vadose zone or by structural treatment BMPs, and depends on the geologic conditions, the land use, and activities at the project site.

Designers intending to use the presumptive approach can use the tables in C.17 Classification of Vadose Zone Treatment Capacity to identify the necessary level of Runoff Treatment prior to discharge to the UIC well.

Designers for industrial sites with no outdoor processing, storage, or handling of raw or finished products may use the Tables in C.17 Classification of Vadose Zone Treatment Capacity. Designers

may not use the tables in C.17 Classification of Vadose Zone Treatment Capacity for stormwater runoff from industrial activities, outdoor processing, storage, or handling of raw or finished products; or areas where stormwater runoff comes into contact with leachate or other prohibited discharges.

Where onsite or nearby geologic and groundwater depth information is available, designers can use the tables in C.17 Classification of Vadose Zone Treatment Capacity to evaluate whether the presumption that a stormwater discharge from a road, commercial site, or residential site to a UIC well meets the non-endangerment standard for solids, metals, oil, grease, and polycyclic aromatic hydrocarbons (PAHs).

Used together, the tables in C.17 Classification of Vadose Zone Treatment Capacity identify Ecology's presumption about the extent to which the vadose zone provides sufficient treatment for a given pollutant loading classification and whether additional treatment is necessary to meet the groundwater quality standards for these pollutants.

Depending on conditions, treatment may be as simple as a catch basin with a downturned elbow, or as complex as an oil/water separator followed by basic and/or metals removal. See Table C.4. Treatment Required for Solids, Oil, and Metals for treatment requirements as a function of pollutant loading classification and vadose zone treatment capacity.

C.16.1 Exceptions Based on Site-Specific or Local Studies

Exceptions to the tables in C.17 Classification of Vadose Zone Treatment Capacity may be made under any of the following circumstances:

- Local planning efforts have generated an alternative method that meets the non-endangerment standard based on local conditions. For example, local jurisdictions may choose to allow changes in the pollutant loading categories in Table C.3. Pollutant Loading Classifications for Solids, Metals, and Oil in Stormwater Runoff Directed to UIC Wells based on source control BMPs implemented at a site.
- More detailed site-specific data are gathered by the project proponent and local permission is granted under a locally developed stormwater management program.
- The required thicknesses of the vadose zone treatment layer listed in Table C.2. Vadose Zone Treatment Capacity may be as little as 3 feet for a high-capacity treatment matrix and 6 feet for a medium-capacity treatment matrix when all of the following requirements are met:
    - The UIC well is regulated under a local stormwater management program that satisfies the requirements in C.4 Meeting the Non-Endangerment Standard, and local jurisdiction approves the change in minimum thicknesses.
    - The pollutant loadings are insignificant or low.
    - Reliable onsite information is available. Designers may use borehole logs within 0.25 miles of the proposed UIC well if geologic conditions are consistent.
    - Site-specific water level data justifies the minimal separation from the groundwater table in cases where the 3 feet of high-capacity treatment matrix provides the entire separation between the bottom of the structure and the seasonal high groundwater table.
    - Potential mounding of infiltrating stormwater above the groundwater table is likely.

Additional separation or treatment may be required.

C.16.2 Vadose Zone Treatment Capacity

In general, the vadose zone may provide adequate filtration, adsorption, and other pollutant reduction capacity to meet the non-endangerment standard for solids, metals, oil, grease, and PAHs. Designers may use the tables in C.17 Classification of Vadose Zone Treatment Capacity to evaluate the use of the vadose zone for treatment and to determine treatment requirements to reduce concentrations of these pollutants prior to discharge to the UIC well.

Studies of stormwater pollutant concentrations in water through and below infiltration systems show mixed results in the effectiveness of vadose zone filtration in protecting groundwater quality (USEPA, 1999), (Pitt et al., 1999), (Mason et al., 1999), and (Appleyard, 1993).

Designers can eliminate many of the problems documented in these studies by proper siting, design, maintenance, and use of the UIC well. Additional actions to offset problems are enhanced source control, spill prevention and response plans, and additional treatment prior to discharge to the UIC well, or prohibition of the discharge.

Studies of subsurface infiltration systems also indicate that filtered and adsorbed pollutants accumulate in the vadose zone at depths of less than a few feet below the UIC well at concentrations that may require soil cleanup activities upon decommissioning of a UIC well (Mikkelsen et al., 1996a), (Mikkelsen et al., 1996b), and (Appleyard, 1993).

Because contaminated soil removal and disposal costs can be considerable, project proponents may wish to consider including pretreatment BMPs to remove solids from stormwater runoff and avoid potential cleanup requirements following long-term use of the UIC well.

C.17 Classification of Vadose Zone Treatment Capacity

The treatment capacity of the vadose zone is classified as high, medium, low, or none. Ecology bases these classifications on minimum thickness and the characteristics of the geologic materials that make up the proposed treatment layer.

The tables include several different ways of describing the geologic materials: grain-size distribution, sand-to-fines ratio, well log lithology, geologic names, and infiltration rate, as defined in Table C.1. Examples of Geologic Material Descriptions.

Table C.1. Examples of Geologic Material Descriptions

Geologic Material Description Method	Example
Grain size characteristics	Materials with median grain size < 0.125 mm
Sand-to-fines ratio	Having a sand to silt/clay ratio of < 1:1 and sand plus gravel < 50%
Well log lithology	Sandy or silty clay Silt Clayey or sandy silt Sandy loam or loamy sand Silt/clay with interbedded sand

Geologic name	This category includes geologic terms that indicate provenance, including till, hardpan, caliche, and loess
Infiltration rate	Infiltration rate of ≥ 12 in/hr

The ability of geologic materials to filter or adsorb pollutants such as solids, oils, and metals is related to grain size, the amount of organic matter, and the presence of clays, among other factors. Native organic matter improves adsorption and filtration (Ingloria et al., 1997) but is rarely found at depths below UIC wells.

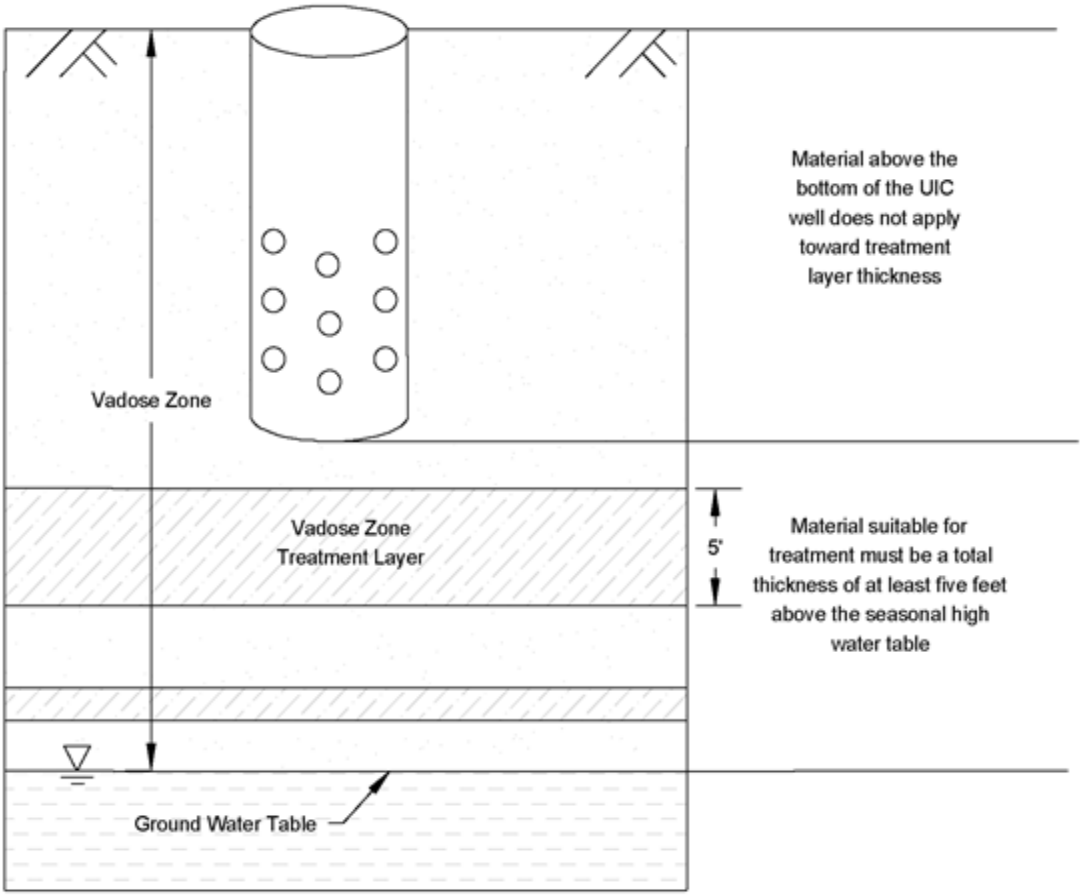
Geologic materials classified as having a high treatment capacity are fine-grained with a greater capacity to filter discharges. These materials also tend to remove pollutants by chemical reactions such as cation exchange capacity (CEC) and sorption. These may be mixtures of materials where silt and clay fill the void spaces in the matrix of the coarser materials. More compaction results in better filtration. High-capacity treatment layers must total a minimum of 5 feet between the bottom of the UIC well and the seasonal high groundwater table to provide an adequate level of treatment (see Figure C.1. Schematic Vadose Zone Treatment Layer Example).

Geologic materials classified as having a medium treatment capacity provide moderate to high filtration and have minor or no chemically reactive characteristics. Medium-capacity treatment layers must total a minimum of 10 feet to provide an adequate level of treatment.

Geologic materials that have a low treatment capacity provide some minimal filtration. Although the sand and gravel mixtures in this category may provide some filtration when the UIC well is initially installed, preferential flow paths develop that contribute to relatively rapid reduction in treatment capacity. Low-capacity treatment layers must total a minimum of 25 feet between the bottom of the UIC well and the seasonal high groundwater table to provide an adequate level of treatment.

Geologic materials that are classified as having no treatment capacity do not provide filtration to remove pollutants. Since this type of material does not have treatment capacity, basic treatment of stormwater (Removal of Solids) is always required prior to discharge to the UIC well, except for sites that are classified as having an insignificant pollutant load in Table C.3. Pollutant Loading Classifications for Solids, Metals, and Oil in Stormwater Runoff Directed to UIC Wells.

Figure C.1 - Schematic Vadose Zone Treatment Layer Example



C.17.1 Classification of Vadose Zone Treatment Capacity

Site exploration or information from the site or, a site nearby, is required to obtain sufficient data to classify the treatment capacity of the vadose zone materials using Table C.2. Vadose Zone Treatment Capacity.

In some cases, geologic information may be available from regional geology maps in publications from the Washington State Department of Natural Resources or the U.S. Geological Survey, from a well borehole log(s) in the same quarter-section on Ecology's well log web page or from local jurisdictions.

The following should be kept in mind when using these sources:

- Surface soil maps generally do not provide adequate information although the parent material information provided may be helpful in some locations.
- Verify well borehole log locations because electronic databases contain many errors of this type.
- When using borehole logs, a "nearby" site is generally defined as being within a quarter of a

mile, but preferably within 50 to 500 feet of the project site, depending on the heterogeneity of the region.

- Subsurface geology can vary considerably in a very short horizontal distance in many areas of the state. Use professional judgment to determine whether the available data are adequate or site exploration is necessary.
- Alternatively, for small projects where site exploration is not cost-effective, a design professional may apply a conservative design approach, subject to the approval of the local jurisdiction.

The treatment capacity classifications in Table C.2. Vadose Zone Treatment Capacity apply to the vadose zone between the bottom of the UIC well and the top of the highest known seasonal groundwater table. Designers should use Table C.2. Vadose Zone Treatment Capacity to assist in the determination of treatment requirements when using Table C.4. Treatment Required for Solids, Oil, and Metals. If vadose zone conditions are unknown, use "none" for treatment capacity. If thicknesses are less than the listed minimums, use "none" for treatment capacity or consider using the demonstrative approach (see C.9 The Demonstrative Approach). Separation between the bottom of the UIC well and the top of the groundwater table is still required, see WAC 173-218-090(1)(b).

C.17.2 Depth to Groundwater

The minimum required separation between the bottom of the UIC well and the highest seasonal groundwater table depends on the characteristics of the vadose zone, the potential for mounding of infiltrating stormwater above the groundwater table, and the degree of certainty of available data as to the seasonal high groundwater table elevation.

Knowledge of the seasonal high groundwater table is especially important for siting UIC wells in areas with seasonal high groundwater table < 15 feet below the bottom of the UIC well.

Significant mounding of infiltrating stormwater can occur above the groundwater table (Appleyard, 1993) and UIC wells must not discharge stormwater directly into ground- water at any time. This applies even if the groundwater level is rising in response to the UIC discharge.

In most cases, one depth to water measurement, such as water level data associated with a single borehole log, is not sufficient to determine the depth/elevation of the seasonal high groundwater table. This is especially true if drilling was conducted outside of the period of seasonal high groundwater levels or following a period of lower than normal precipitation. Seasonal high groundwater tables generally occur during late winter through mid-spring in most of Washington State. In heavily irrigated areas, the seasonal high groundwater table elevation may occur in late summer. The elevation of the seasonal high groundwater table is best determined through installation and periodic monitoring of one or more groundwater monitoring wells at the infiltration BMP location.

At sites where the fluctuation of the seasonal groundwater table is large (several feet) or unknown, designers should err on the side of caution. As described above and reinforced here, UIC wells must not discharge stormwater directly into groundwater.

Table C.2 Vadose Zone Treatment Capacity

Treatment Capacity Classification and Required Minimum Thickness	Description of Vadose Zone Layer[c,d]
High A minimum thickness of 5 feet	Meets all of the following characteristics: • Materials with median grain size < 0.125 mm • Having a sand to silt/clay ratio of < 1:1 and sand plus gravel < 50% • Field-tested saturated hydraulic conductivity below 2.4 in/hr at the bottom elevation of the proposed BMP • Materials with CEC of ≥ 5 milliequivalents CEC/100 g dry soils, and a minimum of 1% organic content, ≥ 18-inch minimum thickness • Typical geotechnical descriptive words for appropriate soils: ◦ Lean, fat, or elastic clay ◦ Sandy or silty clay ◦ Silt ◦ Clayey or sandy silt ◦ Sandy loam or loamy sand ◦ Silt/clay with interbedded sand ◦ Well-compacted, poorly sorted materials *This category generally includes till, hardpan, caliche, and loess.*
Medium A minimum thickness of 10 feet	Meets all of the following characteristics: • Materials with average grain size 0.125 to 4 mm • Having a sand to silt/clay ratio from 1:1 and 9:1 and percent sand > percent gravel • Field-tested saturated hydraulic conductivity between 2.4 in/hr and 6 in/hr at the bottom elevation of the proposed BMP • Materials between 2 and 5 milliequivalents CEC/100 g dry soils, and a minimum of 0.5% to 1% organic content, • Typical geotechnical descriptive words for appropriate soils: ◦ Fine, medium, or coarse sand ◦ Sand with interbedded clay and/or silt ◦ Poorly compacted, poorly sorted materials *This category includes some alluvium and outwash deposits.*
Low A minimum thickness of 25 feet	Meets all of the following characteristics: • Materials with median grain size > 4 mm to 64 mm • Having a sand to silt/clay ratio > 9:1 and percent sand less than percent gravel • Field-tested saturated hydraulic conductivity between 6 in/hr and 12 in/hr at the bottom elevation of the proposed BMP • Materials with CEC of ≤ 2 milliequivalents CEC/100 g dry soils and a minimum of < 0.5% organic content • Typical geotechnical descriptive words for appropriate soils: ◦ Poorly sorted, silty, or muddy gravel ◦ Sandy gravel, gravelly sand, or sand and gravel *This category includes some alluvium and outwash deposits.*

None Minimum thickness not applicable	Meets any of the following characteristics: • Vadose zone conditions are unknown; or • Vadose zone conditions are known and are characterized in any of the following ways: ◦ Sedimentary materials with median grain size > 64 mm ◦ Total fines (sand and mud) < 5% • Field-tested saturated hydraulic conductivity > 12 in/hr at the bottom elevation of the proposed BMP ◦ Materials with no measurable CEC or organic content • Typical geotechnical descriptive words for appropriate soils: ◦ Well-sorted or clean gravel ◦ Boulders and/or cobbles ◦ Fractured rock *This category generally includes vadose zones with conditions that are unknown or vadose zones that are known to be composed of fractured basalt, other fractured bedrock, and cavernous limestone.*

a. This table is applicable to designers intending to use the presumptive approach to identify the necessary level of stormwater treatment prior to discharge to a UIC well. Designers for industrial sites with no outdoor processing, storage, or handling of raw or finished products may also use these tables.
b. This table is not applicable to stormwater runoff from industrial activities, outdoor processing, storage, or handling of raw or finished products; or areas where stormwater runoff comes into contact with leachate or other prohibited discharges.
c. If vadose zone conditions are unknown or if the vadose zone thicknesses are less than those listed, use “none” for the treatment capacity.
d. Separation between the bottom of the UIC well and the top of the groundwater table is required, see WAC 173-218-090(1)(b).

Table C.3 Pollutant Loading Classifications for Solids, Metals, and Oil in Stormwater Runoff Directed to UIC Wells

Classification	Areas Contributing Runoff to the UIC Well
Insignificant	• Impervious surfaces not subject to motorized vehicle traffic or application of sand or deicing chemicals • Unmaintained open space
Low	• Parking areas with < 40 total trip ends per 1,000 square feet (sf) of gross building area or < 100 total trip ends (if you exceed either threshold, move to the Medium Classification) • Other land uses with similar traffic/use characteristics (e.g., most residential parking and employee-only parking areas for small office parks or other commercial buildings) **Inside Urban Growth Management Areas** • Fully controlled and partially controlled limited access highways with ADT < 15,000 • Other roads with ADT < 7,500 vehicles **Outside Urban Growth Management Areas** • All roads with ADT < 15,000 vehicles
Medium	• Parking areas with between 40 and 100 trip ends per 1,000 sf of gross building area or between 100 and 300 total trip ends (if you exceed either threshold, move to the High Classification) • Primary access points for high-density residential apartments • Intersections controlled by traffic signals that do not meet the definition of a high-density intersection (i.e. A road intersection with a measured ADT count of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway, excluding projects proposing primarily pedestrian or bicycle use improvements) • Transit center bus stops **Inside Urban Growth Management Areas** • Fully controlled and partially controlled limited access highways with ADT between 15,000 and 30,000 vehicles • Other roads with ADT between 7,500 and 30,000 vehicles **Outside Urban Growth Management Areas** • All roads with ADT between 15,000 and 30,000 vehicles
High	• High-use sites ◦ Includes roads with ADT > 30,000 vehicles • On-street parking areas of municipal streets in commercial and industrial areas • Highway rest areas • Other land uses with similar traffic/use characteristics (e.g., commercial buildings with a frequent turnover of visitors, such as grocery stores, shopping malls, restaurants, drive-through services, etc.)

Notes:

a. This table is applicable to designers intending to use the presumptive approach to identify the necessary level of treatment upstream of a UIC well. Designers for industrial sites with no outdoor processing, storage, or handling of raw or finished products may also use these tables.

b. This table is not applicable to stormwater runoff from industrial activities, outdoor processing, storage, or handling of raw or finished products; or areas where stormwater runoff comes into contact with leachate or other prohibited discharges.

Use the treatment capacity classification from Table C.2. Vadose Zone Treatment Capacity and the pollutant loading classification from Table C.3. Pollutant Loading Classifications for Solids, Metals, and Oil in Stormwater Runoff Directed to UIC Wells to determine the appropriate level of treatment for solids, oil, and metals in Table C.4. Treatment Required for Solids, Oil, and Metals.

Designers may use UIC wells to provide flow control of excess stormwater runoff for flows greater than the water quality design storm where pollutant concentrations that reach groundwater will meet Washington State groundwater quality standards; or where stormwater is adequately treated prior to discharge.

Table C.4. Treatment Required for Solids, Oil, and Metals

Pollutant Loading	Treatment Capacity			
	High	**Medium**	**Low**	**None**
Insignificant Two-stage drywell[a]		Two-stage drywella	Two-stage drywella	Two-stage drywell[a]
Low	Two-stage drywella	Pretreatmentb	Pretreatmentb	Remove solidsc
Medium	Pretreatmentb	Remove solidsc	Remove solidsc	Remove solidsc
High	Remove oild	Remove oild	Remove oil and solidsc,d	Remove oil and solidsc,d

Notes:

a. A two-stage drywell has a catch basin or other presettling device that traps small quantities of oils and solids. Regularly inspect and maintain the catch basin or other presettling device.

b. Pretreatment removes solids, but at a level less than basic treatment. Ecology's definition for pre- treatment is 50% removal and typically installed upstream of a UIC well.

c. Treatment to remove solids means basic treatment. Removal of solids removes a large portion of the total metals in most stormwater runoff. Any special treatment requirements in this chapter still apply. Owners may use appropriate source control BMPs for low-pollutant-loading sites, in lieu of structural treatment BMPs.

d. Treatment to remove oil is to be accomplished by applying one of the oil control BMPs identified in this manual. See Volume V, Section 10.6.1 for API (Baffle type) Separator and Coalescing Plate (CP) Separator.

- At high-density intersections and at commercial or industrial sites subject to an expected average daily traffic (ADT) count of 100 vehicles/1,000 sf gross building area, sufficient quantities of oil may be generated to justify operation of a separator BMP.
- At other high-use sites, project proponents may select a basic treatment BMP that also provides adsorptive capacity, such as a biofiltration or bioinfiltration swale, a filter, or other adsorptive technology, in lieu of a separator BMP. A catch basin with a turned down elbow is not adequate for oil control in this case.
- The requirement to apply a basic treatment BMP with adsorptive characteristics also applies to commercial parking and to streets with ADT > 7,500.

C.18 Site Suitability Criteria (SSC)

This section provides criteria that must be considered for siting infiltration BMPs. When a site investigation reveals that any of the applicable site suitability criteria cannot be met, appropriate mitigation measures must be implemented so that the infiltration BMP will not pose a threat to safety, health, and the environment.

For site selection and design decisions, a geotechnical and hydrogeologic report shall be

prepared by a licensed engineer in the state of Washington with geotechnical and hydrogeologic experience, or a licensed geologist, hydrogeologist, or engineering geologist. The designer may utilize a team of certified or registered professionals in soil science, hydrogeology, geology, and other related fields.

SSC-1 Setback Criteria

Setback requirements are generally required local regulations, uniform building code requirements, or other state regulations.

These setback criteria are provided as guidance:

- Stormwater infiltration BMPs should be set back at least 100 feet from drinking water wells, septic tanks or drainfields, and springs used for public drinking water supplies. Infiltration BMPs upgradient of drinking water supplies and within 1, 5, and 10-year time of travel zones must comply with Health Department requirements (WSDOH, 2010). Infiltration BMPs that qualify as Underground Injection Control Wells must comply with Chapter 173-218 WAC and the guidance in this appendix.
- Additional setbacks must be considered if roadway deicers or herbicides are likely to be present in the influent to the infiltration BMP.
- From building foundations: ≥ 20 feet downslope and ≥ 100 feet upslope
- From Native Growth Protection Easement (NGPE): ≥ 20 feet
- From the top of slopes >15%: ≥ 50 feet.
- Evaluate onsite and offsite structural stability due to extended subgrade saturation and/or head loading of the permeable layer, including the potential impacts to downgradient properties, especially on hills with known side-hill seeps.

SSC-2 Groundwater Protection Areas

A site is not suitable for an infiltration BMP if the infiltration BMP will cause a violation of Ecology's Ground Water Quality Standards (Chapter 173-200 WAC). See SSC-3 High Vehicle Traffic Areas through SSC-6 Soil Physical and Chemical Suitability for Treatment, and SSC-8 Cold Climate and Impact of Roadway Deicers for measures to protect groundwater quality. Local jurisdiction staff and local ordinances should be consulted for applicable pretreatment requirements if the project site is located in an aquifer sensitive area, sole source aquifer, wellhead protection area, or critical aquifer recharge area.

SSC-3 High Vehicle Traffic Areas

An infiltration BMP may be considered for runoff from areas that require an oil control BMP per Volume V, Chapter 2 – Treatment Facility Selection Process. For such applications, provide the oil control BMP upstream of the infiltration BMP to ensure that groundwater quality standards will not be violated and that the infiltration BMP is not adversely affected.

SSC-4 Soil Infiltration Rate/Drawdown Time

Infiltration Rates: measured (initial) and design (long-term)

For infiltration BMPs used for Runoff Treatment purposes, the measured (initial) soil infiltration rate shall be 9 in/hr or less (For Permeable Pavements, this rate can be 12 in/hr or less). Design (long-term) infiltration rates up to 3.0 inches/hour can also be considered, if the infiltration

receptor is not a sole-source aquifer, and in the judgment of the site professional, the treatment soil has characteristics comparable to those specified in SSC-6 Soil Physical and Chemical Suitability for Treatment to adequately control the target pollutants. Project sites with infiltration rates lower than those identified in the infeasibility criteria may be used for infiltration of stormwater if the local jurisdiction approves the design.

The design infiltration rate should also be used for maximum drawdown time and routing calculations.

Drawdown Time

For infiltration BMPs designed strictly for Flow Control purposes, there isn't a maximum drawdown time.

For infiltration BMPs designed to provide Runoff Treatment, document that the Water Quality Design Volume (as described in Volume V, Section 4.1 Design Volume and Flow) can infiltrate through the infiltration BMP surface within 48 hours. This can be calculated by multiplying the horizontal projection of the infiltration BMP mid-depth dimensions by the estimated design infiltration rate, and multiplying the result by 48 hours.

This drawdown restriction is intended to meet the following objectives:

- Aerate vegetation and soil to keep the vegetation healthy.
- Enhance the biodegradation of pollutants and organics in the soil.

Note: This is a check procedure, not a method for determining infiltration BMP size. If the design fails the check procedure, redesign the infiltration BMP.

SSC-5 Depth to Bedrock, Water Table, or Impermeable Layer

The base of infiltration basins or infiltration trenches shall be ≥ 5 feet above the seasonal high-water mark, bedrock (or hardpan) or other low permeability layer. A separation down to 3 feet may be considered if the groundwater mounding analysis, volumetric receptor capacity, and the design of the overflow and/or bypass structures are judged by the site professional to be adequate to prevent overtopping and meet the other site suitability criteria specified in this section.

SSC-6 Soil Physical and Chemical Suitability for Treatment

This SSC applies to infiltration BMPs that intend to use native soil to provide Runoff Treatment. If the native soils do not meet the criteria below, Runoff Treatment must be prior to infiltration either by a layer within the infiltration BMP (such is the case for Bioretention), a Runoff Treatment BMP upstream of the infiltration BMP, or a layer of engineered soil that meets the criteria below. Refer to Volume V, Chapter 2 – Treatment Facility Selection Process for guidance to determine the appropriate level of Runoff Treatment, based on land use and project type, that is necessary to precede the infiltration BMP.

Consider the soil texture and design infiltration rates along with the physical and chemical characteristics specified below to determine if the soil is adequate for removing the target pollutants. The following soil properties must be carefully considered in making such a determination:

- Cation exchange capacity (CEC) of the treatment soil must be ≥ 5 milliequivalents CEC/100 g dry soil (USEPA, 1986). Consider empirical testing of soil sorption capacity, if practicable. Ensure that soil CEC is sufficient for expected pollutant loadings, particularly heavy metals.

CEC values of > 5 meq/100g are expected in loamy sands (Buckman and Brady, 1969). Lower CEC content may be considered if it is based on a soil loading capacity determination for the target pollutants that is accepted by the local jurisdiction.

- Depth of soil used for infiltration Runoff Treatment must be a minimum of 18 inches. Depth of soil used for infiltration Runoff Treatment below Permeable Pavement that is a pollution-generating hard surface may be reduced to one foot if the permeable pavement does not accept runon from other surfaces.
- Organic Content of the treatment soil (ASTM D 2974): Organic matter can increase the sorptive capacity of the soil for some pollutants. A minimum of 1.0 percent organic content is necessary.
- Waste fill materials shall not be used as infiltration soil media nor shall such media be placed over uncontrolled or non-engineered fill soils.

Engineered soils may be used to meet these design criteria. Field performance evaluation(s), using protocols cited in this manual, would be needed to determine feasibility and acceptability by the local jurisdiction.

SSC-7 Seepage Analysis and Control

Determine whether there would be any adverse effects caused by seepage zones on nearby building foundations, basements, roads, parking lots or sloping sites.

SSC-8 Cold Climate and Impact of Roadway Deicers

Consider the potential impact of roadway deicers on potable water wells in the siting determination. Implement mitigation measures if the infiltration of roadway deicers could cause a violation of groundwater quality standards.

C.19 UIC Program Guidelines - Definitions

Groundwater Protection Area

The area surrounding a drinking water source evaluated as part of SSC-2 Groundwater Protection Areas that includes the wellhead protection area and may also include aquifer sensitive areas, sole source aquifers, groundwater management areas, or critical aquifer recharge areas.

Sanitary Control Area

The inner circle of a wellhead protection area maintained around a drinking water source to minimize direct contamination at the wellhead and reduce the possibility of surface flows reaching the wellhead and traveling down the casing (WAC 246-290-135).

Susceptibility

The ease with which contaminants can move from the land surface to the aquifer, based solely on the types of surface and subsurface materials in the area. Susceptibility usually defines the rate at which a contaminant will reach an aquifer unimpeded by chemical interactions with the vadose zone media.

Susceptibility Drinking Water Source

Sources rated highly susceptible by DOH and any drinking water source where a deep injection well will be placed within a groundwater protection area.

Vulnerability

Vulnerability is a water source's potential for contamination. Two factors influence vulnerability:

- Physical susceptibility to contaminant infiltration. Susceptibility depends on conditions that affect the movement of contaminants from the land surface into a water supply. This includes the depth of the well, its construction, the geology of the area, the pumping rate, the source(s) of groundwater recharge, and the aquifer material.

The source's risk of exposure to contaminants. The risk of exposure is measured by determining whether contaminants were used in the water supply area. However, each type of contaminant may behave differently in the environment, making it difficult to predict groundwater pollution from surface exposure accurately. For this reason, susceptibility is the key factor used in determining vulnerability. See Washington State Wellhead Protection Program Guidance Document (WSDOH, 2010).

Wellhead Protection Area

The area surrounding a drinking water source that is focused on protection from potential contamination that typically includes four or five zones: a sanitary control area, Zone 1 (1-year travel time), Zone 2 (5-year travel time), Zone 3 (10-year travel time), and an additional buffer zone (if warranted) (WAC 246-290-130 and WAC 246-290-135).

Glossary, Acronyms, and Notations

Glossary

The following terms are provided for reference and use with this manual.

Absorption	The penetration of a substance into or through another, such as the dissolving of a soluble gas in a liquid.
Administrator	See Director.
Adsorption	The adhesion of a substance to the surface of a solid or liquid often used to extract pollutants by causing them to be attached to such adsorbents as activated carbon or silica gel. Hydrophobic, or water-repulsing adsorbents, are used to extract oil from waterways when oil spills occur. Heavy metals such as zinc and lead often adsorb onto sediment particles.
Aeration	The process of being supplied or impregnated with air. In waste treatment, the process used to foster biological and chemical purification. In soils, the process by which air in the soil is replenished by air from the atmosphere. In a well-aerated soil, the soil air is similar in composition to the atmosphere above the soil. Poorly aerated soils usually contain a much higher percentage of carbon dioxide and a correspondingly lower percentage of oxygen.
Aerobic	Living or active only in the presence of free (dissolved or molecular) oxygen.
Agricultural Activities	The normal actions associated with the production of crops such as: plowing, cultivating, minor drainage, and harvesting, and/or raising or keeping of livestock, including operation and maintenance of farm and stock ponds, drainage ditches, irrigation systems, and normal operation, maintenance, and repair of existing serviceable agricultural structures, facilities, or improved areas. The term “agricultural activities” as used within this Title does not include the practice of aquaculture. Forest practices regulated under Chapter 76.09 RCW and Title 222 WAC are not included in this definition.
Algal Bloom	Proliferation of living algae on the surface of lakes, streams, or ponds often stimulated by phosphate over-enrichment. Algal blooms reduce the oxygen available to other aquatic organisms.
American Association of State Highway and Transportation Officials (AASHTO) Classification	The official classification of soil materials and soil aggregate mixtures for highway construction, used by the American Association of State Highway and Transportation Officials.
American Public Works Association (APWA)	The Washington State Chapter of the American Public Works Association.
Anti-Seep Collar	A device constructed around a pipe or other conduit and placed through a dam, levee, or dike for the purpose of reducing seepage losses and piping failures.
Applicant	Means the person, party, firm, corporation, or other legal entity that proposes to develop property in unincorporated Pierce County by submitting an application for any of the activities covered by these Regulations.

Appurtenances	Machinery, appliances, or auxiliary structures attached to a main structure, but not considered an integral part thereof, for the purpose of enabling it to function.
Aquifer	A geologic stratum containing groundwater that can be withdrawn and used for human purposes, and must be protected from pollutants.
Areas of Special Flood Hazard	Critical Area regulated per PCC 18E. Land in a floodplain within Pierce County subject to a 1 percent or greater chance of flooding in any given year. Designations on FEMA maps will include the letter "A" or "V." Areas of Special Flood Hazard will also include "shaded X" zones (formerly called "B" zones by FEMA).
As-Built Drawings	As-constructed engineering plans that include all changes made to a project during construction and submitted to the County. All drawing changes shall be made by a professional engineer or land surveyor. Also referred to as record drawings.
Assessed Value	The value of the existing improvements excluding land as listed in current records at the Pierce County Assessor's Office. Alternately, the applicant may provide current appraisal information and request that it be substituted for the Assessor's records.
Assignment of Funds	Retention of funds by a bank to guarantee that work is completed in compliance with Pierce County requirements.
Average Daily Traffic	Means the general unit of measurement for traffic defined as the total volume during a given time period (in whole days) greater than 1 day and less than 1 year divided by the number of days in that time period.
Background	A description of pollutant levels arising from natural sources, and not because of man's immediate activities.
Backwater	Water upstream from an obstruction or conveyance roughness that is deeper than it would normally be without the obstruction or roughness.
Baffle	A device to check, deflect, or regulate flow.
Base Flood	The flood having a 1 percent chance of being equaled or exceeded in any given year, also referred to as the "100-year flood."
Base Flood Elevation (BFE)	The water surface elevation, in feet, above mean sea level for the base flood and referenced to the North American Vertical Datum of 1988.
Baseline sampling	Sampling performed to define the existing environmental and biological conditions present before any modification occurs.
Basin	An area from which surface runoff is concentrated, usually to a single point such as the mouth of a stream.
Bedrock	The more or less solid rock in place either on or beneath the surface of the earth. It may be soft, medium, or hard and have a smooth or irregular surface.
Bench	Means a relatively level step excavated into natural earth or fill material.
Berm	A constructed barrier typically made of compacted earth, rock, or gravel. In a stormwater facility, a berm may serve as a vertical divider.
Best Management Practice (BMP)	The schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices, that when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to waters of Washington.

Biochemical Oxygen Demand (BOD)	An indirect measure of the concentration of biologically degradable materials present in organic wastes. Also called biological oxygen demand.
Biodegradable	Capable of being readily broken down by biological means, especially by microbial action.
Bioengineering	The combination of biological, mechanical, and ecological concepts (and methods) to control erosion and stabilize soil with vegetation or in combination with natural and synthetic construction materials.
Biofilter	A designed treatment facility using a combined soil and vegetation system for filtration, infiltration, adsorption, and biological uptake of pollutants in stormwater when runoff flows over and through the facility. Vegetation growing in these facilities acts as both a physical filter, which causes gravity settling of particulates by regulating velocity of flow, and as a biological sink when direct uptake of dissolved pollutants occurs.
Biofiltration	The process of reducing pollutant concentrations in water by filtering the polluted water through biological materials.
Biological Control	A method of controlling pest organisms by means of introduced or naturally occurring predatory organisms, sterilization, the use of inhibiting hormones, or other means, rather than by mechanical or chemical means.
Bioretention Areas	Small-scale, shallow retention/detention facilities dispersed through the development site that utilize specific soil mixes and plant species to infiltrate and filter runoff from developed sites.
Bioretention BMP	Engineered facilities that store and treat stormwater by passing it through a specified soil profile, and either retain or detain the treated stormwater for flow attenuation. Refer to Section 3.4 of Volume III for Bioretention BMP types and design specifications.
Bollard	A post (may or may not be removable) used to prevent vehicular access.
Bond	A surety bond to guarantee that work is completed in compliance with Pierce County requirements.
Buffer	The zone contiguous with a sensitive area that is required for the continued maintenance, function, and structural stability of the sensitive area.
Building Setback Line	A line measured parallel to a property, easement, drainage facility, or buffer boundary, that delineates the area (defined by the distance of separation) where buildings or other obstructions are prohibited.
Catch Basin	A chamber or well, usually built at the curb line of a street, for the admission of surface water to a stormwater drainage system, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.
Catch line	The point where a steeper slope intercepts a different, gentler slope.
Catchment	Surface drainage area or basin.

Cation Exchange Capacity (CEC)	Cations are positively charged ions such as calcium (Ca2+), magnesium (Mg2+), and potassium (K+), sodium (Na+) hydrogen (H+), aluminum (Al3+), iron (Fe2+), manganese (Mn2+), zinc (Zn2+) and copper (Cu2+). The capacity of the soil to hold on to these cations called the cation exchange capacity (CEC). Units are milli-equivalents per 100 g of soil, typically abbreviated simply as meq. Soil found to have a CEC of 5 meq at pH 7 will have CEC < 5 meq when pH < 7.
Certification	Means a written engineering opinion, stamped, signed, and dated by an engineer, concerning the progress or completion of work.
Certified Erosion and Sediment Control Lead (CESCL)	An individual who has current certification through an approved erosion and sediment control training program that meets the minimum training standards established by the Department (see BMP C160 in the *Stormwater Management Manual for Western Washington*). A CESCL is knowledgeable in the principles and practices of erosion and sediment control. The CESCL must have the skills to assess site conditions and construction activities that could impact the quality of stormwater and, the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges. Certification is obtained through an Ecology approved erosion and sediment control course. Course listings are provided online at Ecology's website.
Channel	A feature that conveys surface water and is open to the air.
Channel, Constructed	Channels or ditches constructed (or reconstructed natural channels) to convey surface water.
Channel, Natural	Streams, creeks, or swales that convey surface/groundwater and have existed long enough to establish a stable route and/or biological community.
Channelization	Alteration of a stream channel by widening, deepening, straightening, cleaning, or paving certain areas to change flow characteristics.
Check Dam	Small dam constructed in a channel or other small watercourse to decrease the streamflow velocity, minimize channel scour, and promote deposition of sediment.
Chemical Oxygen Demand (COD)	A measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water. The COD test, like the BOD test, is used to determine the degree of pollution in water.
Civil Engineer	see professional engineer
Civil Engineering	The application of the knowledge of the forces of nature, principles of mechanics and the properties of materials to the evaluation, design and construction of civil works for the beneficial uses of mankind.
Clearing	The destruction and/or removal of vegetation by manual, mechanical, or chemical methods
Closed Depression	An area which is low-lying and either has no, or such a limited, surface water outlet that during storm events the area acts as a retention basin or pothole area.
Cluster Subdivision	A form of development that permits a reduction in lot area, setbacks, and the arrangement of lots such that there is no increase in the number of lots permitted under a conventional subdivision or increase in the overall density of development. The remaining land area is devoted to open space, active recreation, preservation of sensitive areas, or agriculture.

Cohesion	The capacity of a soil to resist shearing stress, exclusive of functional resistance.
Coliform Bacteria	Microorganisms common in the intestinal tracts of man and other warm-blooded animals; all the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35 degrees Celsius. Used as an indicator of bacterial pollution.
Compaction	The densification, settlement, or packing of soil in such a way that permeability of the soil is reduced. Compaction effectively shifts the performance of a hydrologic group to a lower permeability hydrologic group. Compaction may also refer to the densification of a fill by mechanical means.
Compost	Organic material that has undergone biological degradation and transformation under controlled conditions designed to promote aerobic decomposition at a solid waste facility in compliance with the requirements of Chapter 173-350 WAC, or biosolids composted in compliance with Chapter 173-308 WAC. Composting is a form of organic material recycling. Natural decay of organic solid waste under uncontrolled conditions does not result in composted material. (Note: Various BMPs have restrictions on the percentage of biosolids in compost, or do not allow biosolids in compost.)
Comprehensive Planning	Planning that takes into account all aspects of water, air, and land resources and their uses and limits.
Conservation District	A public organization created under state enabling law as a special-purpose district to develop and carry out a program of soil, water, and related resource conservation, use, and development within its boundaries, usually a subdivision of state government with a local governing body and always with limited authority. Often called a soil conservation district or a soil and water conservation district.
Constructed Wetland	Those wetlands intentionally created on non-wetland areas for the primary purpose of stormwater treatment and managed as such. Constructed wetlands are normally considered as part of the stormwater collection and treatment system and are subject to maintenance requirements. (These wetlands are not the same as wetlands created for mitigation purposes, which are viewed in the same manner as natural, regulated wetlands.)
Construction Stormwater Pollution Prevention Plan (SWPPP)	A document that describes the potential for pollution problems on a construction project, and explains and illustrates the measures to be taken on the construction site to control those problems.
Contour	An imaginary line on the surface of the earth connecting points of the same elevation.
Converted Vegetation (Areas)	The surfaces on a project site where native vegetation, pasture, scrub/shrub, or unmaintained non-native vegetation (e.g., Himalayan blackberry, scotch broom) are converted to lawn or landscaped areas, or where native vegetation is converted to pasture.
Conveyance	A mechanism for transporting water from one point to another, including but not limited to: pipes, ditches, channels, culverts, gutters, manholes, weirs, man-made and natural channels, water quality filtration systems, drywells, etc.

Conveyance system	The drainage facilities, both natural and man-made, which collect, contain, and provide for the flow of surface and stormwater from the highest points on the land down to a receiving water. The natural elements of the conveyance system include swales and small drainage courses, streams, rivers, lakes, and wetlands. The human-made elements of the conveyance system include gutters, ditches, pipes, channels, and most retention/detention facilities.
County, the	The jurisdictional boundaries of Pierce County, and the Pierce County Executive or authorized representative.
Critical Areas	As defined by PCC Title 18E, Development Regulations – Critical Areas.
Critical Tree Root Zone	The area surrounding the tree trunk where the roots of the tree should not be disturbed. The radius of the area is usually based on trunk diameter at diameter breast height and tree species.
Culvert	Pipe or concrete box structure that drains open channels, swales, or ditches under a roadway or embankment. Typically has no catch basins or manholes along its length.
Cut	Portion of land surface or area from which earth has been removed or will be removed by excavating; the depth below original ground surface to excavated surface.
Cut-and-Fill	Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.
Cut Slope	A slope formed by excavating overlying material to connect the original ground surface with a lower ground surface created by the excavation. A cut slope is distinguished from a bermed slope, which is constructed by importing soil to create the slope.
Dead Storage	The volume available in a depression in the ground below any conveyance system, or surface drainage pathway, or outlet invert elevation that could allow the discharge of surface and stormwater runoff.
Dedication	Is the deliberate appropriation of land by an owner for any general and public uses, reserving to himself no other rights than such as are compatible with the full exercise and enjoyment of the public uses to which the property has been devoted. The intention to dedicate land within a subdivision or short subdivision shall be evidenced by the owner by the presenting for filing a final plat or short plat showing the dedication thereon; and the acceptance by the public shall be evidenced by the approval of such plat for filing by the appropriate governmental unit. See RCW 58.17.020(3).
Deep and/or Fast-Flowing Water	A combination of water depth and/or velocity as shown in the graph in PCC Chapter 18E.70. For the purposes of this Title, Pierce County will also consider deep and/or fast-flowing water to be a floodway area.
Degradation	The breakdown (biological or chemical) of complex organic or other chemical compounds into simpler substances, usually less harmful than the original compound, as with the degradation of a persistent pesticide. The (geological) wearing down by erosion. The lowering of the water quality of a watercourse by an increase in the pollutant loading.

Degraded (Disturbed) Wetland (Community)	A wetland (community) in which the vegetation, soils, and/or hydrology have been adversely altered, resulting in lost or reduced functions and values. Generally, implies topographic isolation; hydrologic alterations such as hydroperiod alteration (increased or decreased quantity of water), diking, channelization, and/or outlet modification; soils alterations such as presence of fill, soil removal, and/or compaction; accumulation of toxicants in the biotic or abiotic components of the wetland; and/or low plant species richness with dominance by invasive weedy species.
Design Engineer	See professional engineer
Design Storm (Design Event)	A prescribed hyetograph and total precipitation amount (for a specific duration recurrence frequency) used to estimate runoff for a hypothetical storm of interest or concern for the purposes of analyzing existing drainage, designing new drainage facilities or assessing other impacts of a proposed project on the flow of surface water.
Design Year Average Daily Traffic	The planned average daily traffic five years after the road is scheduled to be built.
Detention	The release of stormwater runoff from the site at a slower rate than it is collected by the stormwater facility system, the difference being held in temporary storage.
Detention Facility	An above or below ground facility, such as a pond or tank, that temporarily stores stormwater runoff and subsequently releases it at a slower rate than it is collected by the drainage facility system. There is little or no infiltration of stored stormwater.
Detention Pond	A detention facility in the form of an open pond.
Detention Time	The theoretical time required to displace the contents of a stormwater treatment facility at a given rate of discharge (volume divided by rate of discharge).
Developer	The person or legal entity who holds title to the property or has a sufficient interest in the project to propose the project. The developer of the project.
Development	Any man-made change to improved or unimproved real estate including, but not limited to, buildings or other structures, placement of manufactured home/mobile home, mining, dredging, clearing, filling, grading, paving, excavation, drilling operations, or the subdivision of property. See also the definitions for new development, redevelopment, and land disturbing activities.
Director	The Director of Planning and Public Works , or their designees, as necessary to ensure compliance with these Regulations, unless explicitly referenced otherwise.
Discharge	Runoff leaving a new development or redevelopment via overland flow, built conveyance systems, or infiltration facilities. A hydraulic rate of flow, specifically fluid flow; a volume of fluid passing a point, per unit of time, commonly expressed as cubic feet per second, cubic meters per second, gallons per minute, gallons per day, or millions of gallons per day.
Discharge Point	The location where a discharge leaves the County's MS4 through MS4 facilities/BMPs designed to infiltrate.

Dispersed Discharge (Dispersion)	The release of surface and stormwater runoff such that the flow spreads over a wide area and is located so as not to allow flow to concentrate anywhere upstream of a drainage channel with erodible underlying granular soils.
Disturbed Area	An area inside project boundaries altered from its natural state.
Disturbed Soils	An area inside the project boundaries where the soils have reduced infiltration, retention, and soil permeability than what would be present in a forested or prairie state due to previous development or land use.
Ditch	A long narrow excavation dug in the earth for drainage with its top width less than 10 feet at design flow.
Drain	A buried pipe or other conduit (closed drain). A ditch (open drain) for carrying off surplus surface water or groundwater.
(To) Drain	To provide channels, such as open ditches or closed drains, so that excess water can be removed by surface flow or by internal flow. To lose water (from the soil) by percolation.
Drainage	Refers to the collection, conveyance, containment, and/or discharge of surface and stormwater runoff.
Drainage Basin	A geographic and hydrologic subunit of a watershed.
Drainage Channel	A drainage pathway with a well-defined bed and banks indicating frequent conveyance of surface and stormwater runoff.
Drainage Course	A pathway for watershed drainage often intermittent in flow.
Drainage Easement	A legal encumbrance that is placed against a property's title to reserve specified privileges for the users and beneficiaries of the drainage facilities contained within the boundaries of the easement.
Drainage Pathway	The route that surface and stormwater runoff follows downslope as it leaves any part of the site.
Drainage Review	An evaluation by the County of a proposed project's compliance with the drainage requirements in this manual or its technical equivalent.

Drainage, Soil	As a natural condition of the soil, soil drainage refers to the frequency and duration of periods when the soil is free of saturation; for example, in well-drained soils the water is removed readily but not rapidly; in poorly drained soils the root zone is waterlogged for long periods unless artificially drained, and the roots of ordinary crop plants cannot get enough oxygen; in excessively drained soils the water is removed so completely that most crop plants suffer from lack of water. Strictly speaking, excessively drained soils are a result of excessive runoff due to steep slopes or low available water-holding capacity due to small amounts of silt and clay in the soil material. The following classes are used to express soil drainage: Well drained - Excess water drains away rapidly and no mottling occurs within 36 inches of the surface. Moderately well drained - Water is removed from the soil somewhat slowly, resulting in small but significant periods of wetness. Mottling occurs between 18 and 36 inches. Somewhat poorly drained - Water is removed from the soil slowly enough to keep it wet for significant periods but not all of the time. Mottling occurs between 8 and 18 inches. Poorly drained - Water is removed so slowly that the soil is wet for a large part of the time. Mottling occurs between 0 and 8 inches. Very poorly drained - Water is removed so slowly that the water table remains at or near the surface for the greater part of the time. There may also be periods of surface ponding. The soil has a black to gray surface layer with mottles up to the surface.
Drainage System	Refers to the combination of BMPs, collection, conveyance, retention, detention, treatment and outfall features or structures on a project.
Drawdown	Lowering of the water surface (in basins or open channel flow), water table or piezometric surface (in groundwater flow) resulting from a withdrawal of water.
Driveway	A vehicle driving surface within a single lot or parcel that connects a building or structure with a road, shared access facility, alley, or vehicle driving surface within an ingress/egress easement (or tract). A driveway begins at the right-of-way line, private road easement (or tract) line, shared access easement (or tract) line, alley easement (or tract) line, or ingress/egress easement (or tract) line, and extends to the building or structure.
Driveway Approach	A privately maintained vehicle driving surface that provides a transition between a road and a driveway, a road and a shared access facility, or a road and an alley.
Drop Structure	A structure for dropping water to a lower level and dissipating its surplus energy; a fall. A drop may be vertical or inclined.
Earth / Earth Material	Means naturally occurring rock, soil, stone, dirt, or a combination thereof.
Earthwork	Means any operation involving the excavation, grading, filling, or moving of earth materials.
Easement	The legal right to use a described piece of land for a particular purpose. It does not include fee ownership, but may restrict the owner's use of the land. All easements granted pursuant to the manual shall be legally recorded with the County Auditor.

Effective Impervious Surface	Those impervious surfaces that are connected via sheet flow or discrete conveyance to a drainage system. See also "Ineffective Impervious Surface."
Embankment	A structure of earth, gravel, or similar material raised to form a pond bank or foundation for a road, building pad, or similar fill for a particular use.
Emergency Spillway	A channel used to safely convey flood discharges in excess of the capacity of the principal outlet, or in the event of a failure of the outlet to function as designed, e.g. a blockage.
Emergent Plants	Aquatic plants that are rooted in the sediment but whose leaves are at or above the water surface. These wetland plants often have high habitat value for wildlife and waterfowl, and can aid in pollutant uptake.
Emerging Technology	Treatment technologies that have not been evaluated with approved protocols, but for which preliminary data indicate that they may provide a necessary function(s) in a stormwater treatment system. Emerging technologies need additional evaluation to define design criteria to achieve, or to contribute to achieving, state performance goals, and to define the limits of their use.
Energy Dissipater	Any means by which the total energy of flowing water is reduced. In stormwater design, they are usually mechanisms that reduce velocity prior to, or at, discharge from an outfall in order to prevent erosion. They include rock splash pads, drop manholes, concrete stilling basins or baffles, and check dams.
Energy Gradient	The slope of the specific energy line (i.e., the sum of the potential and velocity heads).
Engineer	A professional engineer currently licensed in the State of Washington in civil engineering, retained by and acting on behalf of the applicant. The term "engineer" also means design engineer and project engineer.
Engineered Soil	This is a self-sustaining soil and plant system that simultaneously supports plant growth, soil microbes, water infiltration, nutrient and pollutant adsorption, sediment and pollutant biofiltration, water interflow, and pollution decomposition. The system shall be protected from compaction and erosion. The system shall be planted and/or mulched as part of the installation.
Enhancement	Actions performed to improve the condition of existing critical areas and/or buffers so that the quality of their functions or values are increased (e.g., increasing plant diversity, increasing fish and wildlife habitat, installing environmentally compatible erosion controls, removing non-indigenous plant or animal species, removing fill material or solid waste).
Environmental Impact Statement (EIS)	A document that discusses the likely significant adverse impacts of a proposal, ways to lessen the impacts, and alternatives to the proposal. They are required by the national and state environmental policy acts when projects are determined to have significant environmental impact.
Environmentally Sensitive Area (Sensitive Area)	See Critical Areas PCC title 18E.

Erodible Granular Soils	Soil materials that are easily eroded and transported by running water, typically fine or medium grained sand with minor gravel, silt, or clay content. Such soils are commonly described as Everett or Indianola series soil types in the SCS classification. Also included are any soils showing examples of existing severe stream channel incision as indicated by unvegetated stream banks standing over 2 feet high above the base of the channel.
Erodible or leachable materials	Wastes, chemicals, or other substances that measurably alter the physical or chemical characteristics of runoff when exposed to rainfall. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage.
Erosion	The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. Also, detachment and movement of soil or rock fragments by water, wind, ice, or gravity. The following terms are used to describe different types of water erosion: Accelerated erosion – Erosion much more rapid than normal or geologic erosion, primarily from the influence of the activities of man or, in some cases, of the animals or natural catastrophes that expose bare surfaces (e.g., fires). Geological erosion – The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing of mountains, the building up of floodplains, coastal plains, etc. Synonymous with natural erosion. Gully erosion – The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, ranging from 1 to 2 feet to as much as 75 to 100 feet. Natural erosion – Wearing away of the earth's surface by water, ice, or other natural agents under natural environmental conditions of climate, vegetation, etc., undisturbed by man. Synonymous with geological erosion. Normal erosion – The gradual erosion of land used by man that does not greatly exceed natural erosion. Rill erosion – An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently disturbed and exposed soils. See Rill. Sheet erosion – The removal of a fairly uniform layer of soil from the land surface by runoff. Splash erosion – The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may or may not be subsequently removed by surface runoff.
Erosion and Sediment Control Facility	A type of drainage facility designed to hold water for a period to allow sediment contained in the surface and stormwater runoff directed to the facility to settle out to improve the quality of the runoff.
Erosion and Sedimentation Control	Any temporary or permanent measures taken to reduce erosion; control siltation and sedimentation; and ensure that sediment-laden water does not leave the site.
Erosion and Sedimentation Control Plan	See Construction Stormwater Pollution Prevention Plan (SWPPP).
Erosive Soils	See Erodible Granular Soils.

Estuarine wetland	Generally, a vegetated wetland where the salinity of the surface or port waters is greater than 0.5 parts per thousand.
Estuary	A water passage where saltwater meets fresh water. Estuaries often contain saltmarshes and other wetlands, which are important habitat for many species.
Eutrophication	Refers to the process where nutrient over-enrichment of water leads to excessive growth of aquatic plants, especially algae.
Evapotranspiration	The collective term for the processes of evaporation and plant transpiration by which water is returned to the atmosphere.
Excavation	The mechanical removal of earth material.
Exfiltration	The downward movement of runoff through the bottom of an infiltration BMP into the soil layer or the downward movement of water through soil.
Existing Site Conditions	Existing site conditions may be described as follows: For previously developed sites with stormwater facilities that have been constructed to meet the standards of this manual, this shall mean the current conditions on the site. For previously developed sites that do not have stormwater facilities that meet the standards of this manual, existing site conditions shall be considered under redevelopment regulations For undeveloped sites, this shall mean the condition of the site prior to the influence of Euro-American settlement. The predeveloped condition shall be assumed to be forested land cover unless reasonable, historic information is provided that indicates the site was prairie prior to settlement. Exception: If the site is located in a critical and/or sensitive area that affects drainage as defined by county ordinances, the Director may require that a more restrictive definition of existing site conditions be utilized for calculating runoff characteristics.
Experimental Best Management Practice (BMP)	A BMP that has not been tested and evaluated by the Washington State Department of Ecology in collaboration with local governments and technical experts.
Fertilizer	Any material or mixture used to supply one or more of the essential plant nutrient elements.
Fill	"Fill or fill material" means the deposit of organic or inorganic material by human or mechanical means.
Filter Fabric	A woven or non-woven, water-permeable material generally made of synthetic products such as polypropylene and used in stormwater management and erosion and sedimentation control applications to trap sediment or prevent the clogging of aggregates by fine soil particles. See the WSDOT standard specifications and amendments, specifically, Section 9-33 Construction Geotextiles.
Filter Fabric Fence	A temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts, and entrenched. The filter fence is constructed of stakes and synthetic filter fabric with a rigid wire fence backing where necessary for support. Also commonly referred to in the Washington Department of Transportation standard specifications as "construction geotextile for temporary silt fences."
Filter Strip	A grassy area with gentle slopes that treats stormwater runoff from adjacent paved areas before it concentrates into a discrete channel.

Flocculation	The process by which suspended colloidal or very fine particles are assembled into larger masses or floccules that eventually settle out of suspension. This process occurs naturally but can also be caused by such chemicals as alum.
Flood	"Flood" or "flooding" means a general and temporary condition of partial or complete inundation of normally dry land areas from: (1) The overflow of inland or tidal waters, and/or (2) The unusual and rapid accumulation of runoff of surface waters from any source.
Flood Control	Methods or facilities for reducing flood risks and the extent of flooding.
Flood Frequency	The frequency with which the flood of interest may be expected to occur at a site in any average interval of years. Frequency analysis defines the "n-year flood" as being the flood that will, over a long period of time, be equaled or exceeded on the average once every "n" years.
Flood Fringe	The area subject to inundation by the base flood, but outside the limits of the floodway, and which may provide needed temporary storage capacity for flood waters.
Flood Hazard Areas	Those areas subject to inundation by the base flood. Includes, but is not limited to streams, lakes, wetlands, and closed depressions. Also referred to as special flood hazard areas.
Flood Insurance Rate Map (FIRM)	The official map on which the Federal Insurance Administration has delineated areas of special flood hazard and the risk premium zones applicable to Pierce County.
Flood Routing	An analytical technique used to compute the effects of system storage dynamics on the shape and movement of flow represented by a hydrograph.
Flood Stage	The stage at which overflow of the natural banks of a stream begins.
Floodplain	The total area subject to inundation by a flood including the flood fringe and floodway.
Floodway	The channel of a river, marine water, or other watercourse, and the adjacent land areas that must be reserved in order to convey and discharge the base flood without cumulatively increasing the water surface elevation by more than one foot, those areas designated as deep and/or fast-flowing water, and Channel Migration Zones where detailed CMZ studies have been adopted by Pierce County.
Flow Control BMP (or facility)	A drainage facility designed to mitigate the impacts of increased surface and stormwater runoff flow rates generated by development. Flow control facilities are either designed to hold water for a considerable length of time and then release it by evaporation, plant transpiration, and/or infiltration into the ground, or designed to hold runoff for a short period, releasing it to the conveyance system at a controlled rate.
Flow duration	The aggregate time that peak flows are at or above a particular flow rate of interest. For example, the amount of time that peak flows are at or above 50 percent of the 2-year recurrence interval peak flow rate for a period of record.
Flow Frequency	The inverse of the probability that the flow will be equaled or exceeded in any given year (the exceedance probability). For example, if the exceedance probability is 0.01 or 1 in 100, that flow is referred to as the 100-year recurrence interval flow.

Flow Path	The route that surface water follows between two points of interest.
Forebay	An easily maintained, extra storage area provided near an inlet of a BMP to trap incoming sediments before they accumulate in a pond or wetland BMP.
Forest Practice	Any activity conducted on or directly pertaining to forest land and relating to growing, harvesting, or processing timber, including but not limited to: Road and trail construction, Harvesting, final and intermediate, Precommercial thinning, Reforestation, Fertilization, Prevention and suppression of diseases and insects, Salvage of trees, Brush control.
Forest Practices Permit	A permit issued by the County under PCC Title 18H or WDNR for the removal of timber and construction of necessary roads.
Forested Wetlands	In general terms, communities (wetlands) characterized by woody vegetation that is greater than or equal to 6 meters in height; in this manual the term applies to such communities (wetlands) that represent a significant amount of tree cover consisting of species that offer wildlife habitat and other values and advance the performance of wetland functions overall.
Freeboard	The vertical distance between the highest designed water surface elevation and the elevation of the crest of the facility. For example, in pond design, freeboard is the vertical distance between the emergency overflow water surface and the top of the pond embankment. In floodplain management it's the vertical distance between the base flood elevation and lowest floor or support of a structure.
Frequency Of Storm (Design Storm Frequency)	The anticipated period in years that will elapse, based on average probability of storms in the design region, before a storm of a given intensity and/or total volume will recur; thus a 10 recurrence interval storm can be expected to occur on the average once every 10 years. Conveyances designed to handle flows that occur under such storm conditions would be expected to be surcharged by any storms of greater amount or intensity.
Functions	The ecological (physical, chemical, and biological) processes or attributes of a wetland. Functions are often defined in terms of the processes that provide value to society, but they can be defined on processes that are not value based. Wetland functions include food chain support, provision of ecosystem diversity and fish and wildlife habitat, flood flow alteration, groundwater recharge and discharge, water quality improvement, and soil stabilization.
Gabion	A rectangular or cylindrical wire mesh cage filled with rock and used as a protecting agent, revetment, etc., against erosion. Soft gabions, often used in streambank stabilization, are made of geotextiles filled with dirt, in between which cuttings are placed.
Gauge	A measuring device for registering precipitation, water level, discharge, velocity, pressure, temperature, etc. Also, a measure of the thickness of metal.
Geologist	A person currently licensed and registered in the State of Washington as a licensed geologist per WAC 308-15.
Geometrics	The mathematical relationships between points, lines, angles, and surfaces used to measure and identify areas of land.

Geotechnical Professional	A person with experience and training in analyzing, evaluating, and mitigating any of the following: landslide, erosion, seismic, and/or mine hazards, or fluvial geomorphology and river dynamics. A geotechnical professional shall be licensed in the State of Washington as an engineering geologist or professional engineer. Per Washington Administrative Code 308-15-140 and 196-27-020, engineering geologists and professional engineers shall affix their signatures or seals only to plans or documents dealing with subject matter in which they are qualified by training or experience.
Geotechnical Professional Civil Engineer	A practicing, geotechnical/civil engineer licensed as a professional Civil Engineer with the State of Washington who has at least 4 years of professional employment as a geotechnical engineer in responsible charge, including experience with landslide evaluation.
Grade	The slope of a road, channel, or natural ground. The finished surface of a canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared for the support of construction such as paving or the laying of a conduit.
(To) Grade	To finish the surface of a ditch, roadbed, top of embankment or bottom of excavation.
Gradient Terrace	An earth embankment or a ridge-and-channel constructed with suitable spacing and an acceptable grade to reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a stable nonerosive velocity.
Grading	Any excavating, filling, clearing, or creating of hard surfaces or combination thereof.
Grassed Waterway	A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from an area at a reduced flow rate. See also biofilter.
Groundwater	Water in a saturated zone or stratum beneath the land surface or a surface water body.
Groundwater Recharge	Inflow to a groundwater reservoir.
Groundwater Table	The free surface of the groundwater, that surface subject to atmospheric pressure under the ground, generally rising and falling with the season, the rate of withdrawal, the rate of restoration, and other conditions. It is seldom static.
Grubbing	Means the removal and disposing of all unwanted vegetative matter from underground, such as sod, stumps, roots, buried logs, or other debris.
Gully	A channel caused by the concentrated flow of surface and stormwater runoff over unprotected erodible land.
Habitat	The specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all of the basic requirements for life and should be protected from harmful biological, chemical, and physical alterations.
Hardpan	A cemented or compacted and often clay-like layer of soil that is impenetrable by roots. Also known as glacial till.
Hard Surface	An impervious surface, a permeable pavement, or a vegetated roof.

Harmful Pollutant	A substance that has adverse effects to an organism including immediate death, chronic poisoning, impaired reproduction, cancer or other effects.
Head (Hydraulics)	The height of water above any plane of reference. The energy, either kinetic or potential, possessed by each unit weight of a liquid, expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed. Used in various compound terms such as pressure head, velocity head, and head loss.
Head Loss	Energy loss due to friction, eddies, changes in velocity, or direction of flow.
Heavy Metals	Metals of high specific gravity, present in municipal and industrial wastes that pose long-term environmental hazards. Such metals include antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, thallium, and zinc.
High-Use Site	High-use sites are those that typically generate high concentrations of oil due to high traffic turnover or the frequent transfer of oil. High-use sites include: An area of a commercial or industrial site subject to an expected average daily traffic count equal to or greater than 100 vehicles per 1,000 square feet of gross building area; An area of a commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, not including routinely delivered heating oil; An area of a commercial or industrial site subject to parking, storage or maintenance of 25 or more vehicles that are over 10 tons gross weight (trucks, buses, trains, heavy equipment, etc.); A road intersection with a measured count of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway, excluding projects proposing primarily pedestrian or bicycle use improvements.
Hog Fuel	See wood-based mulch.
Humus	Organic matter in or on a soil, composed of partly or fully decomposed bits of plant tissue or from animal manure.
Hydraulic Conductivity	The quality of saturated soil that enables water or air to move through it. Also known as permeability coefficient
Hydraulic Gradient	Slope of the potential head relative to a fixed datum.
Hydrodynamics	The science involving the energy and forces acting on water or other liquids and the resulting impact on the motion of the liquid.
Hydrograph	A graph of runoff rate, inflow rate or discharge rate, past a specific point over time.
Hydrologic Cycle	The circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages or processes as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.

Hydrologic Soil Groups	A soil characteristic classification system defined by the SCS in which a soil may be categorized into one of four soil groups (A, B, C, or D) based upon infiltration rate and other properties. **Type A:** Low runoff potential. Soils having high infiltration rates, even when thoroughly wetted, and consisting chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission **Type B:** Moderately low runoff potential. Soils having moderate infiltration rates when thoroughly wetted, and consisting chiefly of moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. **Type C:** Moderately high runoff potential. Soils having slow infiltration rates when thoroughly wetted, and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. These soils have a slow rate of water transmission. **Type D:** High runoff potential. Soils having very slow infiltration rates when thoroughly wetted, and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan, till, or clay layer at or near the surface, soils with a compacted subgrade at or near the surface, and shallow soils or nearly impervious material. These soils have a very slow rate of water transmission (Novotny and Olem 1994).
Hydrological Simulation Program—Fortran (HSPF)	A continuous simulation hydrologic model that transforms an uninterrupted rainfall record into a concurrent series of runoff or flow data by means of a set of mathematical algorithms that represent the rainfall-runoff process at some conceptual level.
Hydrology	The science of the behavior of water in the atmosphere, on the surface of the earth, and underground.
Hydroperiod	A seasonal occurrence of flooding and/or soil saturation; it encompasses depth, frequency, duration, and seasonal pattern of inundation.
Hyetograph	A graph percentages of total precipitation for a series of time steps representing the total time in which the precipitation occurs.
Illicit Discharge	All non-stormwater discharges to stormwater drainage systems that cause or contribute to a violation of state water quality, sediment quality or groundwater quality standards, including but not limited to sanitary sewer connections, industrial process water, interior floor drains, car washing, and greywater systems.
Impervious	A surface that cannot be easily penetrated. For instance, rain does not readily penetrate paved surfaces.
Impervious Surface	A non-vegetated surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. A non-vegetated surface area that causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, rooftops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam or other surfaces that similarly impede the natural infiltration of stormwater. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces for the purposes of determining whether the thresholds for application of minimum requirements are exceeded. Open, uncovered retention/detention facilities shall be considered impervious surfaces for purposes of runoff modeling.

Impoundment	A natural or man-made containment for surface water.
Improvement	Shall mean things or structures constructed for the benefit of all or some residents of the subdivision or the general public such as but not limited to roads, alleys, stormwater drainage systems and ditches, sanitary sewer pipes or main lines, and storm drainage containment facilities. Streets (with or without curbs or gutters), sidewalks, crosswalks, parking lots, water mains, sanitary and storm sewers, drainage facilities, street trees and other appropriate items.
Industrial Activities	Material handling, transportation, or storage; manufacturing; maintenance; treatment; or disposal. Areas with industrial activities include plant yards, access roads and rail lines used by carriers of raw materials, manufactured products, waste material, or by-products; material handling sites; refuse sites; sites used for the application or disposal of process wastewaters; sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to stormwater.
Ineffective Impervious Surfaces	Impervious surfaces are considered ineffective if: 1) the runoff is dispersed through at least one hundred feet of native vegetation in accordance with Full Dispersion as described in Volume III, Chapter 3; 2) residential roof runoff is infiltrated in accordance with Downspout Infiltration Systems Volume III, Chapter 3; or 3) approved continuous runoff modeling methods indicate that the entire runoff file is infiltrated.
Infiltration	Means the downward movement of water from the surface to the subsoil.
Infiltration Facility (or System)	A drainage facility designed to use the hydrologic process of surface and stormwater runoff soaking into the ground, commonly referred to as a percolation, to dispose of surface and stormwater runoff.
Infiltration Rate	The rate, usually expressed in inches/hour, at which water moves downward (percolates) through the soil profile. Short-term infiltration rates may be inferred from soil analysis or texture or derived from field measurements. Long-term infiltration rates are affected by variability in soils and subsurface conditions at the site, the effectiveness of pretreatment or influent control, and the degree of long-term maintenance of the infiltration facility.
Ingress/Egress	The points of access to and from a property.
Inlet	A form of connection between surface of the ground and a drain or MS4 for the admission of surface and stormwater runoff.
Insecticide	A substance, usually chemical, that is used to kill insects.
Interception (Hydraulics)	The process by which precipitation is caught and held by foliage, twigs, and branches of trees, shrubs, and other vegetation. Often used for "interception loss" or the amount of water evaporated from the precipitation intercepted.
Interflow	That portion of rainfall that infiltrates into the soil and moves laterally through the upper soil horizons until intercepted by a stream channel or until it returns to the surface, for example, in a roadside ditch, wetland, spring or seep. Interflow is a function of the soil system depth, permeability, and water-holding capacity.

Intermittent Stream	A stream where portions flow continuously only at certain times of the year, for example when it receives water from a spring, groundwater source or from a surface source, such as melting snow (i.e. seasonal). At low flow there may be dry segments alternating with flowing segments.
International Building Code (IBC)	The most recent version of the International Building Code adopted by Pierce County.
Invasive Species	Opportunistic plant species (either native or non-native) that colonize disturbed ecosystems and come to dominate the plant community in ways that are seen by us as reducing the values provided by the previous plant community. Most often, opportunistic plants are considered invasive if they reduce the value of an area as habitat for valuable species.
Invert	The lowest point on the inside of a pipe or other conduit.
Invert Elevation	The vertical elevation of a pipe or orifice in a pond that defines the water level.
Isopluvial Map	A map with lines representing constant depth of total precipitation for a given return frequency and duration.
Junction	Point where two or more drainage pipes or channels converge (e.g., manhole).
Jurisdiction	For purposes of this manual, a governmental body which has adopted this manual.
Lag Time	The interval between the center of mass of the storm precipitation and the peak flow of the resultant runoff.
Land-Disturbing Activity	Any activity that results in a change in the existing soil cover (both vegetative and nonvegetative) and/or the existing soil topography. Land disturbing activities include, but are not limited to clearing, grading, filling, and excavation. Compaction that is associated with stabilization of structures and road construction shall also be considered a land-disturbing activity. Vegetation maintenance practices, including landscape maintenance and gardening, are not considered land-disturbing activity. Stormwater facility maintenance is not considered land disturbing activity if conducted according to established standards and procedures
Landscape unit	An area of land that has a specified boundary used for planning purposes that defines an area of interrelated physical, chemical, and biological processes. A watershed or drainage basin is a common type of landscape unit. A groundwater aquifer is another type of landscape unit.
Landscaping	The improvement or installation on a parcel or portion thereof of objects or vegetation for decorative or ornamental effect. Examples include trees, bushes, shrubs, flowers, grass, weeds, ornamental rocks or figures, low-lying ground cover, sprinkler systems, sidewalks, and lighting fixtures.
Landslide	Episodic downslope movement of a mass of soil or rock that includes but is not limited to rockfalls, slumps, mudflows, and earthflows. For the purpose of these rules, snow avalanches are considered to be a special case of landsliding.
Large Lot	As defined by PCC Title 18 or the most recent version thereof.

Large Lot Divisions	Any number of divisions of land into lots, tracts or parcels for any purpose, each of which the smallest lot size is 5 acres or larger or 1/128 of a Section or larger. A tract created for the purpose of accommodating critical areas or infrastructure, and otherwise deemed unbuildable for a dwelling unit, shall be allowed and not subject to the size requirements prescribed above.
Lattice Block Pavement	A pavement, either cast in place or interlocking paving bricks, with interstices allowing infiltration and the growth of vegetation.
Leachable Materials	Those substances that, when exposed to rainfall, measurably alter the physical or chemical characteristics of the rainfall runoff. Examples include erodible soils, uncovered process wastes, manure, fertilizers, oil substances, ashes, kiln dust, and garbage dumpster leakage.
Leachate	Liquid that has percolated through soil and contains substances in solution or suspension.
Leaching	Water or other liquid that has been contaminated by dissolved or suspended materials due to contact with solid waste or gases.
Legume	A member of the legume or pulse family, *Leguminosae*, one of the most important and widely distributed plant families. Practically all legumes are nitrogen-fixing plants.
Level Pool Routing	The basic technique of storage routing used for sizing and analyzing detention storage and determining water levels for ponding water bodies. The level pool routing technique is based on the continuity equation: Inflow – Outflow = Change in storage.
Level Spreader	A device used to spread out stormwater runoff uniformly over the ground surface as sheet flow (i.e., not through channels). The purpose of level spreaders is to prevent concentrated, erosive flows from occurring, and to enhance infiltration.
Live Storage	The amount of storage in a stormwater facility that is intended to completely drain after a storm event.
Local Government	Any county, city, town, or special purpose district having its own incorporated government for local affairs.
Lot	A designated parcel, tract, or area of land established by plat, subdivision, or as otherwise permitted by law, to be used, developed, or built upon as a unit.
Low Flow Channel	An incised or paved channel from inlet to outlet in a dry basin that is designed to carry low runoff flows and/or base flow, directly to the outlet without detention.
Low Impact Development (LID)	A stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration by emphasizing conservation, use of onsite natural features, site planning, and distributed stormwater management practices that are integrated into a project design.
Low Impact Development (LID) Best Management Practices	Distributed stormwater management practices, integrated into a project design, that emphasize pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration. LID BMPs include, but are not limited to: bioretention, rain gardens, permeable pavements, roof downspout controls, dispersion, soil quality and depth, minimal excavation foundations, vegetated roofs, and water re-use.

Low Impact Development (LID) Principles	Land use management strategies that emphasize conservation, use of onsite natural features, and site planning to minimize impervious surfaces, native vegetation loss, and stormwater runoff.
Maintenance	Repair and maintenance includes activities conducted on currently serviceable structures, facilities, and equipment that involves no expansion or use beyond that previously existing and resulting in no significant adverse hydrologic impact. It includes those usual activities taken to prevent a decline, lapse, or cessation in the use of structures and systems. Those usual activities may include replacement of dysfunctional facilities, including cases where environmental permits require replacing an existing structure with a different type structure, as long as the functioning characteristics of the original structure are not changed. One example is the replacement of a collapsed, fish blocking, round culvert with a new box culvert under the same span, or width, of roadway. In regard to stormwater facilities, maintenance includes assessment to ensure ongoing proper operation, removal of built-up pollutants (i.e., sediments), replacement of failed or failing treatment media, and other actions taken to correct defects as identified in the maintenance checklists of Appendix I-A.
Manning's Equation	An equation used to predict the velocity of water flow in an open channel or pipelines: $V = \frac{1.486 R^{2/3} S^{1/2}}{N}$ where: V is the mean velocity of flow in feet per second R is the hydraulic radius in feet S is the slope of the energy gradient or, for assumed uniform flow, the slope of the channel in feet per foot; and N is Manning's roughness coefficient or retardance factor of the channel lining.
Manual, The	The Pierce County Stormwater Management and Site Development Manual including all amendments, corrections, and changes made through subsequent county ordinance.
Manufactured Home/ Mobile Home	A structure, transportable in one or more sections, which is built on a permanent chassis and is designed for use with or without a permanent foundation when connected to the required utilities.
Material	Any solid or semi-solid substance that displaces volume.
Metals	Elements, such as mercury, lead, nickel, zinc and cadmium, which are of environmental concern because they can be toxic to life in high enough concentrations and do not degrade over time. Although many are necessary nutrients, they are sometimes magnified in the food chain. They are also referred to as heavy metals.
Microbes	The lower trophic levels of the soil food web. They are normally considered to include bacteria, fungi, flagellates, amoebae, ciliates, and nematodes. These in turn support the higher trophic levels, such as mites and earthworms. Together they are the basic life forms that are necessary for plant growth. Soil microbes also function to bioremediate pollutants such as petroleum, nutrients, and pathogens.

Mitigation	Means, in the following order of preference: Avoiding the impact altogether by not taking a certain action or part of an action; Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts; Rectifying the impact by repairing, rehabilitating or restoring the affected environment; Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and Compensating for the impact by replacing, enhancing, or providing substitute resources or environments.
Modification, Modified (Wetland)	A wetland whose physical, hydrological, or water quality characteristics have been purposefully altered for a management purpose, such as by dredging, filling, forebay construction, and inlet or outlet control.
Monitor	To systematically and repeatedly measure something in order to track changes.
Monitoring	The collection of data by various methods for the purposes of understanding natural systems and features, evaluating the impacts of development proposals on such systems, and assessing the performance of mitigation measures imposed as conditions of development.
Mulch	A layer of organic material or aggregate applied to the surface of soil. Its purpose is any or all of the following: To conserve soil moisture or temperature To improve the fertility and health of the soil To reduce weed growth To hold fertilizer, seed, and soil in place To enhance the visual appeal of the area. Types of mulches used in this manual include: Chipped site vegetation, compost, hydromulch, wood-based or wood straw, wood strand, straw, and aggregate.
Municipality The	Pierce County government or any jurisdiction adopting this manual for control of stormwater quantity and quality.
National Environmental Policy Act (NEPA)	National Environmental Policy Act, a federal law.
National Pollutant Discharge Elimination System (NPDES)	The part of the Clean Water Act that requires point source dischargers to obtain permits. These permits are referred to as NPDES permits and, in Washington, are administered by the Washington State Department of Ecology.
Native Growth Protection Easement	An easement granted for the protection of native vegetation within a sensitive area or its associated buffer. The native growth protection easement shall be recorded on the appropriate documents of title and filed with the County Auditor.
Native Vegetation	Vegetation comprised of plant species, other than noxious weeds, that are indigenous to the coastal region of the Pacific Northwest and which reasonably could have been expected to naturally occur on the site.

Natural Buffer Area	A parcel or strip of land that is designated to remain permanently in an undisturbed and untouched condition. No building, clearing, filling, or grading is permitted within this area, except for minor firewood harvest and watercourse maintenance when applicable. Roads, septic tank drainfield areas, and reserved drainfield areas are not permitted in natural buffer areas.
Natural Channel	Stream, creek, river, lake, wetland, estuary, gully, swale, ravine, or any open conduit where water will concentrate and flow intermittently or continuously. Only includes manmade channels designed to mimic natural systems.
Natural Hydrologic Function	Refers to the processing of precipitation over and through the landscape in a forest or prairie condition. Includes evapotranspiration by onsite vegetation, storage of rainfall in the soil structure or on the soil surface within depressions in the topography, and the release of stormwater through either infiltration, interflow, or surface flow off the site.
Natural Location	The location of those channels, swales, and other non-manmade conveyance systems as defined by the first documented topographic contours existing for the subject property, from either maps or photographs, or such other means as appropriate. In the case of outwash soils with relatively flat terrain, no natural location of surface discharge may exist.
Nephlometric Turbidity Unit (NTU)	A measure of turbidity for stormwater.
New Development	Land disturbing activities, including Class IV general forest practices that are conversions from timber land to other uses; structural development, including construction or installation of a building or other structure; creation of hard surfaces; and subdivision, short subdivision and binding site plans, as defined and applied in Chapter 58.17 RCW. Projects meeting the definition of redevelopment shall not be considered new development. All other forest practices and commercial agriculture are not considered new development.
New Hard Surface	Hard surface created on or added to a site or structural development including construction, installation, or expansion of a building or other structure. Includes the addition of a hard or compacted surface like roofs, pavement, gravel, or dirt; or resurfacing by upgrading from dirt to gravel, asphalt, or concrete; upgrading from gravel to asphalt, or concrete; or upgrading from a bituminous surface treatment (“chip seal”) to asphalt or concrete. New hard surface may also include existing hard surface that is removed and replaced. To be considered new, the removal and replacement activity must result in changes in hard surface locations, grade, and/or drainage system features, and/or must involve construction, installation, or expansion of a building or structure after complete or substantial intentional demolition thereof by or for the benefit of the applicant.
Nitrate (NO3)	A form of nitrogen that is an essential nutrient to plants. It can cause algal blooms in water if all other nutrients are present in sufficient quantities. It is a product of bacterial oxidation of other forms of nitrogen, from the atmosphere during electrical storms and from fertilizer manufacturing.
Nitrogen, Available	Usually ammonium, nitrite, and nitrate ions, and certain simple amines available for plant growth. A small fraction of organic or total nitrogen in the soil is available at any time.

Nonpoint Source Pollution	Pollution that enters a water body from diffuse origins on the watershed and does not result from discernible, confined, or discrete conveyances.
NPDES	The National Pollutant Discharge Elimination System as established by the Clean Water Act.
NRCS Method	A single-event hydrologic analysis technique for estimating runoff based on the Curve Number method. The Curve Numbers are published by NRCS in Technical Release No. 55: Urban Hydrology for Small Watersheds, 1986. With the change in name to the Natural Resource Conservation Service, the method may be referred to as the NRCS Method.
Normal depth	The depth of uniform flow. This is a unique depth of flow for any combination of channel characteristics and flow conditions. Normal depth is calculated using Manning's Equation.
Nutrients	Essential chemicals needed by plants or animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and algal blooms. Some nutrients can be toxic at high concentrations.
Off-Line Facilities	Water quality treatment facilities to which stormwater runoff is restricted to some maximum flow rate or volume by a flow-splitter.
Offsite	Any area lying upstream of the site that drains onto the site and any area lying downstream of the site to which the site drains.
Off-System Storage	Facilities for holding or retaining excess flows over and above the carrying capacity of the stormwater conveyance system, in chambers, tanks, lagoons, ponds, or other basins that are not a part of the subsurface sewer system.
Oil/Water Separator	A vault, usually underground, designed to provide a quiescent environment to separate oil from water.
On-Line Facilities	Water quality treatment facilities that receive all of the stormwater runoff from a drainage area. Flows above the water quality design flow rate or volume are passed through at a lower percent removal efficiency.
Onsite	The entire property that includes the proposed development.
Onsite Stormwater Management BMPs	As used in this manual, a synonym for Low Impact Development BMPs.
Operational BMPs	Source Control BMPs.
Ordinary High Water Mark	The mark on all lakes, streams, and tidal water that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation as that condition exists on the effective date of this Chapter or as it may naturally change thereafter. Provided, that in any area where the ordinary high water mark cannot be found, the ordinary high water mark adjoining fresh water shall be the line of mean high water.
Organic Matter	Organic matter is decomposed animal or vegetable matter.
Orifice	An opening with closed perimeter, usually sharp-edged, and of regular form in a plate, wall, or partition through which water may flow, generally used for the purpose of measurement or control of water.

Outfall	A point source as defined by 40 CFR 122.2 at the point where a discharge leaves the Permittee's MS4 and enters a surface receiving waterbody or surface receiving waters. Outfall does not include pipes, tunnels, or other conveyances which connect segments of the same stream or other surface waters and are used to convey primarily surface waters (i.e., culverts).
Outlet	Point of water disposal from a stream, river, lake, tidewater, or artificial drain.
Outlet Channel	A waterway constructed or altered primarily to carry water from man-made structures, such as terraces, tile lines, and diversions.
Outwash Soils	Soils formed from highly permeable sands and gravels.
Overtopping	To flow over the limits of a containment or conveyance element.
Parcel	Any portion, piece, or division of land. Fractional part or subdivision of block, according to plat or survey; portion of platted territory measured and set apart for individual and private use and occupancy.
Particle Size	The effective diameter of a particle as measured by sedimentation, sieving, or micrometric methods.
Paved Road	A road that has been treated or covered with asphalt to create an oil mat surface; a road that has a bituminous surface treatment, asphalt, or cement concrete surface.
Peak Discharge	The maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.
Percolation	The movement of water through soil.
Percolation Rate	The rate, often expressed in inches/hour, at which clear water, maintained at a relatively constant depth, will seep out of a standardized test hole that has been previously saturated. The term percolation rate is often used synonymously with infiltration rate (short-term infiltration rate).
Permanent Stabilization	Permanent site stabilization is the covering of exposed surfaces through paving, gravels, landscaping materials, sodding, seeding, etc. but shall not mean the temporary use of erosion/sediment control materials unless used in conjunction with the above measures to aid in seed or landscaping vegetation establishment.
Permanent Stormwater Control (PSC) Plan	A plan which includes permanent BMPs for the control of pollution from stormwater runoff after construction and/or land-disturbing activity has been completed.
Permeable pavement	Pervious concrete, porous asphalt, permeable pavers or other forms of pervious or porous paving material intended to allow passage of water through the pavement section. It often includes an aggregate base that provides structural support and acts as a stormwater reservoir.
Permeable Soils	Soil materials with a sufficiently rapid infiltration rate to greatly reduce or eliminate surface and stormwater runoff. These soils are generally classified as SCS hydrologic soil types A and B.
Person	Any individual, partnership, corporation, association, organization, cooperative, public or municipal corporation, agency of the state, or local government unit, however designated.

Pervious Surface	A surface material that allows stormwater to infiltrate into the ground. Examples include lawn, landscape, pasture, native vegetation areas, and permeable pavements.
Pesticide	A general term used to describe any substance – usually chemical – used to destroy or control organisms; includes herbicides, insecticides, algicides, fungicides, and others. Many of these substances are manufactured and are not naturally found in the environment. Others, such as pyrethrum, are natural toxins that are extracted from plants and animals.
pH	A measure of the alkalinity or acidity of a substance that is based on measuring the concentration of hydrogen ions in the substance. A pH of 7.0 indicates neutral water. A 6.5 reading is slightly acid.
Plan	For purposes of this manual, a Plan shall mean the Abbreviated Plan, Drainage Control Plan, or Construction Stormwater Pollution Prevention Plan.
Planned Unit Development (PUD)	A flexible zoning concept which provides an opportunity to mold a district so that it creates a more desirable environment, and results in as good or better use of land than that produced through the limiting standards provided in the regular zoning classifications.
Plat	A map or representation of a subdivision, short subdivision, large lot or binding site plan, showing thereon the division of a tract or parcel of land into lots, blocks, streets and alleys or other divisions and dedications.
Point Discharge	The release of collected and/or concentrated surface and stormwater runoff from a pipe, culvert, or channel.
Point Of Compliance	The location at which compliance with a discharge performance standard or a receiving water quality standard is measured.
Polishing	Additional treatment of a waste stream that has already received one or more stages of treatment by other means. This is also called advance treatment. The conditions present across a landscape after a specific stormwater management project (e.g., raising the outlet, building, and outlet control structure) are placed in the wetland or a land use change that occurs in the landscape unit that will potentially affect the wetland.
Pollution	Contamination or other alteration of the physical, chemical, or biological properties, of waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive or other substance into any waters of the State as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life.
Pollution-Generating Hard Surface (PGHS)	Those hard surfaces considered to be a significant source of pollutants in stormwater runoff. See the listing of surfaces under pollution-generating impervious surface.

Pollution-Generating Impervious Surface (PGIS)	Those impervious surfaces considered to be a significant source of pollutants in stormwater runoff. Such surfaces include those that receive direct rainfall or runon or blow-in of rainfall and are subject to: vehicular use; industrial activities (as further defined in this glossary); or storage of erodible or leachable materials, wastes, or chemicals. In addition, metal roofs unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating); or roofs that are subject to venting significant amounts of dusts, mists, or fumes from manufacturing, commercial, or other indoor activities are considered PGIS.
Pollution-Generating Pervious Surface (PGPS)	Any non-impervious surface that receives direct rainfall or runon or blow-in of rainfall and is subject to: vehicular use; industrial activities (as further defined in this glossary); storage of erodible or leachable materials, wastes, or chemicals; use of pesticides and fertilizers; or loss of soil. Typical PGPS include permeable pavement subject to vehicular use, lawns and landscaped areas including: golf courses, parks, cemeteries, and sports fields. (natural and artificial turf)
Postdevelopment Conditions	The condition of site after the project has been constructed.
Post-project	For use with Appendix I-B: The conditions present across a landscape after a specific stormwater management project (e.g., raising the outlet, building an outlet control structure) is completed that will potentially affect wetlands.
Pothole	A closed basin. See also closed depression.
Predeveloped Condition	The native vegetation and soils that existed at a site prior to the influence of Euro-American settlement. The predeveloped condition shall be assumed to be forested land cover unless reasonable, historic information is provided that indicates the site was prairie prior to settlement.
Preliminary Plat	A neat and approximate drawing of a proposed subdivision showing the general layout of streets, alleys, lots, blocks and restrictive covenants to be applicable to the subdivision, which shall furnish a basis for the approval or disapproval of the general layout of a subdivision.
Pre-project	For use with Appendix I-B: The conditions present across a landscape before a specific project is constructed.
Pretreatment	A BMP that removes at least 50% solids. Typically installed upstream of a UIC well or a Runoff Treatment BMP.
Private Road	A roadway facility in private ownership providing private access and used for travel of vehicles by the owner(s) or those having express or implied permission from the owner(s), but not by other persons.
Professional Engineer	A person currently licensed and registered in the State of Washington as a professional engineer in civil engineering.
Project	The proposed action of a permit application or an approval which requires a Drainage Control Plan, Construction Stormwater Pollution Prevention Plan, or Abbreviated Plan.
Project Engineer	Professional Engineer.
Project Site	That portion of a property, properties, or right-of-way subject to land disturbing activities, new hard surfaces, or replaced hard surfaces.

Public Storm Drainage Facility	A conveyance, system of conveyances, or stormwater control facility(ies) (including roads with drainage systems, catch basins, curbs, gutters, ditches, man-made channels, storm drains, retention/detention facilities and infiltration facilities) owned and operated by the County, which is (are) designed or used for collection, storage, conveyance and treatment of stormwater.
Rain garden	A non-engineered shallow, landscaped depression, with compost-amended native soils and adapted plants. The depression is designed to pond and temporarily store stormwater runoff from adjacent areas, and to allow stormwater to pass through the amended soil profile.
Rare, Threatened, Or Endangered Species	Plant or animal species that are regional relatively uncommon, are nearing endangered status, or whose existence is in immediate jeopardy and is usually restricted to highly specific habitats. Threatened and endangered species are officially listed by federal and state authorities, whereas rare species are unofficial species of concern that fit the above definitions.
Rational Method	A means of computing storm drainage flow rates (Q) by use of the formula **Q = CIA**, where **C** is a coefficient describing the physical drainage area, **I** is the rainfall intensity and **A** is the area. This method is only allowed for sizing conveyances in certain small basins.
Reach	A length of channel with uniform characteristics.
Receiving Waters (or Receiving Waterbody)	Bodies of water or surface water systems to which surface runoff is discharged via a point source of stormwater or via sheet flow. Groundwater to which surface runoff is directed by infiltration.
Recharge	The addition of water to the zone of saturation (i.e., an aquifer).
Redevelopment	On a site that is already substantially developed (i.e., has 35 percent or more of existing hard surface coverage), the creation or addition of hard surfaces; the expansion of a building footprint or addition or replacement of a structure; structural development including construction, installation or expansion of a building or other structure; replacement of hard surface that is not part of a routine maintenance activity; and land disturbing activities.
Regional Detention (or Retention) Facility	A stormwater quantity control structure designed to correct existing surface water runoff problems of a basin or subbasin. The area downstream has been previously identified as having existing or predicted significant and regional flooding and/or erosion problems. This term is also used when a detention or retention facility is sited to detain or infiltrate stormwater runoff from a number of new developments or areas within a catchment.
Replaced Hard Surface	For structures, the removal and replacement of hard surfaces down to the foundation. For other hard surfaces, the removal down to bare soil or base course and replacement.
Replaced Impervious Surface	For structures, the removal and replacement of impervious surfaces down to the foundation. For other impervious surfaces, the removal down to bare soil or base course and replacement.
Restoration	The re-establishment of a viable plant community, forest, wetland, or critical fish or wildlife habitat area from a previously filled or degraded site.
Retention	The process of collecting and holding surface and stormwater runoff with no surface outflow.

Retention Pond	A retention facility that is an open pond.
Retention/Detention Facility	A facility with an outlet to surface water but which is intended to primarily discharge to groundwater and evaporation.
Retrofitting	The renovation of an existing structure or facility to meet changed conditions or to improve performance.
Return Frequency	A statistical term for the average time of expected interval that an event of some kind will equal or exceed given conditions (e.g., a stormwater flow that occurs every 2 years).
Rill	A small intermittent watercourse with steep sides, usually only a few inches deep. Often rills are caused by an increase in surface water flow when soil is cleared of vegetation.
Riparian	Pertaining to the banks of streams, wetlands, lakes, or tidewater.
Riparian Areas	Transition zones between water bodies and upland areas that exhibit vegetation or soil characteristics reflective of permanent surface or subsurface water influence. Lands along, adjacent to, or contiguous with perennially and intermittently flowing rivers and streams, glacial potholes, and the shores of lakes and reservoirs with stable water levels are typical riparian areas.
Riprap	A facing layer or protective mound of rocks placed to prevent erosion or sloughing of a structure or embankment due to flow of surface and stormwater runoff.
Riser	A vertical pipe extending from the bottom of a pond BMP that is used to control the discharge rate from a BMP for a specified design storm.
Roadway Width	The sum of the traveled way width and the shoulder width measured at its narrowest location.
Rodenticide	A substance used to destroy rodents.
Runoff	Water originating from rainfall and other precipitation that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes and wetlands as well as shallow groundwater. As applied in this manual, it also means the portion of rainfall or other precipitation that becomes surface flow and interflow.
Salmonid	Any member of the family *Salmonidae*, which includes all species of salmon, trout, and char.
Sand Filter	A man-made depression or basin with a layer of sand that treats stormwater as it percolates through the sand.
Saturation Point	In soils, the point at which a soil or an aquifer will no longer absorb any amount of water without losing an equal amount.
Scour	Erosion of channel banks due to excessive velocity of the flow of surface and stormwater runoff.
SCS	Soil Conservation Service (now the Natural Resources Conservation Service), USDA.
SCS Method	See NRCS Method.

Seasonal High Groundwater	Seasonal high groundwater is the highest annual groundwater elevation as determined by a qualified soil scientist, geohydrologist, or licensed engineer in the state of Washington based on monitoring wells or other recognized methods.
Seasonal High Groundwater Level	The upper level at which the groundwater table normally is located during the season of the year when such levels are at their highest (typically December 1 through April 30).
Sediment	Fragmented material that originates from weathering and erosion of rocks or unconsolidated deposits, and is transported by, suspended in, or deposited by water.
Sedimentation	The depositing or formation of sediment.
Sensitive Area	Those areas designated by resolution or ordinance of the Pierce County Council pursuant to WAC 197-11-908 and PCC Title 18E or the most recent amendments thereto. See Environmentally Sensitive Area.
SEPA	See State Environmental Policy Act.
Settleable Solids	Those suspended solids in stormwater that separate by settling when the stormwater is held in a quiescent condition for a specified time.
Shared Access Facility	A privately-owned drivable surface which provides vehicular access to at least two lots and meets the design standards specified in the *Manual on Design Guidelines and Specifications for Road and Bridge Construction in Pierce County* and is designated as a shared access facility on a recorded land division map.
Sheet Erosion	The relatively uniform removal of soil from an area without the development of conspicuous water channels.
Sheet Flow	Runoff that flows over the ground surface as a thin, even layer, not concentrated in a channel.
Shoreline Development	The proposed project as regulated by the Shoreline Management Act. Usually the construction over water or within a shoreline zone (generally 200 feet landward of the water) of structures such as buildings, piers, bulkheads, and breakwaters, including environmental alterations such as dredging and filling, or any project which interferes with public navigational rights on the surface waters.
Short Circuiting	The passage of runoff through a BMP in less than the design treatment time.
Short Plat or Short Subdivision	As defined in PCC Title 18F, or most recent version thereof.
Shoulder Width	The improved and maintained area between the edge of the traveled way and the point of intersection of shoulder slope with the fore slope or ditch slope.
Siltation	The process by which a river, lake, or other water body becomes clogged with sediment. Silt can clog gravel beds and prevent successful salmon spawning.
Single-Family Residential Structure	A structure used to house one or two families, including appurtenant structures such as a garage, storage shed, or other structure not used for living purposes, all for the private, non-commercial use of the property owner or renter.

Site	The area defined by the legal boundaries of a parcel or parcels of land that is (are) subject to new development or redevelopment. For road projects, the length of the project site and the right-of-way boundaries define the site.
Site Development Permit	A permit issued by Pierce County giving an applicant permission to: perform land disturbing activity; remove vegetation; construct roads, shared accesses, alleyways, driveways, parking areas, impervious surfaces or other hard surfaces; perform grading and or clearing; and construct stormwater facilities.
Site Suitability Criteria	Eight criteria that must be considered for siting infiltration BMPs for Flow Control and Runoff Treatment. See Volume I, Appendix I-C Site Suitability Criteria (SSC).
Slope	Degree of deviation of a surface from the horizontal measured as a numerical ratio, percent, or in degrees. Expressed as a ratio, the first number is the horizontal distance (run) and the second is the vertical distance (rise), as 2:1. A 2:1 slope is a 50 percent slope. Expressed in degrees, the slope is the angle from the horizontal plane, with a 90-degree slope being vertical (maximum) and 45-degree being a 1:1 or 100 percent slope.
Sloughing	The sliding of overlying material. It is the same effect as caving, but it usually occurs when the bank or an underlying stratum is saturated or scoured.
Soil	The unconsolidated mineral and organic material on the immediate surface of earth supporting plant life. See also topsoil, engineered soil/ landscape system, and properly functioning soil system.
Soil Group, Hydrologic	A classification of soils by the SCS into four runoff potential groups. The groups range from A soils, which are very permeable and produce little or no runoff, to D soils, which are not very permeable and produce much more runoff.
Soil Horizon	A layer of soil, approximately parallel to the surface, which has distinct characteristics produced by soil-forming factors.
Soil Permeability	The ease with which gases, liquids, or plant roots penetrate or pass through a layer of soil.
Soil Profile	A vertical section of the soil from the surface through all horizons, including C horizons.
Soil Stabilization	The use of measures such as rock lining, vegetation or other engineering structures to prevent the movement of soil when loads are applied to the soil.
Soil Structure	The relation of particles or groups of particles which impart to the whole soil a characteristic manner of breaking; some types are crumb structure, block structure, platy structure, and columnar structure.
Soil Texture Class	The relative proportion, by weight, of particle sizes, based on the USDA system, of individual soil grains less than 2 mm equivalent diameter in a mass of soil. The basic texture classes in the approximate order of increasing proportions of fine particles include sand, loamy sand, sandy loam, loam, silt loam, silt, clay loam, sandy clay, silty clay, and clay.

Soils Professional	A person certified by the Soil Science Society of America (or an equivalent national program); a locally licensed onsite sewage designer; or a suitably trained person working under the supervision of a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington.
Sorption	The physical or chemical binding of pollutants to sediment or organic particles.
Source Control BMP	A structure or operation that is intended to prevent pollutants from coming into contact with stormwater through physical separation of areas or careful management of activities that are sources of pollutants. This manual separates source control BMPs into two types. Structural source control BMPs are physical, structural, or mechanical devices or facilities that are intended to prevent pollutants from entering stormwater. Operational BMPs are non-structural practices that prevent or reduce pollutants from entering stormwater. See Volume IV for details.
Spill Control Device	A T-section or turned-down elbow designed to retain a limited volume of pollutant that floats on water, such as oil or antifreeze. Spill control devices are passive and must be cleaned-out for the spilled pollutant to be removed.
Spillway	A passage such as a paved apron or channel for surplus water over or around a dam or similar obstruction. An open or closed channel, or both, used to convey excess water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of excess water.
Standard Plans and Standard Specifications	The most recent edition of the *Standard Plans for Road, Bridge, and Municipal Construction* and the *Standard Specifications for Road, Bridge, and Municipal Construction* by WSDOT in cooperation with the APWA and as amended by Pierce County.
State Environmental Policy Act (SEPA)	The Washington law (RCW 43.21c) intended to minimize environmental damage. SEPA requires that state agencies and local governments consider environmental factors when making decisions on activities, such as development proposals over a certain size and comprehensive plans. As part of this process, environmental documents are prepared and opportunities for public comment are provided.
Steep Slope	Slopes of 20 percent gradient or steeper, with 10 feet of vertical relief.
Storage Routing	A method to account for the attenuation of peak flows passing through a detention facility or other storage feature.
Storm Drains	The enclosed conduits that transport surface and stormwater runoff toward points of discharge (sometimes called storm sewers).
Storm Sewer	A sewer that carries stormwater and surface water, street wash and other washwaters or drainage, but excludes sewage and industrial wastes. Also called a storm drain.
Stormwater	Runoff during and following precipitation and snowmelt events, including surface runoff, drainage, and interflow.
Stormwater Drainage System	Constructed and natural features that function together as a system to collect, convey, channel, hold, inhibit, retain, detain, infiltrate, divert, treat, or filter stormwater.

Stormwater Facility	A constructed component of a stormwater drainage system designed or constructed to perform a particular function, or multiple functions. Stormwater facilities include, but are not limited to, pipes, swales, ditches, culverts, street gutters, detention ponds, retention ponds, constructed wetlands, infiltration devices, catch basins, oil/water separators, bioretention, permeable pavement, and biofiltration swales.
Stormwater Management Manual for Western Washington	The Stormwater Manual prepared by Ecology to provide guidance on measures necessary in western Washington to control the quantity and quality of stormwater runoff from new development and redevelopment.
Stormwater Program	Either the basic stormwater program or the comprehensive stormwater program (as appropriate to the context of the reference) called for under the Puget Sound Water Quality Management Plan.
Streambanks	The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream.
Streams	Those areas where surface waters flow sufficiently to produce a defined channel or bed. A defined channel or bed is an area that demonstrates clear evidence of the passage of water and includes, but is not limited to, indicated by hydraulically sorted sediments or the removal of vegetative litter or loosely rooted vegetation by the action of moving water. The channel or bed need not contain water year-round. This definition is not meant to include irrigation ditches, canals, stormwater runoff devices, or other entirely artificial watercourses unless they are used to convey streams naturally occurring prior to construction. Those topographic features that resemble streams but have no defined channels (i.e., swales) shall be considered streams when hydrologic and hydraulic analyses done pursuant to a development proposal predict formation of a defined channel after development.
Structural Source Control BMPs	See Source Control BMPs.
Structure (habitat)	The physical components of an ecosystem, both the abiotic (physical and chemical) and biotic (living).
Stub-Out	A short length of pipe provided for future connection to a stormwater drainage system.
Subbasin	A drainage area that drains to a point contained within a larger basin.
Subdivision	As defined in the Pierce County Subdivision Code, PCC Title 18F or the most recent version thereof.
Subgrade	A layer of stone or soil used as the underlying base for a BMP.
Subsoil	The B horizons of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below the plowed soil (or its equivalent of surface soil), in which roots normally grow. Although a common term, it cannot be defined accurately. It has been carried over from early days when "soil" was conceived only as the plowed soil and that under it as the "subsoil."
Substrate	The natural soil base underlying a BMP.
Suspended Solids	Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles (and associated pollutants) as well as solids in stormwater.

Swale	A shallow drainage conveyance with relatively gentle side slopes, generally with flow depths less than 1 foot.
Terrace	An embankment or combination of an embankment and channel across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.
Threshold Discharge Area	An onsite area draining to a single natural discharge location or multiple natural discharge locations that combine within one-quarter mile downstream (as determined by the shortest flow path). The examples in Volume I, Figure 4.1 illustrate this definition. The purpose of this definition is to clarify how the thresholds of this manual are applied to project sites with multiple discharge points.
Tightline	A continuous length of pipe that conveys water from one point to another (typically down a steep slope) with no inlets or collection points in between.
Tile, Drain	Pipe made of burned clay, concrete, or similar material, in short lengths, usually laid with open joints to collect and carry excess water from the soil.
Till	A layer of poorly sorted soil deposited by glacial action that generally has very low infiltration rates.
Time of concentration	The time period necessary for surface runoff to reach the outlet of a subbasin from the hydraulically most remote point in the tributary drainage area.
Toe of Slope	A point or line of slope in an excavation or cut where the lower surface changes to horizontal or meets the existing ground slope.
Top of Slope	A point or line on the upper surface of a slope where it changes to horizontal or meets the original surface.
Topography	General term to include characteristics of the ground surface such as plains, hills, mountains, degree of relief, steepness of slopes, and other physiographic features.
Topsoil	The upper portion of a soil, usually dark colored and rich in organic material. It is more or less equivalent to the upper portion of an A horizon in an ABC soil.
Total Maximum Daily Load (TMDL) – Water Cleanup Plan	A calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. A TMDL (also known as a Water Cleanup Plan) is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonable variation in water quality. Water quality standards are set by states, territories, and tribes. They identify the uses for each waterbody, for example, drinking water supply, contact recreation (swimming), and aquatic like support (fishing), and the scientific criteria to support that use. The Clean Water Act, Section 303, establishes the water quality standards and TMDL programs.
Total Solids	The solids in water, sewage, or other liquids, including the dissolved, filterable, and nonfilterable solids. The residue left when the moisture is evaporated and the remainder is dried at a specified temperature, usually 130 degrees Celsius.

Total Suspended Solids	That portion of the solids carried by stormwater that can be captured on a standard glass filter.
Toxic	Poisonous, carcinogenic, or otherwise directly harmful to life.
Tract	Any parcel of land that is exclusive of a lot. An example of a tract for the purpose of this Title is a parcel of land that consists of sensitive areas such as open space, wetlands or steep slopes or land dedicated for roads or utility purposes. For the purpose of this definition, a tract may be buildable or unbuildable.
Trash Rack	A structural device used to prevent debris from entering a spillway or other hydraulic structure.
Travel Time	The estimated time for surface water to flow between two points of interest.
Traveled Way	That portion of the roadway used for the movement of vehicles exclusive of the portion of the roadway width that is used, or available for parking of vehicles. The traveled way does not include curbs and gutters.
Treatment BMP or Facility	A BMP that is intended to remove pollutants from stormwater. A few examples of treatment BMPs are bioretention areas, detention ponds, oil/water separators, biofiltration swales, and constructed wetlands.
Treatment Liner	A layer of soil that is designed to slow the rate of infiltration and provide sufficient pollutant removal to protect groundwater quality.
Turbidity	Dispersion or scattering of light in a liquid, caused by suspended solids and other factors; commonly used as a measure of suspended solids in a liquid.
Underdrain	Plastic pipes with holes or slots drilled through the top, installed on the bottom of an infiltration BMP, which are used to collect and remove excess runoff.
Underground Injection Control (UIC) Program	A federal regulatory program established to protect underground sources of drinking water from UIC well discharges. In Washington, the U.S. EPA has granted Ecology authority to regulate UIC wells, except for UIC wells on tribal land.
Underground Injection Control (UIC) Well	A UIC well is defined as a structure built to discharge fluids from the ground surface into the sub-surface; a bored, drilled, or driven shaft whose depth is greater than the largest surface dimension; or a dug hole whose depth is greater than the largest surface dimension; or an improved sinkhole, which is a natural crevice that has been modified; or a subsurface fluid distribution system that includes an assemblage of perforated pipes, drain tiles, or other similar mechanisms intended to distribute fluids below the surface of the ground. Examples of UIC wells or sub-surface infiltration systems include drywells, drainfields, infiltration trenches with perforated pipe, storm chamber systems with the intent to infiltrate, french drains, bioretention systems intended to distribute water to the subsurface by means of perforated pipe installed below the treatment soil, and other similar devices that discharge to the ground.
Undisturbed Buffer	A zone where development activity shall not occur, including logging, and/or the construction of utility trenches, roads, and/or surface and stormwater facilities.

Uninterruptible Services	Those services to the public which the County has identified as important enough to merit a higher standard of protection against flooding such as hospitals, police, and fire stations.
Unpaved Road	A road that consists of gravel, crushed surfacing top course, or other dirt surface that has not received a surfacing coat of asphalt. A road treated with only a dust preventative or dust treatment shall be considered an unpaved road.
Unstable Slopes	Those sloping areas of land which have in the past exhibited, are currently exhibiting, or will likely in the future exhibit, mass movement of earth.
Utility Line	Pipe, conduit, cable, or other similar facility by which services are conveyed to the public or individual recipients. Such services shall include but are not limited to water supply, electric power, gas, communications, and sanitary sewers.
Values	Wetland processes or attributes that are valuable or beneficial to society (also see Functions). Wetland values include support of commercial and sport fish and wildlife species, protection of life and property from flooding, recreation, education, and aesthetic enhancement of human communities.
Variance	Relief from the application of a Minimum Requirement to a project. See PCC Title 17A.
Vegetated Flow Path	A vegetated flow path consists of well-established lawn or pasture, landscaping with well-established groundcover, native vegetation with natural groundcover, or an area that meets Soil Preservation and Amendment (see Volume III, Section 3.1). The groundcover shall be dense enough to help disperse and infiltrate flows and to prevent erosion.
Vegetation	Any organic plant life growing on the surface of the earth.
Vehicular Use	Regular use of an impervious or pervious surface by motor vehicles. The following are subject to regular vehicular use: roads, un-vegetated road shoulders, bike lanes within the traveled lane of a roadway, driveways, parking lots, unrestricted access fire lanes, vehicular equipment storage yards, and airport runways. The following are not considered subject to regular vehicular use: paved bicycle pathways separated from and not subject to drainage from roads for motor vehicles, restricted access fire lanes, and infrequently used maintenance access roads.
Water Body	Surface waters including rivers, streams, lakes, marine waters, estuaries, and wetlands.
Water Cleanup Plan	See total maximum daily load.
Water Quality	A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water Quality BMP	A BMP specifically designed to control the quality of runoff.
Water Quality Design Storm	The 24-hour rainfall amount with a 6-month return frequency. Commonly referred to as the 6-month, 24-hour storm.

Water Quality Standards	Minimum requirements of purity of water for various uses; for example, water for agricultural use in irrigation systems should not exceed specific levels of sodium bicarbonate, pH, total dissolved salts, etc. In Washington, the Department of Ecology sets water quality standards.
Water Table	The upper surface or top of the saturated portion of the soil or bedrock layer indicates the uppermost extent of groundwater.
Watercourse	A river, stream, creek, or other course of flowing water that flows intermittently or perennially and discharges into another watercourse or body of water.
Watershed	The region drained by or contributing water to a stream, lake, or other body of water.
Wet Pool	A pond or constructed wetland that stores runoff temporarily and whose normal discharge location is elevated so as to maintain a permanent pool of water between storm events.
Wet Ponds and Wet Vaults	Drainage facilities for water quality treatment that contain permanent pools of water that are filled during the initial runoff from a storm event. They are designed to optimize water quality by providing retention time in order to settle out particles of fine sediment to which pollutants such as heavy metals absorb, and to allow biologic activity to occur that metabolizes nutrients and organic pollutants.
Wetlands	Defined by PCC Title 18E.
WSDOT Specifications	The requirements or standards of the latest edition of the WSDOT Standard Plans and Specifications.

Acronyms

APWA	American Public Works Association (Washington State Chapter)
API	American Petroleum Institute
ADA	Americans with Disabilities Act
APWA	American Public Works Association
ASTM	American Society for Testing and Materials
BFE	Base Flood Elevation
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CEC	Cation Exchange Capacity
CESCL	Certified Erosion and Sediment Control Lead
CIP	Capital Improvement Project or Program
COD	Chemical Oxygen Demand
CWA	Clean Water Act
DNS	Determination of Nonsignificance
EIA	Effective Impervious Areas
ESA	Endangered Species Act
ESC	Erosion and Sediment Control
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HPA	Hydraulic Project Approvals
HSPF	Hydrological Simulation Program—Fortran
IBC	International Building Codes (also I Codes)
JARPA	Joint Aquatic Resources Permit Application
LID	Low Impact Development
MSDS	Material Safety Data Sheets
MOA	Memorandum of Agreement
NEPA	National Environmental Policy Act
NGVD 29	National Geodetic Vertical Datum of 1929
NAVD 88	North American Vertical Datum of 1988
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	Nephlometric Turbidity Unit
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
PALS	Planning and Land Services (Pierce County)
PAHs	Polyacrylamide Aromatic Hydrocarbons
PAM	Polyacrylamide
PCB	Polychlorinated Biphenyls
PCC	Pierce County Code

PCCD	Pierce County Conservation District
PDD	Planned Development District
PUD	Planned Urban Development
PGHS	Pollution-Generating Hard Surface
PGIS	Pollution-Generating Impervious Surface
PGPS	Pollution-Generating Pervious Surface
RCW	Revised Code of Washington
SCS	Soil Conservation Service
SBUH	Santa Barbara Urban Hydrograph method
SEPA	State Environmental Policy Act
SFR	Single Family Residential
SWPPP	Stormwater Pollution Prevention Plan
TESC	Temporary Erosion and Sediment Control
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
UGA	Urban Growth Area
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
U.S. EPA	The United States Environmental Protection Agency
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WSDOT	Washington State Department of Transportation
WISHA	Washington Industrial Safety and Health Act
WRIA	Water Resource Inventory Area
WWHM	Western Washington Hydrology Model

Notations

This list of notations is provided only as a guide to some of the notations to be used in a submittal. The exact definition and units are listed when the symbol is used. Since the same symbol can be used for different design methods, the exact definition should be described in the appropriate section of the submittal.

A = drainage area (square miles), also full cross-sectional area of culvert barrel (square feet)

A_b = top surface area of basin (square feet), also area of pond bottom (square feet)

A_d = drainage area

A_s = surface area of swale (square feet), also average surface area for detention BMP

A_t = total area (acres)

C = estimated runoff coefficient

CN = SCS runoff curve number

CN = change in curve number

D = interior height of culvert barrel (feet)

D_{50} = median stone diameter (riprap)

d = average permanent pool depth of a detention BMP

d_b = basin depth (feet)

d_c = critical depth (feet)

d_s = depth of swale check dam (feet)

d_t = time interval in minutes

d_x = a mixture of riprap sizes where the percent of stone by weight is less than x (the specified diameter)

E = designated fraction of particulates to be removed by a BMP

f = final infiltration rate of soil (in/hr)

f_d = infiltration rate including a safety factor of two

g = acceleration due to gravity, 32.2 ft/sec^2

H = stage height (feet) or water depth above pond bottom, also $H=H_f+H_e+H_{ex}$; head on orifice

H_c = specific head at critical depth ($d_c + V_c^2/2g$) (feet)

H_d = design depth of pond

H_e = entrance head loss (feet) = $K_c (V^2/2g)$

H_{ex} = exit head loss (feet) = $V^2/2g$)

H_f = Friction loss (feet) = $V^2n^2L/2.22R^{1.33}$ Note: if (H_f+TW-L*S) less than D, adjust H_f such that (H_f+TW-L*S) = D. This will keep the analysis simple and still yield reasonable results (erring on the conservative side)

HW = headwater depth above inlet invert (feet)

h_b = height from the hydraulic grade line at the 2-year recurrence interval flow on the outflow pipe to the overflow elevation

I = inflow at time 1 and time 2

I(t) = instantaneous hydrograph, in cubic feet per second, (Santa Barbara Urban Hydrograph [SBUH] method)

I = hydraulic gradient (ft/ft)

Ke = entrance loss coefficient

k = time of concentration velocity factor (feet/second)

k_c = time of concentration velocity factor; channel flow

k_s = time of concentration velocity factor; shallow flow

L = distance of flow across a given segment, also length of culvert (feet), also width of emergency overflow weir

MB_{el} = mean tributary basin elevation above sea level (feet)

M_s = potential average snowmelt during storms (in)

m = number of flow segments

N_s = number of check dams along total length of swale

n = Manning's "n", effective roughness coefficient

n_s = sheet flow; Manning's effective roughness coefficient

O = outflow at time 1 and time 2

P = rainfall depth (inches), total for a storm event

P_R = the total precipitation at a site for the 24-hour design storm event for the given return frequency (R)

Q = flow or discharge (cubic feet per second)

Q_a = after development depth of runoff (inches)

Q_b = before development depth of runoff (inches)

Q_c = depth of runoff from contributing area (feet)

Q_d = runoff depth in inches over a given area

Q_o = average release rate from detention BMP

Q_s = depth of runoff controlled by vegetated swale (inches)

Q_t = release rate for orifice

Q_{total} = total flow at maximum head

Q(t) = the routed flow of the runoff hydrograph (SBUH method)

$Q_{10\%}$ = the flow that is not exceeded more than 10 percent of the time during the months of adult salmonid migration

ΔQ = change in runoff depth (inches)

Δq = change in peak discharge (cubic feet per second)

R = hydraulic radius (feet) in Manning's Equation, equals the cross-sectional area divided by the wetted perimeter

R(t) = the total runoff depth at time increment dt, in inches; also known as precipitation excess

S = storage, also culvert barrel slope (ft/ft)

S(H) = storage (ft^3) at stage height (H)

S_d = the largest volume from an initial pond sizing

s_f = friction slope = $n^2V^2/2.22R^{4/3}$

s_o = slope of flow path (ft/ft), also bottom slope

T = width of swale or vegetated filter strip

T_c = time of concentration (hrs)

T_t = travel time of overland flow across separate flow path segments

$T_{1,2,n}$ = the consecutive flow paths of different land cover categories having significant differences in flow path slope

TW = tailwater depth above invert of culvert outlet (feet) Note: if TW is less than $(D+d_c)/2$, set $TW=(D+d_c)/2$

t_d = design detention time of a BMP

Δt = time interval; time 2 – time 1

V = average velocity across the land cover (ft/sec), also barrel velocity (fps), also mean velocity

V_c = flow velocity at critical depth (fps)

V_{max} = maximum allowed velocity of runoff in a Biofilter

V_{pp} = permanent pool volume

V_r = void ratio

V_{sed} = settling velocity of the design soil particle

W_{50} = the median stone size (riprap)

w = settling velocity of target particle

y = depth of flow

y_n = normal flow depth

Z = basin side slope ratio (h:v)

Z^1, Z^2 = side slope ratio of swale cross-section (h:v)

ΔZ = energy coefficient which corrects for the non-uniform distribution of velocity over the channel cross-section

Pierce County
Stormwater Management and Site Development Manual

Volume II
Construction Stormwater Pollution Prevention

Prepared by: Pierce County Planning & Public Works

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Table of Contents

Volume II Construction Stormwater Pollution Prevention

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

1.1 Purpose of This Volume 1-1

1.2 Content and Organization of This Volume 1-1

1.3 Thirteen Elements of Construction Stormwater Pollution Prevention 1-2

1.4 Water Quality Standards 1-2

1.4.1 Surface Water Quality Standards 1-2

1.4.2 Compliance with Standards 1-3

1.4.3 Other Applicable Regulations and Permits 1-4

Chapter 2. Planning 2-1

2.1 General Guidelines 2-1

2.1.1 What is a Construction Stormwater Pollution Prevention Plan? 2-1

2.1.2 Who is Responsible for the Construction SWPPP? 2-2

2.1.3 What is an Adequate Plan? 2-2

2.1.4 BMP Standards and Specifications 2-3

2.2 Construction SWPPP Requirements 2-3

2.2.1 Narrative 2-4

2.2.2 Drawings 2-5

2.3 Step-by-Step Procedure 2-7

2.3.1 Step 1 – Data Collection 2-7

2.3.2 Step 2 – Data Analysis 2-8

2.3.3 Step 3 – Construction SWPPP Development and Implementation 2-10

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

3.1 Source Control BMPs 3-1

BMP C102: Buffer Zones 3-5

BMP C103: High Visibility Fence 3-6

BMP C105: Stabilized Construction Entrance/Exit 3-7

BMP C106: Wheel Wash 3-8

BMP C107: Construction Road/Parking Area Stabilization 3-11

BMP C120: Temporary and Permanent Seeding 3-12

BMP C121: Mulching 3-18

BMP C122: Nets and Blankets 3-21

BMP C123: Plastic Covering 3-25
BMP C124: Sodding 3-27
BMP C125: Topsoiling/Composting 3-28
BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection 3-31
BMP C130: Surface Roughening 3-34
BMP C131: Gradient Terraces 3-36
BMP C140: Dust Control 3-38
BMP C150: Materials on Hand 3-40
BMP C151: Concrete Handling 3-41
BMP C152: Sawcutting and Surfacing Pollution Prevention 3-43
BMP C153: Material Delivery, Storage, and Containment 3-44
BMP C154: Concrete Washout Area 3-46
BMP C160: Certified Erosion and Sediment Control Lead 3-50
BMP C162: Scheduling 3-52
3.2 Runoff Conveyance and Treatment BMPs 3-53
BMP C200: Interceptor Dike and Swale 3-54
BMP C201: Grass-Lined Channels 3-56
BMP C202: Riprap Channel Lining 3-60
BMP C203: Water Bars 3-61
BMP C204: Pipe Slope Drains 3-63
BMP C205: Subsurface Drains 3-65
BMP C206: Level Spreader 3-67
BMP C207: Check Dams 3-70
BMP C208: Triangular Silt Dike (TSD) (Geotextile-Encased Check Dam) 3-72
BMP C209: Outlet Protection 3-74
BMP C220: Storm Drain Inlet Protection 3-75
BMP C231: Brush Barrier 3-81
BMP C233: Silt Fence 3-82
BMP C234: Vegetated Strip 3-86
BMP C235: Wattles 3-87
BMP C236: Vegetative Filtration 3-90
BMP C240: Sediment Trap 3-93
BMP C241: Temporary Sediment Pond 3-95
BMP C250: Construction Stormwater Chemical Treatment 3-100

BMP C251: Construction Stormwater Filtration 3-108
BMP C252: Treating and Disposing of High pH Water 3-110
3.3 Protection of LID Facilities During Construction 3-113
3.3.1 Introduction 3-113
3.3.2 General Erosion and Sediment Control BMPs Applicable to LID 3-113
3.3.3 Additional Construction Techniques for LID BMPs 3-114
3.3.4 BMP-specific Construction Techniques 3-116
Appendix II-A –
Recommended Standard Notes for Construction Stormwater Pollution Prevention Plans A-1

List of Tables

Table 3.1. - Source Control BMPs by SWPPP Element....3-2
Table 3.2. - Temporary Erosion Control Seed Mix....3-16
Table 3.3. - Landscaping Seed Mix....3-16
Table 3.4. - Low-Growing Turf Seed Mix....3-16
Table 3.5. - Bioswale Seed Mix....3-16
Table 3.6. - Wet Area Seed Mix....3-17
Table 3.7. - Meadow Seed Mix....3-17
Table 3.8. - Mulch Standards and Guidelines....3-19
Table 3.9. - PAM and Water Application Rates....3-32
Table 3.10. - Runoff Conveyance and Treatment BMPs by SWPPP Element....3-53
Table 3.11. - Storm Drain Inlet Protection....3-75
Table 3.12. - Geotextile Standards....3-82
Table 3.13. - Vegetated Strips....3-86

Table of Figures

Figure 3.1. - Wheel Wash 3-10
Figure 3.2. - Channel Installation. 3-23
Figure 3.3. - Surface Roughening by Tracking and Contour Furrows. 3-35
Figure 3.4. -Gradient Terraces. 3-36
Figure 3.5. - Prefabricated Concrete Washout Container with Ramp 3-48
Figure 3.6. - Typical Grass-Lined Channels. 3-56
Figure 3.7. - Temporary Channel Liners. 3-59
Figure 3.8. - Water Bar. 3-61
Figure 3.9. - Cross-Section of Level Spreader. 3-68
Figure 3.10. - Detail of Level Spreader. 3-68
Figure 3.11. - Block and Gravel Curb Inlet Protection. 3-78
Figure 3.12. - Curb and Gutter Barrier. 3-79
Figure 3.13. - Straw Wattles. 3-88
Figure 3.14. - Manifold and Branches in a Wooded, Vegetated Spray Field 3-91
Figure 3.15. - Riser Inflow Curves. 3-98

Chapter 1. Introduction to Construction Stormwater Pollution Prevention

1.1 Purpose of This Volume

Volume II focuses on managing stormwater impacts associated with construction activities. Best management practices (BMPs) that are properly planned, installed, and maintained can minimize stormwater impacts, such as heavy stormwater flows, soil erosion, water-borne sediment from exposed soils, and degradation of water quality, from onsite pollutant sources. This volume addresses the planning, design, and implementation of BMPs before and during construction projects.

The construction phase of a project is usually a temporary condition, ultimately giving way to permanent improvements and facilities. However, construction work may take place over an extended period of time. Ensure that all of your management practices and control facilities are of sufficient size, strength, and durability to outlast the longest possible construction schedule and the worst anticipated rainfall conditions.

Linear projects, such as roadway construction and utility installations, may present a 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. It may be advantageous to phase portions of long, linear projects and apply all necessary controls to individual phases.

This volume details BMPs for controlling or maintaining stormwater runoff quality from a developed or artificially altered site during construction. The project applicant or his/her designated project engineer shall prepare one of the two site development and stormwater submittals; a Drainage Control Plan or an Abbreviated Plan. For most projects, a component of the submittal is the Construction Stormwater Pollution Prevention Plan (SWPPP).

The Construction SWPPP serves as a tool for the site operator to manage the site and to avoid immediate and long-term environmental loss. Additional information on erosion and sedimentation processes as well as factors influencing erosion potential may be found in the latest version of the Washington State Department of Ecology (Ecology) *Stormwater Management Manual for Western Washington*.

1.2 Content and Organization of This Volume

Volume II consists of three chapters that address the key considerations and mechanics of construction stormwater BMPs.

Chapter 1 includes the introduction and purpose of the volume. The chapter briefly lists 13 Elements of pollution prevention to be considered for all projects. Additional local, state, and federal requirements that may apply to construction sites and their stormwater discharges are noted. This includes Ecology's National Pollutant Discharge Elimination System (NPDES) Discharge Permit and Washington's water quality standards pertaining to construction stormwater, and explains how they apply to field situations.

Chapter 2 provides additional information on requirements for construction erosion control, including seasonal limitations and required components of the Construction SWPPP.

Chapter 3 contains BMPs for construction stormwater control and site management. The first section of Chapter 3 contains BMPs for source control. The second section addresses runoff,

conveyance, and treatment BMPs. 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). Use various combinations of these BMPs in the Construction SWPPP to satisfy each of the 13 Elements applicable to the project. Design and facility sizing information is included within the applicable BMP sections. The project applicant should refer to this chapter to determine which BMPs will be included in the Construction SWPPP, and to design and document application of these BMPs to the project construction site.

1.3 Thirteen Elements of Construction Stormwater Pollution Prevention

The **13 Elements** listed below must be considered in the development of the Construction SWPPP. If an Element is considered unnecessary, the Construction SWPPP must provide the justification.

These Elements cover the general water quality protection strategies of limiting site impacts, preventing erosion and sedimentation, and managing activities and sources.

The 13 Elements 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

A complete description of each Element and associated BMPs is given in Chapter 2.

1.4 Water Quality Standards

1.4.1 Surface Water Quality Standards

"Numerical" water quality criteria are numerical values set forth in the State of Washington's Water Quality Standards for Surface Waters (Chapter 173-201A Washington Administrative Code [WAC]). They specify the levels of pollutants allowed in receiving waters to protect aquatic life.

U.S. Environmental Protection Agency (U.S. EPA) has promulgated 91 numeric water quality criteria to protect human health that apply to Washington State. These criteria are designed to protect humans from cancer and other diseases, and are primarily applicable to fish and shellfish consumption and drinking water obtained from surface waters.

In addition to numerical criteria, "narrative" water quality criteria (e.g., WAC 173-201A-200, -240, and -250) limit concentrations of toxic, radioactive, or otherwise harmful material below concentrations that have the potential to adversely affect characteristic water uses, cause acute or chronic toxicity to biota, impair aesthetic values, or adversely affect human health. Narrative criteria protect the specific beneficial uses of fresh (WAC 173-201A-600 and 602) and marine (WAC 173-201A-610 and 612) waters in the State of Washington.

Pollutants that might be expected in the discharge from construction sites are turbidity, pH, and petroleum products. The numeric surface water quality standards for turbidity and pH for fresh and marine waters designated for various aquatic life uses are specified in WAC 173-201A-200 and 210.

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

The groundwater quality criteria require protection from contamination in order to support the beneficial uses of the groundwater, such as for drinking water. Therefore, the primary water quality consideration for stormwater discharges to groundwater from construction sites is the control of contaminants other than sediment. Sediment control is necessary to protect permanent infiltration facilities from clogging during the construction phase.

1.4.2 Compliance with Standards

Stormwater discharges from construction sites 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 173200 WAC), 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, the project applicant must apply all known, available, and reasonable methods of prevention, control, and treatment (AKART). This includes preparing and implementing a Construction SWPPP, with all appropriate BMPs installed and maintained in accordance with the Construction SWPPP and the terms and conditions of the Construction Stormwater General Permit.

In accordance with Chapter 90.48 RCW (ESSB 6415), compliance with water quality standards is presumed unless discharge monitoring data or other site specific information demonstrates otherwise, when the project applicant fully:

- Complies with applicable permit conditions for planning, sampling, monitoring, reporting, and recordkeeping; and
- Implements the BMPs contained in this manual, including the proper selection, implementation, and maintenance of all applicable and appropriate BMPs for onsite pollution control.

Proper implementation and maintenance of appropriate BMPs is critical to adequately control any adverse water quality impacts from construction activity.

Because Ecology has determined that a local manual may be used where the local requirements for construction sites are at least as stringent as Ecology's, applicants should be able to prepare one Construction SWPPP under the county's manual to satisfy both the Ecology permit and Pierce County permits. However, for sites also subject to Ecology's NPDES Construction Stormwater General Permit requirements, applicants are responsible for confirming that no additional

requirements apply to comply with Ecology's regulations.

1.4.3 Other Applicable Regulations and Permits

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

- NPDES Construction Stormwater General Permit – (Ecology) < https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormater-permit>
- Total maximum daily load or water cleanup plans (Ecology)
- Endangered Species Act (ESA) – (National Oceanic and Atmospheric Administration Fisheries Service or U.S. Fish and Wildlife Service [USFWS])
- Hydraulic project approval permits – (WDFW)
- General provisions from the Washington State Department of Transportation – (WSDOT)
- Remediation agreements for contaminated sites (such as Model Toxics Control Act or Voluntary Cleanup Program sites)

See Volume I, Section 1.7, for further information

Chapter 2. Planning

This chapter provides an overview of the important components of, and the process for, developing and implementing a Construction SWPPP.

Section 2.1 contains general guidelines with which site planners should become familiar. It describes criteria for plan format and content and ideas for improved plan effectiveness.

Section 2.2 discusses the two main components of a Construction SWPPP, the narrative and the drawings.

Section 2.3 outlines and describes the step-by-step procedure for developing a Construction SWPPP from data collection to finished product. Step 3 in Section 2.3 provides a description of each of the Construction SWPPP elements. This procedure is written in general terms to be applicable to all types of projects.

Design standards and specifications for BMPs referred to in this chapter are found in Chapter 3.

The Construction SWPPP is a subset of the submittal requirements outlined in Volume I.

2.1 General Guidelines

2.1.1 What is a Construction Stormwater Pollution Prevention Plan?

The Construction SWPPP means a written plan to implement measures to identify, prevent, and control the contamination of point source discharge of stormwater. The Construction SWPPP explains and illustrates the measures, usually in the form of BMPs, to implement on a construction site to control potential pollution problems. A Construction SWPPP for projects that add or replace 2,000 square feet or more of impervious surface or clear more than 7,000 square feet must have a narrative as well as drawings and details (see Volume I, Chapter 3, Table 3.1 for threshold limits for various plan submittals). For some single-family home construction projects, the applicable Elements of a Construction SWPPP can be part of an Abbreviated Plan if acceptable for construction stormwater control purposes (see also Volume I).

The Construction SWPPP shall include a narrative and drawings. All BMP's shall be clearly referenced in the narrative and marked on the drawings. The Construction SWPPP narrative shall include documentation to explain and justify the pollution prevention decisions made for the project. Each of the 13 Construction SWPPP Elements (listed below) must be considered and included in the Construction SWPPP unless site conditions render the Element unnecessary and the exemption from that Element is clearly justified in the narrative of the Construction SWPPP.

Clearing and grading activities for projects 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. These permitted clearing and grading areas and any other required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas, shall be delineated on the site plans and the development site.

The Construction SWPPP shall be implemented beginning with initial land disturbance and until final stabilization. Sediment and Erosion control BMPs shall be consistent with the BMPs contained in Table 3.1 Source Control BMPs by SWPPP Element in Chapter 3.

As site work progresses, the plan must be modified to reflect changing site conditions, subject to the rules for plan modification by the Construction Stormwater General Permit and/or the county. See also Construction SWPPP Element #12 in Section 2.3.3.

Seasonal Work Limitations:

From October 1 through April 30, clearing, grading, and other soil disturbing activities are permitted only if shown to the satisfaction of the county that the site operator will prevent silt-laden runoff from leaving the site through a combination of the following:

- Compliance with Construction SWPPP Element #5 to Stabilize Soil and BMP Usage
- Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters
- Limit activities and the extent of disturbed areas
- Proposed Construction SWPPP measures.

Based on the information provided and/or local weather conditions, the county may expand or restrict the seasonal limitation onsite 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

If clearing and grading limits or Construction SWPPP 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 Construction SWPPP 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
- Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed Construction SWPPP facilities.

2.1.2 Who is Responsible for the Construction SWPPP?

The owner or lessee of the land being developed has the responsibility for Construction SWPPP preparation and submission to the county. The owner or lessee may designate someone (i.e., an engineer, architect, contractor, etc.) to prepare the Construction SWPPP, but he/she retains the ultimate responsibility for environmental protection at the site.

The Construction SWPPP must be located on the construction site or within reasonable access to the site for construction and inspection personnel, although a copy of the drawings must be kept on the construction site at all times.

2.1.3 What is an Adequate Plan?

The Construction SWPPP must contain sufficient information to satisfy the county that the problems of construction pollution 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 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.

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 actions taken as a result of these inspections must be prepared and retained as part of the Construction SWPPP.

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.

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. Several of the other Elements are very important at these sites as well, such as marking the clearing limits, establishing the construction access, and managing the project.

Whether the stormwater discharges to surface water or completely infiltrates, each of the 13 Elements must be included in the Construction SWPPP, unless an Element is determined not to be applicable to the project and the exemption is justified in the narrative.

The step-by-step procedure outlined in Section 2.3 of this volume is recommended for the development of Construction SWPPPs.

2.1.4 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 commonly used in Construction SWPPPs to address the 13 Elements. BMPs can be used singularly or in combination. If a Construction SWPPP makes use of a BMP, the narrative and drawings must clearly reference the specific BMP title and number.

The standards and specifications in Chapter 3 are not intended to limit any innovative or creative effort to effectively control erosion and sedimentation. Construction SWPPPs can contain experimental BMPs or make minor modifications to standard BMPs. However, both the county and Ecology must approve such practices before use. All experimental BMPs and modified BMPs must achieve the same or better performance than the BMPs listed in Chapter 3.

2.2 Construction SWPPP Requirements

The Construction SWPPP shall consist of two parts: a narrative and the drawings. The following sections describe the contents of each.

2.2.1 Narrative

Cover Sheet: The Construction SWPPP narrative report will have a cover sheet with the project name; applicant's name, address, telephone number, and email address; project engineer's name, address, telephone number, and email address; date of submittal; contact's name, address telephone number, and email address; and the name, address telephone number, and email address of contractor, if known.

Project Engineer's Certification: For some Abbreviated Plan submittals, the Construction SWPPP need not be developed by a professional engineer (PE). However, for more complex projects submitting an Abbreviated Plan with engineering elements (e.g., to support Minimum Requirement #5, as outlined in Volume I) or a Drainage Control Plan, as per the rest of the submittal the Construction SWPPP must be developed by a professional engineer licensed to practice in the State of Washington. For projects where a PE is required, the Construction SWPPP report shall contain a page with the project engineer's seal with the following statement:

> "I hereby state that this Construction Stormwater Pollution Prevention Plan 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 Pierce County does not and will not assume liability for the sufficiency, suitability, or performance of Construction SWPPP BMPs prepared by me."

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

Certified Erosion Control Lead: Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. For project 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 shall be onsite or on-call at all times.

For complex projects where a Drainage Control Plan is required or where the Construction SWPPP involves engineering calculations, the applicant shall have a professional engineer file with the county an Engineer's Inspection Report Form (obtainable from Pierce County Planning and Public Works' website). before the project is accepted by the county as being completed. 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.

The author of the Construction SWPPP should evaluate the following subject areas for inclusion in the Construction SWPPP narrative. The subject areas below are not a required outline for the Construction SWPPP narrative.

- **General Information on the Existing Site and Project:**
  - *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 area expected to be disturbed by clearing, grading, excavation or other construction activities, including offsite borrow and fill areas; and the volumes of grading cut and fill that are proposed.
  - *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.

- *Adjacent areas* – Describe adjacent areas, including streams, lakes, wetlands, residential areas, and roads that might be affected by the construction project. Describe how upstream drainage areas may affect the site. Provide a description of the downstream drainage leading from the site to the receiving body of water.
- *Critical areas* – Describe areas on or adjacent to the site that are classified as critical areas. Critical areas that receive runoff from the site shall be described up to one-fourth mile away. Describe special requirements and provisions for working near or within these areas.
- *Soil* – Describe the soil on the site, giving such information as soil names, mapping unit, erodibility, ability to settle, permeability, depth, texture, and soil structure.
- *Potential erosion problem areas* – Describe areas on the site that have potential erosion problems.

- **Thirteen 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. Often using a combination of BMPs is the best way to satisfy required Elements. If an Element is not applicable to a project, provide a written justification for why it is not necessary.
- **Construction Phasing:** Describe the intended sequence and timing of construction activities and any proposed construction phasing.
- **Construction Schedule:** Describe the construction schedule. If the schedule extends into the wet season(October 1–April 30), describe what activities 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 (including construction restraints for environmentally sensitive areas).
- **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. See also PCC Title 17A.20.
- **Engineering Calculations:** Attach any calculations made for the design of such items as sediment ponds, diversions, and waterways, as well as calculations for runoff and stormwater detention design (if applicable).

2.2.2 Drawings

It is the responsibility of the project engineer to ensure that engineering drawings supporting the Construction SWPPP shall be sufficiently clear to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of drainage laws and ordinances and these design guidelines. The Construction SWPPP drawings shall include the following items:

- **Vicinity Map:** Provide a map with enough detail to identify the location of the construction site, adjacent roads, and receiving waters.
- **Site Map:** Provide a site map(s) showing the following features. The site map 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) on the drawings.

- The direction of north in relation to the site.
- Existing structures and roads.
- The boundaries and identification of different soil types.
- Areas of potential erosion problems.
- Any onsite and adjacent surface waters, critical areas, their buffers, floodplain boundaries, and Shoreline Management boundaries.
- Existing contours and drainage basins and the direction of flow for the different drainage areas. Contour intervals on the site plan shall be at a minimum as follows:

Slope (%)	Contour Interval (feet)
0–15	2
16–40	5
> 40	10

- Topography must be field verified for drainage easements and conveyance systems. Contours shall extend a minimum of 25-feet beyond property lines and shall 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; e.g., LiDAR data.
- Final and interim grade contours as appropriate, drainage basins, and 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 will discharge to surface waters 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.
- Total cut and fill quantities and the method of disposal for excess material.
- Stockpile; waste storage; and vehicle storage, maintenance, and washdown areas.
- Locations of all joint utility trenches and details of associated erosion and sediment transport control features.

- **Conveyance Systems:** Show on the site map the following temporary and permanent conveyance features:
  - Locations for temporary and permanent swales, interceptor trenches, or ditches
  - Drainage pipes, ditches, or cut-off trenches associated with erosion and sediment control and stormwater management
  - Temporary and permanent pipe inverts and minimum slopes and cover
  - Grades, dimensions, and direction of flow in all ditches and swales, culverts, and pipes
  - Details for bypassing offsite runoff around disturbed areas

  - Locations and outlets of any dewatering systems.
- **Location of Treatment and Detention BMPs:** Show on the site map the locations of temporary and permanent stormwater treatment and/or flow control BMPs.
- **Erosion and Sediment Control BMPs:** Show on the site map all major structural and nonstructural BMPs, including:
  - The location of sediment pond(s), pipes, and structures
  - Dimension pond berm widths and inside and outside pond slopes
  - The trap/pond storage required and the depth, length, and width dimensions
  - Typical section views through pond and outlet structure
  - Typical details of gravel cone and standpipe, and/or other filtering devices
  - Stabilization technique details for inlets and outlets
  - Control/restrictor device location and details
  - Stabilization and cover practices for berms, slopes, and disturbed areas
  - Rock specifications and detail for rock check dam, if used
  - Spacing for rock check dams as required
  - Front and side sections of typical rock check dams
  - The location, detail, and specification for silt fence
  - The construction entrance location and a detail.
- **Detailed Drawings:** Any structural practices used that are not referenced in this manual or other local manuals should be explained and illustrated with detailed drawings.
- **Other Pollutant BMPs:** Indicate on the site map the location of BMPs to be used for the control of pollutants other than sediment. This can include designated concrete washout area, refueling sites, or other BMPs for pollutant control.
- **Monitoring Locations:** Indicate on the site map any required water quality sampling locations. Sampling stations shall be located in accordance with applicable permit requirements.
- Standard Notes are Suggested in Appendix IIA: Notes addressing construction phasing and scheduling shall be included on the drawings.

2.3 Step-by-Step Procedure

There are three basic steps in producing a Construction SWPPP:

1. Data collection
2. Data analysis
3. Construction SWPPP development and implementation.

2.3.1 Step 1 – Data Collection

Evaluate existing site conditions and gather information that will help develop the most effective Construction SWPPP.

- **Evaluate Zoning:** Determine if site zoning per 18A – Development Regulations – Zoning and/or 18J – Development Regulations – Design Standards and Guidelines requires a full/comprehensive LID development or if applicant chooses to apply a full/comprehensive LID development. If pursuing comprehensive LID, see Volume VI for additional requirements and guidelines.
- **Topography:** Prepare a topographic drawing of the site to show the existing contour elevations at intervals of 1- to 5-feet depending upon the slope of the terrain.
- **Drainage:** Locate and clearly mark existing drainage swales and patterns on the drawing, including existing storm drain pipe systems.

  Soils: Identify and label soil type(s) and erodibility (slight, moderate, severe, very severe, or an index value from the Natural Resources Conservation Service (NRCS) manual) on the drawing or in the narrative.

  Characterize soils for permeability, water holding capacity, percent organic matter, and effective depth. Express these qualities in averaged or nominal terms for the subject site or project. This information is typically available in literature published by qualified soil professionals or engineers, such as the NRCSSoil Survey of Pierce County or the NRCS' Web Soil Survey website. For projects that trigger Minimum Requirements #5, #6, or #7, a more detailed soils investigation is required and must be used for the Construction SWPPP soils characterization.
- **Ground Cover:** Label existing vegetation on the drawing. Show features such as tree clusters, grassy areas, and unique or sensitive vegetation. Unique vegetation may include existing trees above a given diameter. Requirements regarding tree preservation should be investigated; these are primarily found in Pierce County Code (PCC) Title 18J and 18E. In addition, existing denuded or exposed soil areas should be indicated.
- **Critical Areas:** Delineate PCC Title 18E defined critical areas adjacent to or within the site on the drawing. 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 drawings. On the drawings, show other related jurisdictional boundaries such as Shorelines Management and the Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas. Some critical areas may require specialist and or a separate permit to develop and locate. Consult with Planning andPublic Works – PPW if the site is in a potential critical hazard area.
- **Adjacent Areas:** Identify existing buildings, roads, and facilities adjacent to or within the project site on the drawings. Identify existing and proposed utility locations, construction clearing limits and Construction SWPPP BMPs on the drawings.
- **Existing Encumbrances:** Identify wells, existing and abandoned septic drainfield, utilities, easements, setbacks, and site constraints.
- **Precipitation Records:** Determine the average monthly rainfall and rainfall intensity for the required design storm events. These records may be available from the county. Volume III also includes resources for determining rainfall values.

2.3.2 Step 2 – Data Analysis

Consider the data collected in Step 1 to visualize potential problems and limitations of the site. Determine those areas that have critical erosion hazards. The following are some important

factors to consider in data analysis:

- **Ground Cover:** Ground cover is the most important factor in terms of preventing erosion. Existing vegetation that can be saved will prevent erosion better than constructed BMPs. Trees and other vegetation protect the soil structure. If the existing vegetation cannot be saved, consider such practices as phasing construction, temporary seeding, and mulching. Phasing construction involves stabilizing one part of the site before disturbing another. In this way, the entire site is not disturbed at once.
- **Topography:** The primary topographic considerations are slope steepness and length. Steeper and longer slopes have greater erosion potential than do flat and short slopes. A qualified engineer, soil professional, or certified erosion control specialist should determine erosion potential.
- **Drainage:** Convey runoff through the use of natural drainage patterns that consist of overland flow, swales and depressions to avoid constructing an artificial drainage system. Properly stabilize man-made ditches and waterways so they do not create erosion problems. Take care to 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 where groundwater may be encountered and away from critical areas where drainage will concentrate. Preserve natural drainage patterns on the site.
- **Soils:** Evaluate soil properties such as surface and subsurface runoff characteristics, depth to impermeable layer, depth to seasonal groundwater table, permeability, shrink-swell potential, texture, ability to settle, and erodibility. Develop the Construction SWPPP based on known soil characteristics. Protect infiltration sites from clay and silt, which will reduce infiltration capacities and from compaction by heavy traffic.
- **Critical Areas:** Critical areas, per PCC Title 18E, may include but are not limited to flood hazard areas, mine hazard areas, slide hazard areas, sole source aquifers, wetlands, stream banks, fish-bearing streams, and other water bodies. Delineate critical areas and their buffers on the drawings and clearly flag critical areas in the field. For example, fencing may be more useful than flagging to ensure that equipment operators stay out of critical areas. Only unavoidable work shall take place within critical areas and their buffers. Such unavoidable work will require special BMPs, permit restrictions, and mitigation plans – documented in the Construction SWPPP.
- **Adjacent Areas:** 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, and sensitivities of and risks to downstream resources, such as private property, stormwater facilities, public infrastructure, or aquatic systems. Select Construction SWPPP BMPs accordingly.
- **Precipitation Records:** Refer to Volume III, Chapter 2, to determine the required rainfall records and the method of analysis for design of BMPs.
- **Timing of the Project:** Consider the timing and duration of the project when selecting BMPs. 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.

2.3.3 Step 3 – Construction SWPPP Development and Implementation

After collecting and analyzing the data to determine the site limitations, a Construction SWPPP can then be developed. The 13 Elements below must be considered and included in the Construction SWPPP. If site conditions render the Element unnecessary, the exemption from that Element must be clearly justified in the narrative of the Construction SWPPP.

The Construction SWPPP shall be implemented beginning with initial land disturbance and until final stabilization.

Element #1: Preserve Vegetation/Mark Clearing Limits

- Before 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.
- Retain the duff layer, native top soil, and natural vegetation in an undisturbed state to the maximum degree practical.
- Plastic, metal, or fabric fence may be used to mark the clearing limits. [Note the difference between the practical use and proper installation of BMP C233:Silt Fence, and the proper use of BMP C103:High Visibility Fence.]
- If it is not practical to retain the native topsoil or duff layer in place, then stockpile it onsite or at an approved location, cover it to prevent erosion, and replace it immediately when you finish disturbing the site. See soil preservation and amendment in Volume III, Section 3.1 for more information.

  Suggested BMPs:
  - BMP C101: Preserving Natural Vegetation
  - BMP C102: Buffer Zones
  - BMP C103: High Visibility Fence
  - BMP C233: Silt Fence

Element #2: Establish Construction Access

- Limit construction vehicle access and exit to one route, if possible. Minimize construction site access points along linear projects, such as roadways.
- Stabilize access points with a pad of quarry spalls, crushed rock, or other equivalent BMPs, to minimize tracking sediment onto all roads and accesses.
- Locate wheel wash or tire baths onsite, if the stabilized construction entrance is not effective in preventing tracking sediment onto roads/accesses.
- If sediment is tracked offsite, clean the affected roadway/access thoroughly at the end of each day, or more frequently as necessary (for example, during wet weather). Remove sediment from roads by shoveling, sweeping, or picking up and transporting the sediment to a controlled sediment disposal area.
- Conduct street washing only after sediment is removed in accordance with the above bullet.
- Control street wash wastewater by pumping back onsite, or otherwise preventing it from discharging into systems tributary to the county municipal separated storm sewer system

(MS4), wetlands, or waters of the State.

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 of 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.

Where necessary to comply with the bullet above, construct stormwater infiltration or detention BMPs as one of the first steps in grading. Assure that detention BMPs function properly before constructing site improvements (e.g., impervious surfaces).

- Sites that must implement flow control 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 predeveloped condition for the range of predeveloped discharge rates from half of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. The predeveloped condition to be matched shall be the land cover condition immediately prior to the development project. This restriction on release rates can affect the size of the storage pond and treatment cells. The county may require designs that provide additional or different stormwater flow control if necessary to address local conditions or to protect properties and waterways downstream from high flow impacts.
- If permanent infiltration BMPs are used for temporary flow control during construction, protect these BMPs from siltation during the construction phase.
- Conduct downstream analysis if changes in offsite flows could impair or alter conveyance systems, streambanks, bed sediment, or aquatic habitat. See Volume I, Chapters 2 and 3 for potential offsite analysis requirements and guidelines.
- Even gently sloped areas need flow controls such as straw 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.

  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.

  Erosion has the potential to occur because of increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site. The county may require infiltration or detention BMP designs that provide additional or different stormwater flow control than the designs detailed in this manual. These requirements may be necessary to address local conditions or to protect properties and waterways downstream.

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 a county 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 county storm 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.
- 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 Volume III, Detention Facilities, Infiltration Stormwater Quantity and Flow Control.

Element #4: Install Sediment Controls

Designs install, and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants.

- Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.
- Minimize sediment discharges from the site. The design, installation, and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity, and duration of precipitation; the nature of resulting stormwater runoff; and soil characteristics, including the range of soil particle sizes expected to be present on the site.
- Direct stormwater runoff from disturbed areas through a sediment pond or other appropriate sediment removal BMP, before the runoff leaves a construction site or before discharge to an infiltration facility. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard in Element #3: Control Flow Rates.

  Locate BMPs intended to trap sediment onsite in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.
- Provide and maintain natural buffers around surface waters, direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltraton, unless infeasible.
- Design outlet structures that withdraw impounded stormwater from the surface to avoid

discharging sediment that is still suspended lower in the water column.

Outlet structures that withdraw impounded stormwater from the surface are for construction period only. If installing a floating pump structure, include a stopper to prevent the pump basket from hitting the bottom of the pond.

If a sediment trapping BMP utilizes a control structure that will also be used in a permanent detention BMP applicaton, the control structure construction must be finalized for the permanent BMP application upon project completion.

Install sediment controls in a manner that protects the sensitive areas and their buffers marked in accordance with Element #1: Preserve Vegetation/Mark Clearing Limits

- Where feasible, direct stormwater to vegetated areas to increase sediment removal and maximize stormwater infiltration.

  Seed and mulch earthen structures such as dams, dikes, and diversions according to the timing indicated in Element #5: Stabilize Soils.

  Full stabilization includes 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 may inspect and approve areas fully stabilized by means other than pavement or quarry spalls.

  Suggested BMPs:
  - BMP C231: Brush Barrier
  - 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 exposed and unworked soils by application of effective BMPs that prevent erosion. Applicable BMPs 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.
- Full stabilization means all soil disturbing activities at the site have been completed and areas where the soil or natural vegetative cover has been disturbed have been properly covered and accepted to meet permanent erosion control. Permanent erosion control can include concrete or asphalt paving; quarry spalls used as ditch lining; application of thick layers of gravel or mulch; or vegetative cover in a manner that will fully prevent soil erosion.

  Where the term “fully established” is used to describe vegetative cover or plantings, it shall

be understood to mean that healthy vegetation covers 90 percent of exposed bare soil. The application of hydroseeding, even in conjunction with a bonded fiber matrix (BFM) or rolled erosion product, will not be accepted as fully established permanent erosion control before the necessary development and ground cover requirements of the plantings are met. The strong root structures of well-established vegetation are an essential mechanism in controlling soil erosion. The county will inspect and must approve all areas as fully stabilized before the release of financial guarantees.

- Control stormwater volume and velocity within the site to minimize soil erosion.
- 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.
- Soils must not remain exposed and unworked for more than the time periods set forth below to prevent erosion.
    - During the dry season (May 1–Sept. 30): 7 days
    - During the wet season (October 1–April 30): 2 days
- Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.

  Stabilize soil stockpiles from erosion; protect with sediment trapping measures; and where possible, locate 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.
- Soil stabilization BMP 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.
- Ensure that gravel base used for stabilization is clean, does not contain fines or sediment, and remains clean and within specifications prior to paving.

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 to minimize erosion.
- Consider soil type and its potential for erosion. Applicable practices include, but are not limited to, reducing continuous length of slope with terracing and diversions, reducing slope steepness, and roughening slope surfaces (for example, track walking).
- Divert offsite stormwater (run-on) or groundwater away from slopes and disturbed areas with interceptor dikes, pipes, and/or swales. Offsite stormwater must be managed 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 volumetic 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 should be modeled as “landscaped” area.
- Permanent pipe slope drains shall be sized for the 100year, 24hour 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: Stabilize Soils.
- BMP combinations are the most effective method of protecting slopes with disturbed soils. For example, use both mulching and straw erosion control 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.
- Clean or remove and replace inlet protection devices when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).
- Inlets shall be inspected weekly at a minimum and daily during storm events.
- Where possible, protect all existing storm drain inlets 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 (as defined above) unless treatment is provided before the storm drain discharges to waters of the State.

Suggested BMPs:

- BMP C220: Storm Drain Inlet Protection

Element #8: Stabilize Channels and Outlets

- Design, construct, and stabilize all onsite 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 should 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 preferred 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: Net 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 proponents must:

- Handle and dispose of all pollutants, including waste materials and demolition debris that occur onsite in a manner that does not cause contamination of stormwater. Woody debris may be chopped and spread onsite.
- 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. Onsite fueling tanks must include secondary containment. Secondary containment means placing tanks or containers within an impervious structure capable of containing 110 percent of the volume contained in the largest tank within the containment structure. Double-walled tanks do not require additional secondary containment.
- Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident.
- Conduct 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 using spill prevention measures, such as drip pans.
- Discharge wheel wash or tire bath wastewater to a separate onsite treatment system that prevents discharge to surface water, or to the sanitary sewer. For discharges to the sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 7983013.
- Apply 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.
- Use BMPs to prevent contamination of stormwater runoff by pH-modifying sources. The 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.
- Adjust the pH of stormwater if necessary to prevent violations of the water quality

standards.

- Assure that washout of concrete trucks is performed offsite 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. Washout of small concrete handling equipment may be disposed of in a formed area awaiting concrete where it will not contaminate surface or groundwater. Do not dump excess concrete onsite, except in designated concrete washout areas. Concrete spillage or concrete discharge directly to groundwater or surface waters of the State is prohibited. Do not wash out to formed areas awaiting infiltration BMPs.

  Obtain written approval from Ecology before using chemical treatment other than CO_2, dry ice or food grade vinegar to adjust pH.

- 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 pH is in the range of 6.5 to 8.5 (su).

- 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.

- Do not use upland land applications for discharging wastewater from concrete washout areas.

  Clean contaminated surfaces immediately following any discharge or spill incident. Emergency repairs may be performed onsite using temporary plastic placed beneath and, if raining, over the vehicle.

  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 Dewatering

- Discharge foundation, vault, and trench dewatering water, which have characteristics similar to stormwater runoff at the site, into a controlled conveyance system before discharge to BMP C240:Sediment Trap or BMP C241: Temporary Sediment Pond.

- Discharge clean, non-turbid dewatering water, such as well-point groundwater, to systems tributary to, or directly into surface waters of the State, as specified in Element #8: Stabilize Channels and Outlets, provided the dewatering flow does not cause erosion or flooding of

receiving waters. 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 offsite; for example, a creek running through a site.

- Highly turbid or contaminated dewatering water from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, shall be handled separately from stormwater.
- Other dewatering treatment or disposal options may include:
  - Infiltration.
  - Transport offsite in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute waters of the State.
  - Ecology-approved onsite chemical treatment or other suitable treatment technologies.
  - Sanitary or combined sewer discharge with local sewer authority approval, if there is no other option. For discharges to the sanitary sewer, permits must be obtained from the Pierce County's Industrial Pretreatment Program at (253) 798-3013.
  - Use of a sedimentation bag with discharge to a ditch or swale for small volumes of localized dewatering.
- Channels must be stabilized, as specified in Element #8: Stabilize Channels and Outlets.
- 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.
- Dewatering water from contaminated sites must be handled separately from stormwater. Direct contaminated stormwater to approved treatment or to a sanitary sewer with local sewer authority approval if there is no other option. For discharges to the sanitary sewer, permits must be obtained from Pierce County's Industrial Pretreatment Program at (253) 798- 3013.

Suggested BMPs:

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

Element #11: Maintain BMPs

- Maintain and repair all temporary and permanent Construction SWPPP 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 achieving final site stabilization or after the temporary BMPs are no longer needed.
- Note: Some temporary erosion and sediment control BMPs are bio-degradable and designed to remain in place following construction such as compost socks.
- Provide protection to 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 conditions. 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.

- Remove or stabilize trapped sediment onsite. Permanently stabilize disturbed soil resulting from removal of BMPs or vegetation.

  Suggested BMPs:

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

Element #12: Manage the Project

- Phase development projects to the maximum degree practicable and take into account seasonal work limits.
- Inspection and monitoring – Inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function. Conduct site inspections and monitoring in accordance with all applicable county requirements. Projects regulated under the Construction Stormwater General Permit (CSWGP) must conduct site inspections and monitoring in accordance with Special Condition S4 of the CSWGP.
- Maintaining an updated Construction SWPPP – Maintain, update, and implement the Construction SWPPP in accordance with the Construction Stormwater General Permit requirements and the requirements outlined in this Element (#12).
- Project sites that disturb 1 acre or more must have site inspections conducted by a Certified Erosion and Sediment Control Lead (CESCL). Project sites disturbing less than 1 acre may have a CESCL or a person without CESCL certification conduct inspections. By the initiation of construction, the Construction SWPPP must identify the CESCL or inspector, who shall be present onsite 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 an updated Construction SWPPP

Additional Guidance for Site Inspections:

- The CESCL (or other inspector for sites disturbing less than 1 acre) must have the skills to assess the:
  - Site conditions and construction activities that could impact the quality of stormwater
  - Effectiveness of Construction SWPPP 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.

- 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 Construction SWPPP Elements and making appropriate revisions within 7 days of the inspection
  - Immediately begin 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 an extension within the initial 10day 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 site inspector must inspect all areas disturbed by construction activities, all BMPs, and all stormwater discharge locations 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 1 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.) Note that for projects that require a CESCL per BMP C160: Certified Erosion and Sediment Control Lead additional requirements may apply. The inspector may reduce the inspection frequency for temporary stabilized, inactive sites to once every calendar month during the dry season only (May 1 through September 30).

Additional Guidance:

- **Phasing of Construction:**

  Phase development projects where feasible in order to prevent soil erosion and, to the maximum extent practical, and prevent transporting sediment from the site during construction. Revegetate exposed areas and maintain that vegetation as an integral part of the clearing activities for any phase.

- **Coordination with Utilities and Other Contractors:**

  The primary project applicant 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:**

  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 knowledgeable in the principles and practices of erosion and sediment control. The person 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 Construction SWPPP measures used to control the quality of stormwater discharges.

  For project sites that will disturb 1 acre or more and that discharge stormwater to surface waters of the State, a CESCL must be identified in the Construction SWPPP; this person must be onsite 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.

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.

Inspection reports and daily logs must be available onsite or within reasonable access to the site with the Construction SWPPP and shall be submitted to the county upon request at any time during the course of the project.

- **Maintaining an Updated Construction SWPPP:**

  Retain the Construction SWPPP onsite or within reasonable access to the site.

  Modify the Construction SWPPP 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, or the applicable county or state regulatory authority, it is determined that the Construction SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. Modify the Construction SWPPP as necessary to include additional or modified BMPs designed to correct problems identified. Complete revisions to the Construction SWPPP 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

The primary purpose of Onsite Stormwater Management is to reduce the disruption of the natural site hydrology through infiltration. BMPs used to meet 2.4.5 Minimum Requirement #5: Onsite Stormwater Management in Volume I of this manual (often called LID BMPs) are permanent facilities.

- 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 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 capabilities 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.
- Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material

or pavement. Do not allow sediment-laden runoff onto permeable pavements, including permeable pavement subgrade, reservoir course, or wearing course.

- Permeable pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures shown in Volume III of this manual or the manufacturer's procedures.

  Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.

- **See Section 3.3 for more details on protecting LID BMPs.**

  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 (TSD) (Geotextile-Encased Check Dam)
  - BMP C231: Brush Barrier
  - BMP C233: Silt Fence
  - BMP C234: Vegetated Strip

Chapter 3. Best Management Practices Standards and Specifications

Best Management Practices (BMPs) are defined as schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices, that when used singly or in combination, prevent or reduce the release of pollutants to waters of Washington State. This chapter contains standards and specifications for temporary BMPs to be used as applicable 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 throughout 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.

The standards for each individual BMP are divided into four sections:

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

Note that the “conditions of use” always refer to site conditions. As site conditions change, BMPs must be changed to remain in compliance.

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

3.1 Source Control BMPs

This section contains the standards and specifications for source control BMPs. Table 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 2.3.3. Elements not shown on Table 3.1 are not satisfied through installation of source controls.

Table 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 #8 Stabilize Channels and Outlets	Element #9 Control Pollutants	Element #11 Maintain BMPs	Element #12 Manage the Project	Element #13 Protect Low Impact Development
BMP C101: Preserving Natural Vegetation	✓								
BMP C102: Buffer Zones	✓								✓
BMP C103: High Visibility Plastic or Metal 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 C151: 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

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. For example, conifers can hold up to about 50 percent of all rain that falls during a storm. Up to 20 to 30 percent of this rain may never reach the ground but is taken up by the tree or evaporates. Another benefit is that the rain held in the tree can be released slowly to the ground after the storm.

Conditions of Use

- Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas.
- As required by the county or other agencies.

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. County ordinances to save natural vegetation and trees should be reviewed.
- Fence or clearly mark areas around trees that are to be saved. It is preferable to keep ground disturbance away from the trees at least as far out as the dripline.

Plants need protection from three kinds of injuries:

- **Construction Equipment:** This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Placing a fenced buffer zone around plants to be saved prior to construction can prevent construction equipment injuries.
- **Grade Changes:** Changing the natural ground level will alter grades, which affects the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary and should be checked. Trees can typically tolerate fill of 6-inches or less. For shrubs and other plants, the fill should be less.

  When there are major changes in grade, it may become necessary to supply air to the roots of plants. 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 dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area.

  Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage of the plant roots are in the upper 12-inches of the soil and cuts of only 2-to 3-inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the dripline of

the plant.

- **Excavations:** Protect trees and other plants when excavating for drainfields, power, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers. If it is not possible to route the trench around plants to be saved, then the following should be observed:
  - Cut as few roots as possible. When you have to cut, cut clean. Paint cut root ends with a wood dressing like asphalt base paint if roots will be exposed for more than 24 hours.
  - Backfill the trench as soon as possible.
  - Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots.

Some problems that can be encountered with a few specific trees are:

- Maple, Dogwood, Red alder, Western hemlock, Western red cedar, and Douglas fir do not readily adjust to changes in environment and special care should be taken 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. These can cause trouble in sewer lines and infiltration fields. On the other hand, they 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 recover 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

Delineation of an area to remain undisturbed or strip of natural vegetation or an established suitable planting that will 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 be used to protect natural swales and can be incorporated into the natural landscaping of an area.

Critical-areas buffer zones should not be used 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 generally 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. High visibility fencing is the most effective method in protecting sensitive areas and buffers. Alternatively, 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 shall be 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 remains undisturbed. Replace all damaged fencing or flagging immediately.

BMP C103: High Visibility Fence

Purpose

Fencing is intended to:

- Restrict clearing to approved limits
- Prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed
- Limit construction traffic to designated construction entrances, exits or internal roads
- Protect areas where marking with flagging/survey tape 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. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high visibility orange. The fence tensile strength shall be 360 pounds/feet using the American Society for Testing and Materials (ASTM) D4595 testing method.
- If appropriate install fabric silt fence in accordance with BMP C233: Silt Fence to act as high visibility fence. Except that the silt fence shall be at least 3-feet high and must be highly visible to meet the requirements of this BMP.
- Metal fences are the least preferred but might be appropriate to address security concerns. Metal fencing shall be designed and installed according to the manufacturer's specifications.
- Metal fences shall be at least 4-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

Stabilized construction entrances are established to reduce the amount of sediment transported onto paved roads outside the project site by vehicles or equipment. This is done 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 be entering or leaving a construction site if paved roads or other paved areas are within 1,000-feet of the site.

For residential construction, 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 and configuration.

Design and Installation Specifications

- See Attachments Section C, Detail 4.0 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).
- 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. For single family residential lots pad may be reduced in length to fit site, to no less than 20-feet long, and in depth, to 6-inch thick with 4-inch to 6inch quarry spalls, provided that performance standards are still met.
- Do not use crushed 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 minimum
    - Grab Tensile Elongation (ASTM D4632): 30 percent maximum
    - Mullen Burst Strength (ASTM D378680a): 400 psi minimum
    - AOS (ASTM D4751): 20 to 45 (U.S. standard sieve size).
- Fencing (see BMP C103: High Visibility Fence) 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.

Maintenance Standards

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

- Construction entrances should avoid crossing existing sidewalks and back of walk drains if at all possible. 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.
- 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 onsite. The pavement shall not be cleaned by washing down the street, except when high efficiency sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump to contain the wash water may be required. The sediment would then be washed 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 as these sweepers create dust and throw soil into nearby storm systems or conveyance ditches.
- Any quarry spalls that are loosened from the pad, which 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: High Visibility Fence) 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.

Approved as Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C105: Stabilized Construction Entrance/Exit. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from the Pierce County Planning and Public Works (PPW) website. The county website is updated routinely, but the latest list is available on Ecology's website.

Contact the county if a new Ecology approved product is not listed on the county website.

BMP C106: Wheel Wash

Purpose

Wheel washes reduce the amount of sediment transported onto paved roads by washing dirt from the wheels of motor vehicles prior to the motor vehicles leaving the construction site.

Conditions of Use

Use a wheel wash when BMP C105: Stabilized Construction Entrance/Exit is not preventing sediment from being tracked off site.

- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope

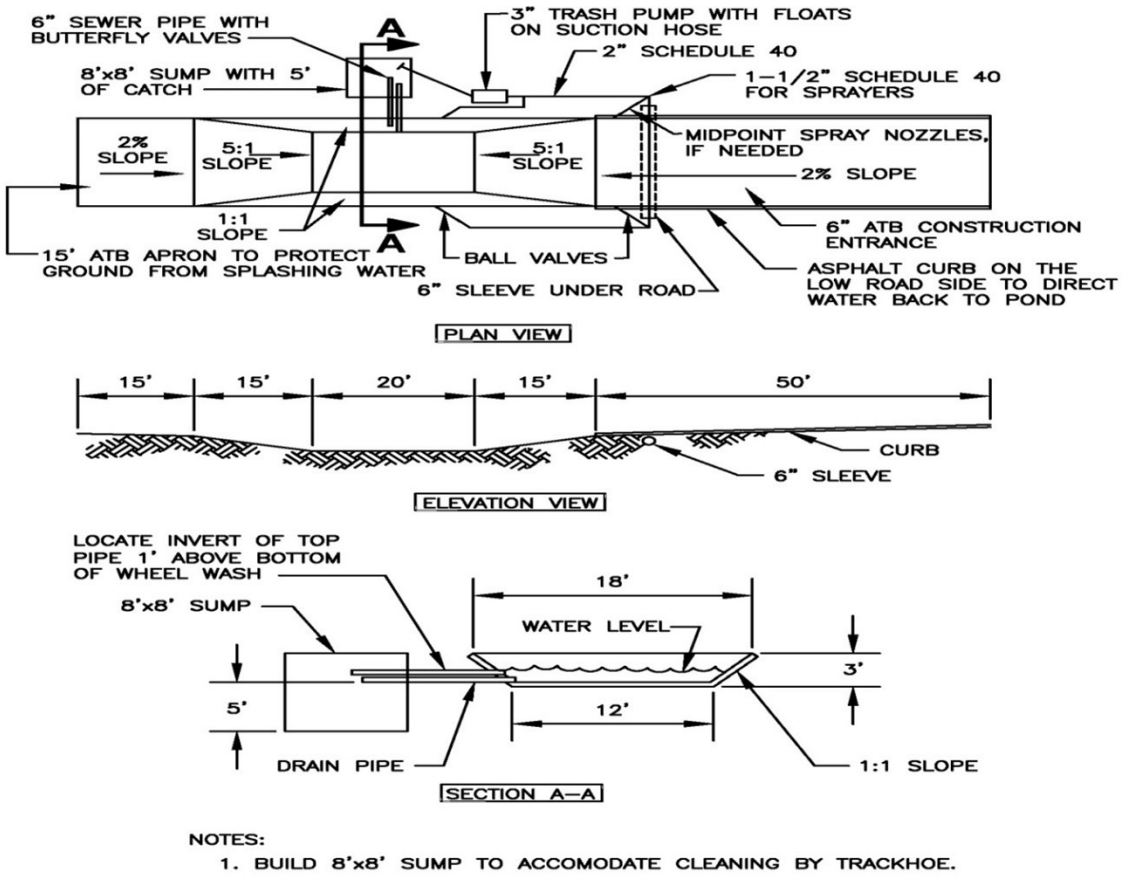
abutting a right-of-way where the water from the dripping truck can run unimpeded into the street.

- 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 onsite treatment system that prevents discharge to waters of the State, or to the sanitary sewer with county approval. For discharges to the sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 798-3013.
- Wheel washes may use closed-loop recirculation systems to conserve water use.
- Wheel wash wastewater shall 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 3.1. A minimum of 6 inches of asphalt treated base 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 the wheel wash 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.
- Wheel wash systems should be designed 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 resuspension of sediment. A drainpipe with a 2 to 3foot riser should be installed 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

Figure 3.1. - Wheel Wash



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 the sump can be cleaned with a trackhoe.

6 Asphalt curb on the low road side to direct water back to pond.

7 6-inch sleeve under road.

8 Ball valves.

9 15-foot. Asphalt treated base apron to protect ground from splashing water.

Maintenance Standards

The wheel wash should start out the day with fresh water.

The washwater should be changed a minimum of once per day. On large earthwork jobs where more than 10 to 20 trucks per hour are expected, the washwater will need to be changed more often.

BMP C107: Construction Road/Parking Area Stabilization

Purpose

Stabilizing subdivision roads, parking areas, and other onsite vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

Conditions of Use

- Roads or parking areas shall be stabilized wherever they are constructed, whether permanent or temporary, for use by construction traffic.
- High Visibility Fencing (see BMP C103: High Visibility Fence) 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. This is not appropriate when final surface is permeable pavement.
- A 6inch depth of 2 to 4inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. If the area will not be used for permanent roads, parking areas, or structures, a 6inch 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 superelevated 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 that water can flow through, then it is generally 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 stormwater drainage system (see BMP C220: Storm Drain Inlet Protection).

Maintenance Standards

- Inspect stabilized areas regularly, especially after large storm events.
- Crushed rock, gravel base, hog fuel, 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 preconstruction 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 with a well-established vegetative cover. This is one of the most effective methods of reducing erosion.

Conditions of Use

- Use seeding 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 with straw or an erosion control blanket until 75 percent grass cover is established.
- Where the term "fully established" is used to describe vegetative cover or plantings, it shall be understood to mean that healthy vegetation covers 90 percent of exposed soil.
- Inspect all disturbed areas in late August to early September and complete all seeding by the end of September. Otherwise, vegetation will not establish itself enough to provide more than average protection.
- 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.
- Seed and mulch all disturbed areas not otherwise vegetated at final site stabilization. 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) that will prevent erosion.

Design and Installation Specifications

- Seed infiltration/detention ponds as required.
- Install channels intended for vegetation before starting major earthwork and hydroseeded with a Bonded Fiber Matrix (BFM). 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.
- Confirm the installation of all required surface water control measures to prevent seed from washing away.
- The seedbed should be firm and rough. All soil should be roughened no matter what the 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 the

subgrade should be initially ripped to improve long-term permeability, infiltration, and water inflow qualities. At a minimum, permanent areas shall use soil amendments to achieve organic matter and permeability performance defined in engineered soil/landscape systems. For systems that are deeper than 8-inches the rototilling process should be done in multiple lifts, or the prepared soil system shall be prepared properly and then placed to achieve the specified depth.

- 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, 1046 NPK (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 and agitated more than 20 minutes before it is to be used. If agitated too much, the slow-release coating is destroyed.
- There are numerous products available on the market that takes 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.
- Hydroseed applications shall include a minimum of 1,500 pounds per acre of mulch with 3 percent tackifier. See BMP C121: Mulching for specifications.
- On steep slopes, BFM or Mechanically Bonded Fiber Matrix (MBFM) products should be used. 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.
- BFMs and MBFMs have some advantages over blankets:
    - 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
    - They are at least $1,000 per acre cheaper installed.
- 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.
- 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 on

the disturbed soil surface before application. See also soil preservation and amendment in Volume III, Section 3.1.

- When installing seed via hydroseeding operations, only about one-third 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 seed quantities by up to 50 percent.
- Enhance vegetation establishment by dividing the hydromulch operation into two phases:
  1. Phase 1 – Install all seed and fertilizer with 25 to 30 percent mulch and tackifier onto soil in the first lift.
  2. Phase 2 – Install the rest of the mulch and tackifier over the first lift.

  Or, enhance vegetation by:

  1. Installing the mulch, seed, fertilizer, and tackifier in one lift.
  2. Spread or blow straw over the top of the hydromulch at a rate of 800 to 1,000 pounds per acre.
  3. 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 BFM or Mechanically Bonded Fiber Matrix (MBFM) (3,000 pounds per acre minimum).

  - Seed may be installed by hand if:
    - Temporary and covered by straw, mulch, or topsoil
    - Permanent in small areas (usually less than 1 acre) and covered with mulch, topsoil, or erosion blankets.
      - The seed mixes listed in the tables below include recommended mixes for both temporary and permanent seeding.
      - Apply these mixes, with the exception of the wetland mix, at a rate of 120 pounds per acre. This rate can be reduced if soil amendments or slow-release fertilizers are used.
      - Consult the local suppliers or the local conservation district for their 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.
      - Other mixes may be appropriate, depending on the soil type and hydrology of the area.
      - Table 3.2 represents the standard mix for areas requiring a temporary vegetative cover.

Table 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 3.3 lists a recommended mix for landscaping seed.

Table 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

- Table 3.4 lists a turf seed mix in dry situations where there is no need for watering. This mix requires very little maintenance.

Table 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 3.5 lists a mix for bioswales and other intermittently wet areas.

Table 3.5. - Bioswale Seed Mix.[a]

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

- Table 3.6 lists a low-growing, relatively non-invasive seed mix appropriate for very wet areas that are not regulated wetlands. Apply this mixture at a rate of 60 pounds per acre. Consult Hydraulic Permit Authority (HPA) for seed mixes if applicable.

a Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix

Table 3.6. - Wet Area Seed Mix.[a]

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

- Table 3.7 lists a recommended meadow seed mix for infrequently maintained areas or non-maintained areas where colonization by native plants is desirable. 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. Consider the appropriateness of clover, a fairly invasive species, in the mix. Amending the soil can reduce the need for clover.

Table 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, this time limit may be relaxed at the discretion of the county when sensitive areas would otherwise be protected.
- Reseed and protect by mulch any areas that experience erosion after achieving adequate cover. Reseed and protect by mulch any eroded area.
- Supply seeded areas with adequate moisture, but do not water to the extent that it causes runoff.

Approved as Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C120: Temporary and Permanent Seeding. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from Pierce County Planning and Public Works' (PPW) website. The county website is updated routinely, but the latest list from Ecology is available on Ecology's website. Contact the county if a new Ecology approved product is not listed on the county website.

a Modified Briargreen, Inc. Hydroseeding Guide Wetlands Seed Mix

BMP C121: Mulching

Purpose

Mulching soils provides immediate temporary protection from erosion. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures. There is an enormous variety of mulches that can be used. This section discusses only the most common types of mulch.

Conditions of Use

As a temporary cover measure, mulch should be used:

- For less than 30 days on disturbed areas that require cover.
- At all times for seeded areas, especially during the wet season and during the 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 of wood, recycled cellulose, hemp, kenaf; compost; or blends of these. Tackifier shall be plant-based, such as guar or alpha plantago, or chemical-based such as polyacrylamide or polymers. Any mulch or tackifier product used shall be installed per manufacturer's instructions. Generally, mulches come in 40 to 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: Polyacrylmide (PAM) for Soil Erosion Protection for conditions of use. PAM shall not be directly applied to water or allowed to enter a water body.

Design and Installation Specifications

For mulch materials, application rates, and specifications, see Table 3.8. Always use a 2inch minimum mulch thickness; increase the thickness until the ground is 95 percent 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.

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

- Mulch may be applied at any time of the year and must be refreshed periodically
- Minimum Percent passing 3" sieve openings 100 percent
- Minimum Percent passing 1" sieve openings 90 percent
- Minimum Percent passing 0.75" sieve openings 70 percent
- Minimum Percent passing 0.25" sieve openings 40 percent.

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 Hydraulic Permit Authority (HPA) for mulch mixes if applicable.

Table 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" thick; five bales per 1,000 sf or 2 to 3 tons per acre	Cost-effective protection when applied with adequate thickness. Hand-application generally requires greater thickness than blown straw. The thickness of straw 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 as even light winds will blow it away. Straw, however, has several deficiencies that should be considered when selecting mulch materials. It often introduces and/or encourages the propagation of weed species and it has no significant long-term benefits. It should also not be used within the ordinary high-water elevation of surface waters (due to flotation).
Hydromulch	No growth inhibiting factors.	Approx. 35 to 45 lbs per 1,000 sf or 1,500 to 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 0.75 to 1-inch clog hydromulch equipment. Fibers should be kept to less than 0.75 inch.
Compost	No visible water or dust during handling. Must be produced per WAC 173-350, Solid Waste Handling Standards, but may have up to 35% biosolids.	2" thick min.; approx. 100 tons per acre (approx. 750 lbs per cubic yard)	More effective control can be obtained by increasing thickness to 3". Excellent mulch for protecting final grades until landscaping because it can be directly seeded or tilled into soil as an amendment. Compost used for mulch has a coarser size gradation than compost used for BMP C125 or the soil preservation and amendment BMP see Volume III, Section 3.1. It is more stable and practical to use in wet areas and during rainy weather conditions. Do not use near wetlands or near phosphorous impaired water bodies.
Chipped Site Vegetation	Gradations from fines to 6 inches in length for texture, variation, and interlocking properties. Include a mix of various sizes so that the average size is between 2-and 4-inches	2" thick min.	This is a cost-effective way to dispose of debris from clearing and grubbing, and it eliminates the problems associated with burning. Generally, it should not be used on slopes above approx. 10 percent because of its tendency to be transported by runoff. It is 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. Note: thick applicatin of this material over existing grass, herbaceous species, and some groundcovers could smother and kill vegetation.

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" thick min.; approx. 100 tons per acre (approx. 750 lbs. per cubic yard)	This material is often called “wood straw” or hog 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" 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 one-sixteenth and three-eighths 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 (914.4(4))

Maintenance Standards

- The thickness of the cover must be maintained.
- Any areas that experience erosion shall be remulched 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 remulched.

BMP C122: Nets and Blankets

Purpose

Erosion control nets and blankets are intended to prevent erosion and hold seed and mulch in place on steep slopes and in channels so that vegetation can become well established. In addition, some nets and blankets can be used to 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 instead form a layer of interlocking fibers, typically held together by a biodegradable or photodegradable netting (for example, excelsior or straw blankets). They 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 nets and blankets should be used:

- 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). The application of appropriate netting or blanket to drainage ditches and swales can protect bare soil from channelized runoff while vegetation is established. Nets and blankets can capture a great deal of sediment due to their open, porous structure. Nets and blankets can be used to permanently stabilize channels and may provide a cost-effective, environmentally preferable alternative to riprap. One-hundred percent synthetic blankets manufactured for use in ditches may be easily reused as temporary ditch liners.

Disadvantages of blankets include:

- Surface preparation required
- On slopes steeper than 2.5H:1V, 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 blankets include:

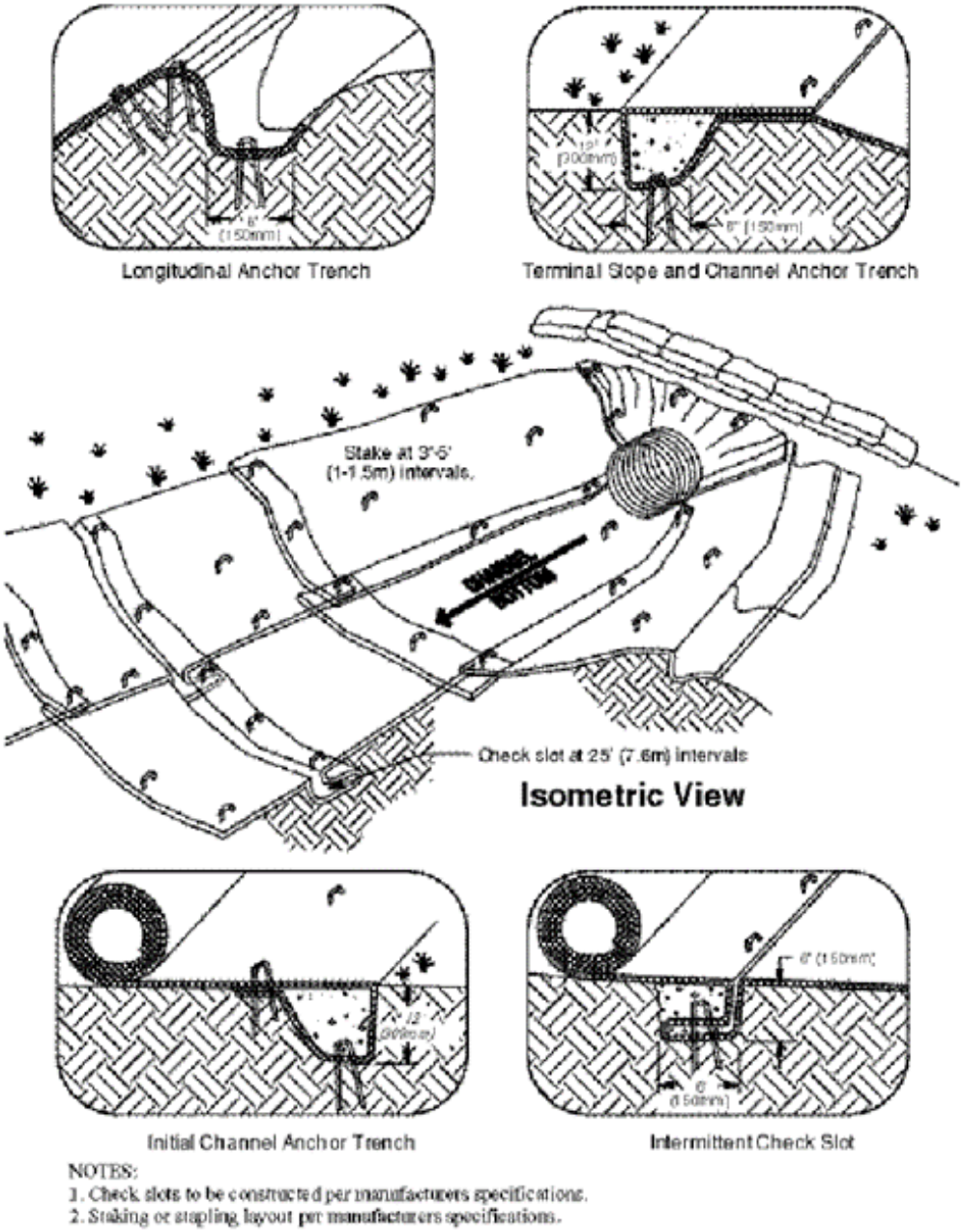
- Installation without mobilizing special equipment
- Installation by anyone with minimal training
- Installation in stages or phases as the project progresses
- Installers can hand place seed and fertilizer as they progress down the slope
- Installation in any weather
- There are numerous types of blankets 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 3.2 and Attachments Section C, Detail 16.0 for typical orientation and installation of blankets used in channels and as slope protection. Note: These are typical only; all blankets must be installed per 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 Blankets on Slopes:**
  - Complete final grade and track walk up and down the slope.
  - Install hydromulch with seed and fertilizer.
  - Dig a small trench, approximately 12-inches wide by 6-inches deep along the top of the slope.
  - Install the leading edge of the blanket into the small trench and staple approximately every 18-inches. NOTE: Staples are metal, Ushaped, and a minimum of 6-inches long. Longer staples are used in sandy soils. Biodegradable stakes are also available.
  - Roll the blanket slowly down the slope as installer walks backwards. NOTE: The 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 blanket being installed. The blanket is not to be allowed to roll down the slope on its own as this stretches the blanket making it impossible to maintain soil contact. In addition, no one is allowed to walk on the blanket after it is in place.
  - If the blanket is not long enough to cover the entire slope length, the trailing edge of the upper blanket should overlap the leading edge of the lower blanket and be stapled. On steeper slopes, this overlap should be installed in a small trench, stapled, and covered with soil.

Figure 3.2. - Channel Installation.



- With the variety of products available, it is impossible to cover all the details of appropriate use and installation. Therefore, it is critical that the design engineer consult 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 at WSDOT's website.
- Use jute matting in conjunction with mulch (BMP C121: Mulching). 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 (e.g., jute matting) require mulch in order to prevent erosion because

they have a fairly open structure. Blankets typically do not require mulch because they usually provide complete protection of the surface.

- Extremely steep, unstable, wet, or rocky slopes are often appropriate candidates for use of synthetic blankets, as are riverbanks, beaches and other high-energy environments. If synthetic blankets are used, the soil should be hydromulched first.
- One-hundred 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 may 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

Plastic covering provides immediate, short-term erosion protection to 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. Note: The relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than 6 months) applications.
- Due to rapid runoff caused by plastic covering, do not use this method 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 additional onsite measures to counteract the increases. Creating a trough with wattles or other material can convey clean water away from these areas.
- To prevent undercutting, trench and backfill rolled plastic covering products.
- While plastic is inexpensive to purchase, the added cost of installation, maintenance, removal, and disposal make this an expensive material, up to $1.50 to $2 per square yard.
- Whenever plastic is used to protect slopes install water collection measures 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. Do not mix clean runoff from a plastic covered slope with dirty runoff from a project.
- Other uses for plastic include:
    - Temporary ditch liner
    - Pond liner in temporary sediment pond
    - Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored
    - Emergency slope protection during heavy rains
    - Temporary drainpipe (“elephant trunk”) used to direct water.

Design and Installation Specifications

- Plastic slope cover must be installed as follows:
    - Run plastic up and down slope, not across slope.
    - Plastic may be installed perpendicular to a slope if the slope length is less than 10-feet.
    - Minimum of 8inch overlap at seams.
    - On long or wide slopes, or slopes subject to wind, tape all seams.
    - Place plastic into a small (12inch wide by 6inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath.
    - Place sand filled burlap or geotextile bags every 3-to 6-feet along seams and tie them

together with twine to hold them in place.

- 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.
- 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 6 mil.
- 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 the plastic if it begins to deteriorate due to ultraviolet radiation.
- Completely remove plastic when no longer needed.
- Dispose of old tires used to weight down plastic sheeting appropriately.

Approved as Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C123: Plastic Covering. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from Pierce County Public Works' (PPW) website. The county website is updated routinely, but the latest list from Ecology is available on Ecology's website . Contact the county if a new Ecology approved product is not listed on the county website.

BMP C124: Sodding

Purpose

The purpose of sodding is to establish permanent turf for immediate erosion protection and to 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 overexcavated 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 10 percent or the permeability is less than 0.6 inches per hour. See <http://www.buildingsoil.org/tools/When_to_Amend.pdf> for further information.
- Fertilize according to the supplier's recommendations.
- Work lime and fertilizer 1-to 2-inches into the soil, and smooth the surface.
- 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. 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

Topsoiling and composting provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling and composting are an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Use this BMP in conjunction with other BMPs such as seeding, mulching, or sodding. Note that this BMP is functionally the same as the soil preservation and amendment BMP (see Volume III, Section 3.1), which is required for all disturbed areas that will be developed as lawn or landscaped areas at the completed project site.

Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they 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

- Permanent landscaped areas shall contain healthy topsoil that reduces the need for fertilizers, improves overall topsoil quality, provides for better vegetative health and vitality, improves hydrologic characteristics, and reduces the need for irrigation.
- Leave native soils and the duff layer undisturbed to the maximum extent practicable. Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. Preserve existing soil systems in undisturbed and uncompacted condition if functioning properly.
- Areas that already have good 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 equal to or better than the original site condition's moisture-holding capacity. Use onsite native soil, incorporate amendments into onsite soil, or importing blended topsoil to meet this requirement.
- 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, and what vegetation was onsite 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 US #200 sieve.
  - Mulch planting beds with 2-inches of organic material.
- Accomplish the required organic content, depth, and pH by returning native topsoil to the site, importing topsoil of sufficient organic content, and/or incorporating organic amendments.
  - When using the option of incorporating amendments to meet the organic content requirement, use compost that meets the composted material specification for bioretention (see Volume III, Section 3.4.6), with the exception that the compost may have up to 35 percent biosolids or manure.
  - Sections three through seven of the document entitled Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington provides useful guidance for implementing whichever option is chosen. It includes guidance for pre-approved default strategies and guidance for custom strategies. The document may be found at soilsforsalmon.org/resources.
- The final composition and construction of the soil system will result in a natural selection or favoring of certain plant species over time. For example, incorporation of topsoil may favor grasses, while layering with mildly acidic, high-carbon amendments may favor more woody vegetation.
- Allow sufficient time in scheduling for topsoil spreading prior to seeding, sodding, or planting.
- Take care when applying top soil to subsoils with contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6-inches.
- 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-inch to 6inch 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 a 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 onsite 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
  - Within 2 days, complete erosion control seeding, or covering stockpiles with clear plastic, or other mulching materials.
- Between May 1 and September 30:
  - An interceptor dike with gravel outlet and silt fence shall surround all topsoil 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 covering stockpiles with clear plastic, or other mulching materials.
- When native topsoil is to be stockpiled and reused the following should apply to ensure that 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 used on construction sites to prevent soil erosion.

Applying PAM to bare soil in advance of a rain event 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 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.

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 website.

In areas that drain to a sediment pond, PAM can be applied to bare soil 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 roadbase.
- 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, PAM should be used together with mulch.

Design and Installation Specifications

PAM may be applied with water in dissolved form. The preferred application method is the dissolved form.

PAM is to be applied at a maximum rate of two-thirds of a pound of PAM per 1,000 gallons water (80 mg/L) per 1 acre of bare soil. Table 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 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:

- Premeasure 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 (two-thirds of a pound PAM/1,000 gallons/acre).
- PAM has high solubility in water, but dissolves very slowly. Dissolve premeasured 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.
- Prefill the water truck about one-eighths 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 pounds per acre. This must be applied on a day that is dry. For areas less than 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:

- Powered 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 3 months after exposure to sunlight and air.
- Proper application and reapplication 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.
- 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 less than 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 U.S. Department of Agriculture (USDA)/ARS demonstrated that soil stabilization was optimized by using very high molecular weight (12 to 15 mg/mole), highly anionic (more than 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 pound per 1,000 gallons of water in a hydromulch machine. Some tackifier product instructions say to use at a rate of 3 to 5 pounds 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 Revised Code of Washington (RCW) 90.48.080.

  PAM may affect the treatment efficiency of chitosan flocculent systems.

BMP C130: Surface Roughening

Purpose

Surface roughening aids in the establishment of vegetative cover, reduces runoff velocity, increases infiltration, and provides 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 of Use

- All slopes steeper than 3H:1V 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

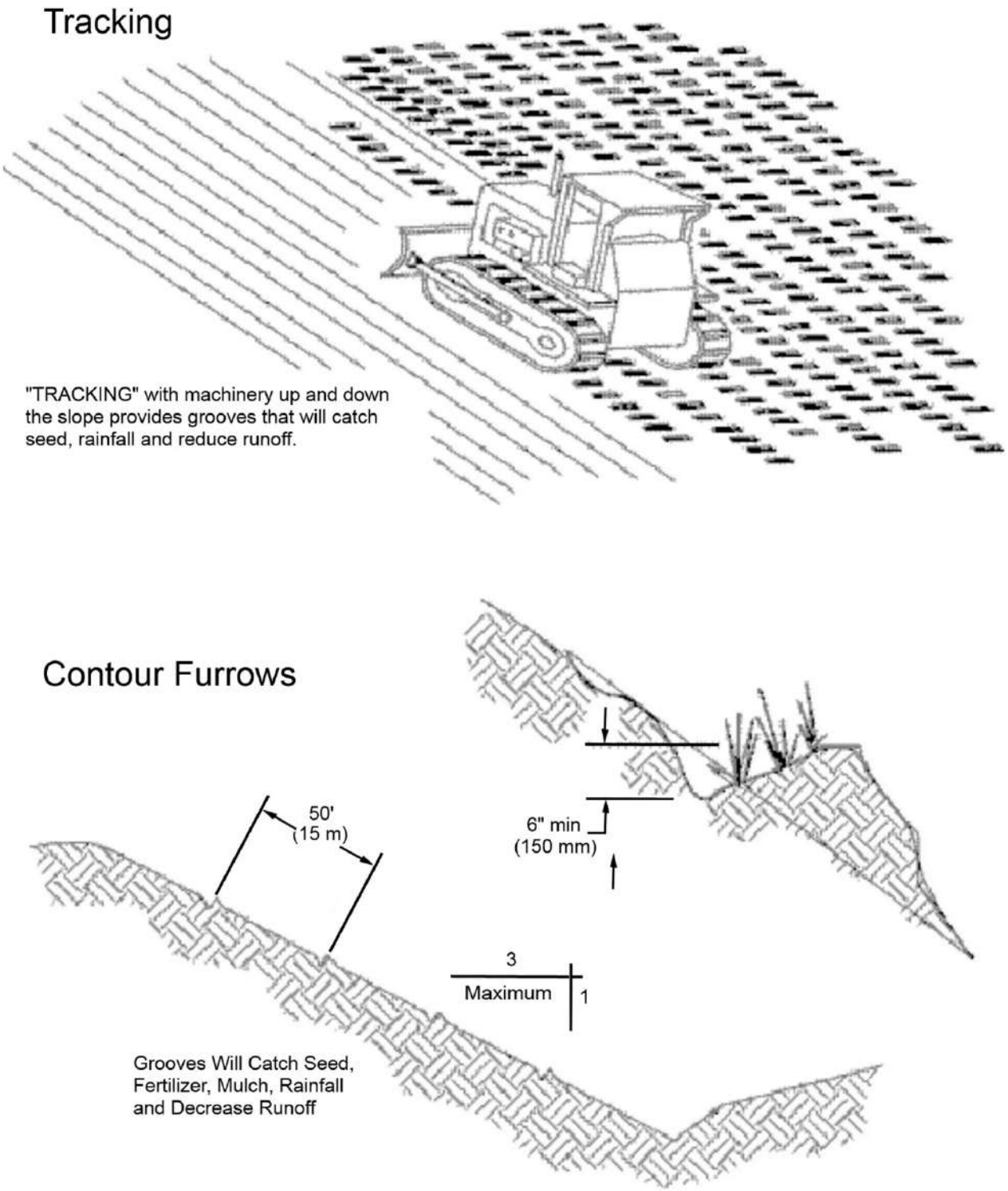
There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, contour furrows, and tracking. See Figure 3.3 for tracking and contour furrows. Factors to 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 3H:1V) may have small furrows left by disking, harrowing, raking, or seed-planting machinery operated on the contour.
- Graded areas with slopes steeper than 3H:1V but less than 2H:1V should be roughened before seeding. This can be accomplished in a variety of ways, including “track walking,” or driving a crawler tractor up and down the slope, 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 graded in this manner should be seeded as quickly as possible.
- Regular inspections should be made of the area. If rills appear, they should be regraded and reseeded immediately.

Figure 3.3. - Surface Roughening by Tracking and Contour Furrows.



BMP C131: Gradient Terraces

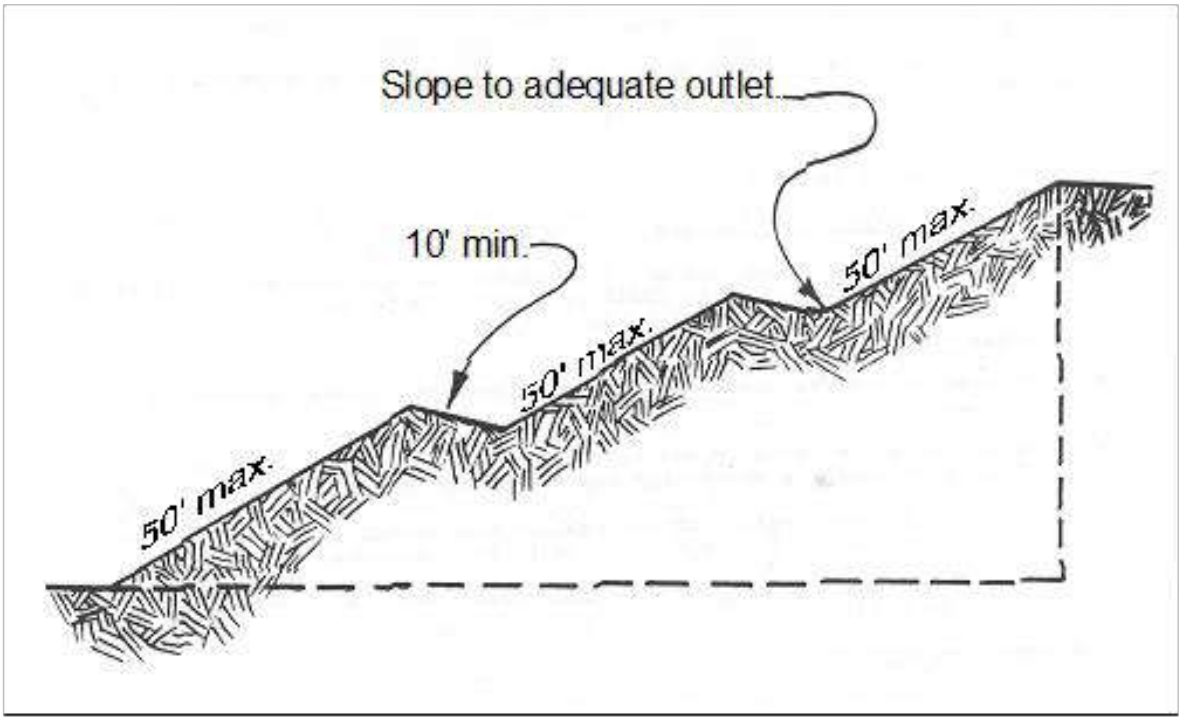
Purpose

Gradient terraces 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 3.4 for gradient terraces.

Figure 3.4. -Gradient Terraces.



Design and Installation Specifications

- The maximum spacing of gradient terraces should be determined by the following method:

  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 (1.5 tons of straw/acre equivalent) is on the surface.

- The minimum constructed cross-section should meet the design dimensions.
- The top of the constructed ridge should 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 should 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 percent). For short distances, terrace grades may be increased to improve alignment. The channel velocity should not exceed that which is nonerosive for the soil type.
- All gradient terraces should 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. Vegetative cover should be used in the outlet channel.
- The design elevation of the water surface of the terrace should 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 top should not exceed the area that would be drained by a terrace with normal spacing.
- The terrace should 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 should have a minimum top width of 3-feet at the design height. The minimum cross-sectional area of the terrace channel should 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 vehicle.

Maintenance Standards

- Maintenance should be performed as needed. Terraces should be inspected regularly; at

least once a year, and after large storm events.

BMP C140: Dust Control

Purpose

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters.

Conditions of Use

For use in areas (including roadways) subject to surface and air movement of dust where onsite and offsite 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. 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, refer to BMP C105: Stabilized Construction Entrance/Exit.
- Irrigation water can be used for dust control. Irrigation systems should be installed 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: Polyacrylamide (PAM) for Soil Erosion Protection) added to water at a rate of 0.5 pounds per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to 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. Note that the application rate specified here applies to this BMP, and is not the same application rate that is specified in BMP C126: Polyacrylamide (PAM) for Soil Erosion Protection, but the downstream protection still applies. 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.

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 use of paved roadways 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 Puget Sound Clean Air Agency for guidance and training on other dust control measures. Compliance with Puget Sound Clean Air Agency guidance and BMPs constitutes compliance with this BMP.

Maintenance Standards

Respray area as necessary to keep dust to a minimum.

BMP C150: Materials on Hand

Purpose

Keep quantities of erosion prevention and sediment control materials on the project site at all times to be used for regular maintenance and emergency situations such as unexpected heavy summer rains. Having these materials onsite 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 Tposts.
- Materials are stockpiled and readily available before any site clearing, grubbing, or earthwork begins. A contractor or developer could keep a stockpile of materials that are available for use 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:

Material
Clear Plastic, 6 mil
Drainpipe, 6- or 8inch diameter
Sandbags, filled
Straw Bales for mulching,
Quarry Spalls
Washed Gravel
Geotextile Fabric
Catch Basin Inserts
Steel “T” Posts
Silt fence material
Straw Wattles

Maintenance Standards

- All materials with the exception of the quarry spalls, steel Tposts, and gravel should be kept covered and out of both sun and rain.
- Restock 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 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, utilize these management practices. Concrete construction project components include, but are not limited to, the following:

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

Disposal options for concrete, in order of preference are:

- Offsite disposal
- Concrete washout areas (see BMP 154: Concrete Washout Area
- De minimus washout to formed areas awaiting concrete

Design and Installation Specifications

Wash concrete truck, drums at an approved offsite location or in designated concrete washout areas only, in accordance with BMP C154: Concrete Washout Area. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams.

Return unused concrete remaining in the truck and pump to the originating batch plant for recycling. Do not dump excess concrete onsite, except in designated concrete washout areas as allowed in BMP C154: Concrete Washout Area.

- Wash small concrete handling equipment (e.g. hand tools, screeds, shovels, rakes, floats, trowels, and wheelbarrels) into designated concrete washout or into formed areas awaiting concrete.
- At no time shall concrete be washed off into the footprint of an area where an infiltration feature will be installed.
- Wash equipment difficult to move, such as concrete paving machines, 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.
- Contain washwater and leftover product in a lined container when no designated concrete

washout areas (or formed areas, allowed as described above) are available. Dispose of contained concrete and concrete washwater (process water) properly.

- Always use forms or solid barriers for concrete pours, such as pilings, within 15-feet of surface waters.
- Refer to BMP 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 repair the same day.

BMP C152: Sawcutting and Surfacing Pollution Prevention

Purpose

Sawcutting and 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 or 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 of collected slurry and cuttings in a manner that does not violate groundwater or surface water quality standards.
- Do not allow process water generated during hydro-demolition, surface roughening or similar operations to drain to any natural or constructed drainage conveyance including stormwater systems. Dispose of process water in a manner that does not violate groundwater or surface water quality standards.
- Handle and dispose of cleaning waste material and demolition debris in a manner that does not cause contamination of water. Dispose of sweeping material from a pick-up sweeper at 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 vacuum trucks.

BMP C153: Material Delivery, Storage, and Containment

Purpose

Prevent, reduce, or eliminate the discharge of pollutants to the stormwater system or watercourses from material delivery and storage. Minimize the storage of hazardous materials onsite, store materials in a designated area, and install 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

The following steps should be taken to minimize risk:

- Temporary storage area should be located 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 materials stored. Chemicals should be kept in their original labeled containers.
- Hazardous material storage onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the wet weather season (October 1 to April 30), consider storing materials in a covered area.
- Materials should be stored in secondary containments, such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids 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 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.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- During the wet weather season (October 1 to 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 cleanup material (spill kit).
- The spill kit should include, at a minimum:
    - 1 water resistant nylon bag
    - 3 oil absorbent socks 3-inches x 4-feet
    - 2 oil absorbent socks 3-inches x 10-feet
    - 12 oil absorbent pads 17-inches x 19-inches
    - 1 pair splash resistant goggles
    - 3 pair nitrile gloves
    - 10 disposable bags with ties
    - Instructions.

BMP C154: Concrete Washout Area

Purpose

Prevent or reduce the discharge of pollutants from concrete waste to stormwater by conducting washout offsite, or performing onsite washout in a designated area.

Conditions of Use

Concrete washout areas 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 offsite (ready mix plant, etc.).
- Concrete truck drums are washed onsite.
- 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:

- Perform washout of concrete truck drums at an approved offsite 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 onsite, 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-ground structures should only be used if excavation is not practical.
- Concrete washout areas shall be constructed and maintained 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 should be installed adjacent to each concrete washout area 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 area 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 spalls (see BMP C105: Stabilzation Construction Entrance/ Exit). 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.

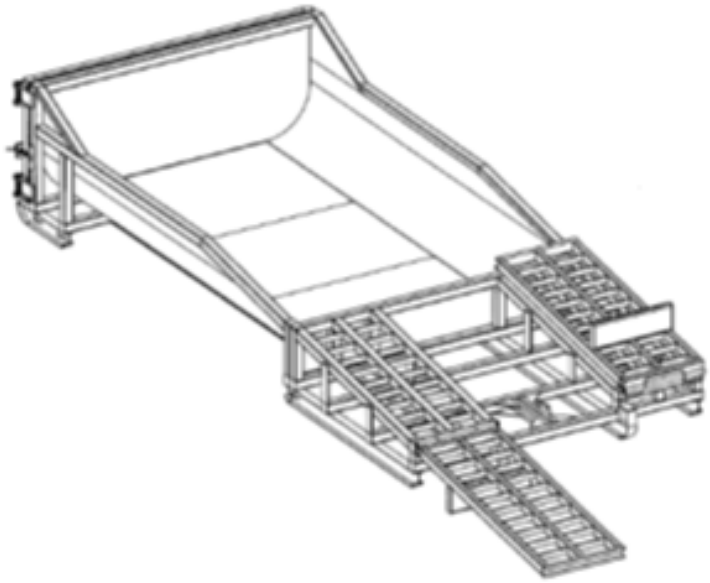
Concrete Truck Washout Procedures:

- Washout of concrete truck drums shall be performed 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 area or properly disposed of offsite.

Concrete Washout Area Installation:

- Concrete washout areas should be constructed as shown in the figure 3.5 below and Attachments, Section C, Details 23.0 and 23.1, with a recommended minimum length and minimum 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 shall 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.

Figure 3.5. - Prefabricated Concrete Washout Container with Ramp



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 the concrete washout areas daily to verify continued performance.
    - Check overall condition and performance
    - Check remaining capacity (percent full)
    - If using self-installed concrete washout areas, verify plastic liners are intact and sidewalls are not damaged
    - If using prefabricated containers, check for leaks.
- Maintain the concrete washout areas to provide adequate holding capacity with a minimum freeboard of 12-inches.
- Concrete washout areas must be cleaned, or new concrete washout areas must be constructed and ready for use once the concrete washout area is 75 percent 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 ground.

- Do not use sanitary sewer without a permit that must be obtained from the County Industrial Pretreatment Program at (253) 798-3013.
- Place a secure, non-collapsing, non-water collecting cover over the concrete washout area 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 onsite or hauled away for disposal or recycling.

- When you remove materials from the 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 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.

BMP C160: Certified Erosion and Sediment Control Lead

Purpose

The project applicant designates at least one person as the responsible representative in charge of erosion and sediment control, and water quality protection. The designated person shall be the Certified Erosion and Sediment Control Lead (CESCL) who is responsible for ensuring compliance with all local, state, and federal Construction SWPPP and water quality requirements.

Conditions of Use

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

The CESCL shall:

- Have a current certificate proving attendance in an erosion and sediment control training course that meets the minimum training and certification requirements established by Ecology (see details below)
- Ecology will maintain a list of erosion and sediment control training and certification providers.

  OR

- Be a Certified Professional in Erosion and Sediment Control (CPESC).

Specifications

Certification shall remain valid for 3 years.

- The CESCL shall have authority to act on behalf of the contractor or developer 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, email address, 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.

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 Monitorin Reports (WebDMR).
- Keeping daily logs, and inspection reports. Inspection reports should 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:
  - Locations of BMPs inspected
  - Locations of BMPs that need maintenance
  - Locations of BMPs that failed to operate as designed or intended
  - 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

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

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

- Minimize 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 3.10 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 3.10. - 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 Storm Drain Inlets	Element #8 Stabilize Channels and Outlets	Element #9 Control Pollutants	Element #10 Control Dewatering	Element #13 Protect Low Impact Development
BMP C200: Interceptor Dike and Swale			✓					✓
BMP C201: Grass-Lined Channels			✓					✓
BMP C202: 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 (TSD) (Geotex 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: Waffles	✓	✓						
BMP C236: Vegetated Filtration							✓	
BMP C240: Sediment Trap	✓	✓						
BMP C241: Temporary Sediment Pond	✓	✓						
BMP C250: Construction Stormwater Chemical Treatment		✓				✓		
BMP C251: Construction Stormwater Filtration		✓				✓		
BMP C252: High pH Neutralization using CO_2						✓		
BMP C2: pH Control for High pH Water						✓		

BMP C200: Interceptor Dike and Swale

Purpose

Provide a ridge of compacted soil, or a ridge with an upslope 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 and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area or sediment-laden runoff from leaving the construction site. See Attachments Section C, Detail 17.0 for an example schematic.

Conditions of Use

Where the runoff from an exposed site or disturbed slope must be conveyed to an erosion control facility which can safely contain the stormwater:

- Locate upslope of a construction site to prevent runoff from entering 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 water to a sediment trapping facility.

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.
- Subbasin tributary area should be 1 acre or less.
- Design capacity for the peak flow from a 10year, 24hour storm event assuming a NRCS Type 1A rainfall distribution resolved to 10minute time steps, for temporary facilities. Alternatively, use the 10-year, 15-minute time step flow indicated by an approved continuous runoff model. For conveyance systems that will also serve on a permanent basis see design standards in Volume III, Chapter 4.
- **Interceptor dikes** shall meet the following criteria:
    - Top Width: 2-feet minimum.
    - Height: 1.5-feet minimum on berm.
    - Side Slope: 2H:1V or flatter.
    - Grade: Depends on topography; however, dike system minimum is 0.5 percent, maximum is 1 percent
    - Compaction: Minimum of 90 percent ASTM D698 standard proctor.
    -

- Horizontal Spacing of Interceptor Dikes:

Average Slope	Slope %	Flow Path Length
> 20H:1V or flatter	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 less than 5 percent: Seed and mulch applied within 5 days of dike construction (see *BMP C121:, Mulching*).
  - Slopes 5 to 40 percent: Dependent on runoff velocities and dike materials. Stabilization should 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.

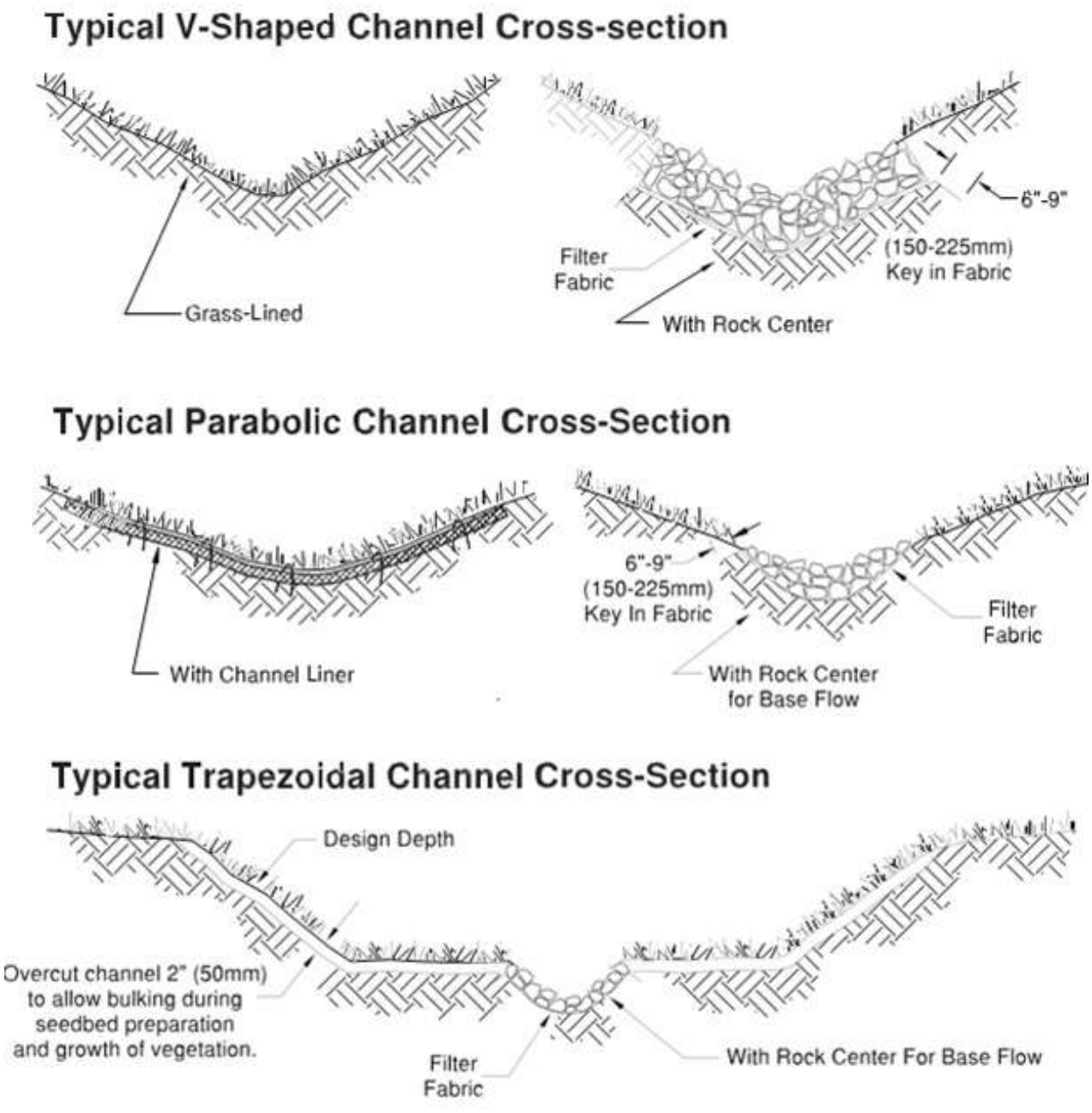
- **Interceptor swales** shall meet the following criteria:
  - Bottom Width: 2-feet minimum; the cross-section bottom shall be level.
  - Depth: 1-foot minimum.
  - Side Slope: 2H:1V or flatter.
  - Grade: Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment pond).
  - 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.
- 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 3.6 for typical grass-lined channels.

Figure 3.6. - 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.

- 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.
- Channels that will be vegetated should be installed before major earthwork and hydroseeded 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, erosion control blankets should be installed over the hydroseed. If vegetation cannot be established from seed before water is allowed in the ditch, sod should be installed 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 runoff from a 10year, 24hour storm event assuming a NRCS Type 1A rainfall distribution resolved to 10minute time steps. Alternatively, use the 10year, 15-minute time step flow indicated by an approved continuous runoff model to determine a flow rate which the channel must contain.
- Where the grass-lined channel will also function as a permanent stormwater conveyance facility, the channel must meet the drainage conveyance requirements defined in Volume III, Chapter 4.
- 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 feet/sec, a temporary channel liner is required. Geotextile or special mulch protection such as straw or netting provides stability until the vegetation is fully established. See Figure 3.7.
- Check dams shall be removed once the grass roots and aboveground biomass have grown enough to stabilize soils and sufficiently protect the swale bottom and side slopes from erosion. Check dams will remain when swale slopes are greater than 4 percent for long term erosion protection. The area beneath the check dams shall be seeded and mulched 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-

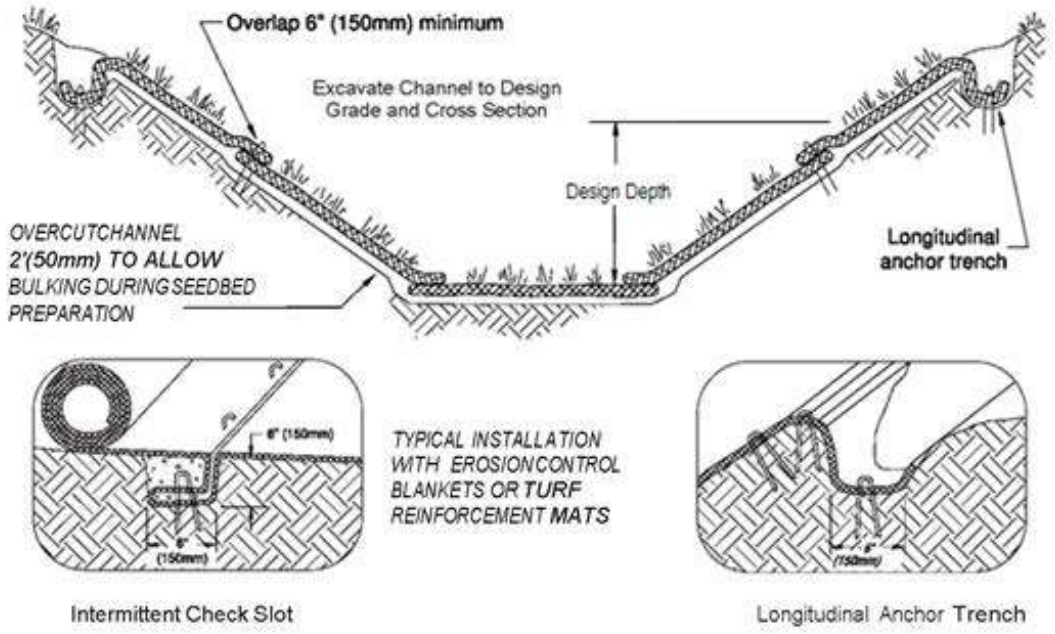
trapping BMPs upstream of the channel.

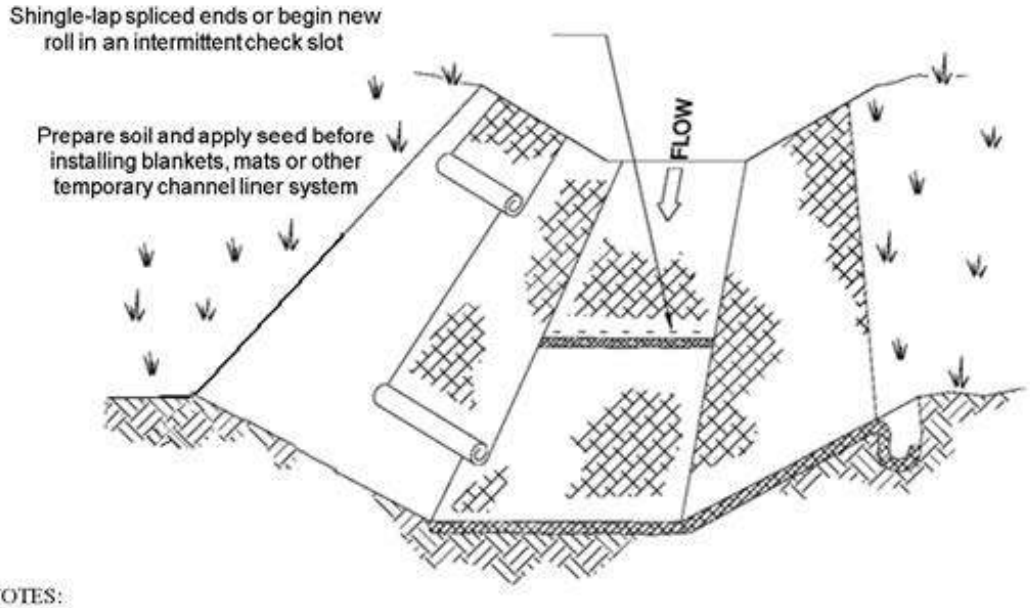
- **V-shaped grass channels** generally apply where the quantity of water is small, such as in short reaches along roadsides. The Vshaped cross section is least desirable because it is difficult to stabilize the bottom where velocities may be high.
- **Trapezoidal grass channels** are used where runoff volumes are large and slope is low so that velocities are nonerosive 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, should carry peak runoff for temporary construction drainage facilities from the 10-year, 24hour 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. Immediately make repairs.
- 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

Figure 3.7. - Temporary Channel Liners.





NOTES:

2 Design velocities exceeding 2 ft/sec (0.5m/sec) require temporary blankets, mats or similar liners to protect seed and soil until vegetation becomes established.

3 Grass-lined channels with design velocities exceeding 6 ft/sec (2m/sec) should include turf reinforcement mats.

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 C212: Nets and Blankets.

The Federal Highway Administration recommends not using geotextiles 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).*
- A lining of engineering filter fabric (geotextile) shall be placed between the riprap and the underlying soil surface to prevent soil movement into or through the riprap. The geotextile should be keyed in at the top of the bank.
- Filter fabric shall not be used on slopes greater than 1.5H: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

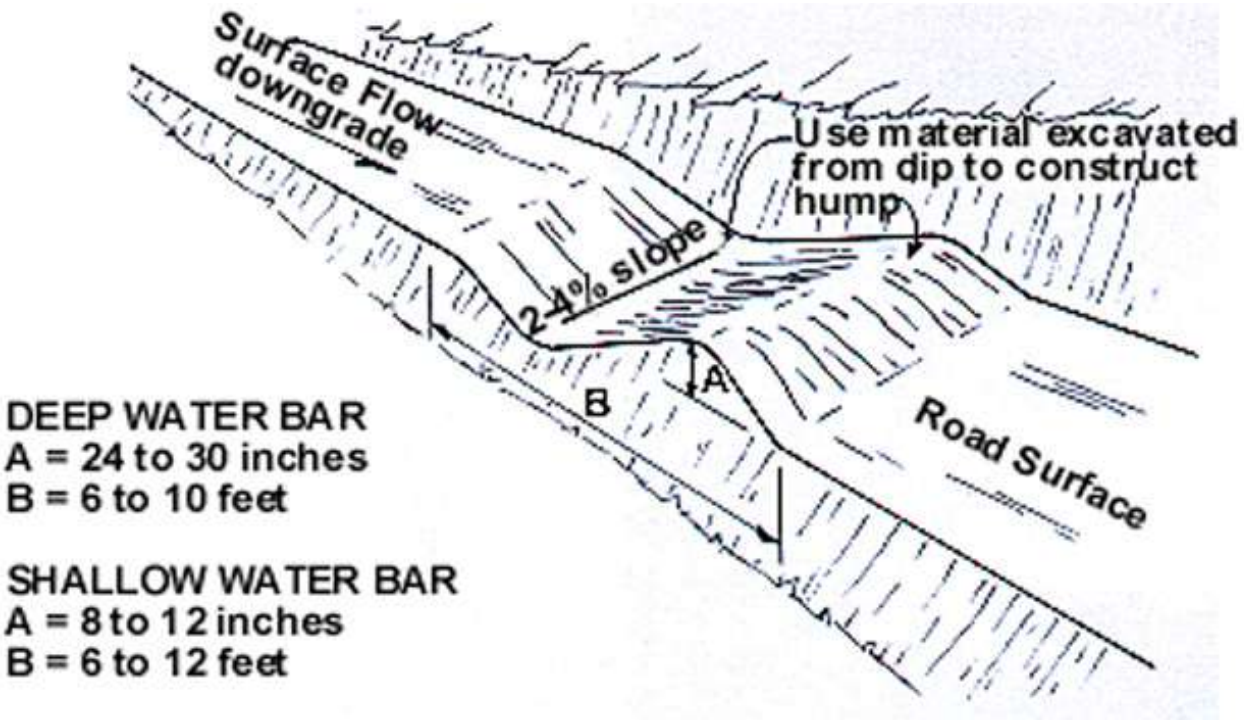
- Replace riprap as needed.

BMP C203: Water Bars

Purpose

A small ditch or ridge of material is constructed diagonally across a road or right-of-way to divert stormwater runoff from the road surface, wheel tracks, or a shallow road ditch. See Figure 3.8.

Figure 3.8. - Water Bar.



Conditions of Use

Clearing right-of-way and construction of access for power lines, pipelines, and other similar installations often require long narrow right-of-ways 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: 8inch 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: 6inch minimum.
- Locate them to use natural drainage systems and to discharge into well vegetated stable areas.
- Guideline for Spacing:

Average Slope	Slope %	Spacing (ft)
>20H:1V or flatter	< 5	125
(>10 to 20) H:1V	5 to <10	100
(>5 to 10) H:1V	10 to <20	75
(>2.86 to 5) H:1V	20 to <35	50
2.86 H:1V or steeper	≥ 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.

BMP C204: Pipe Slope Drains

Purpose

To use a pipe to convey stormwater anytime water needs to be diverted away from or over bare soil to prevent gullies, channel erosion, and saturation of slide-prone soils.

Conditions of Use

Pipe slope drains should be used when a temporary or permanent stormwater conveyance is needed to move the water down a steep slope to avoid erosion. See also Attachments Section C, Detail 15.0.

On highway projects, pipe slope drains should be used 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 sand-bags, or other temporary diversion devices, these will prevent massive amounts of sediment from leaving a project.

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

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.
- Connected to existing downspouts 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 the peak flow from a 10year, 24hour storm event assuming a NRCS Type 1A rainfall distribution resolved to 10minute time steps. Alternatively, use the 10year, 15-minute time step flow indicated by an approved continuous runoff model.

- Use care in clearing vegetated slopes for installation.
- Reestablish cover immediately on areas disturbed by installation.
- Use temporary drains on new cut or fill slopes.
- Use diversion dikes or swales 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. Sand-bags 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.
- Thrust blocks should be installed anytime 90 degree or sharper bends are utilized. Depending on size of pipe and flow, these can be constructed with sand-bags, straw bales staked in place, Tposts and wire, or ecology blocks.
- Pipe needs to be secured along its full length to prevent movement. This can be done with steel Tposts and wire. A post is installed on each side of the pipe and the pipe is wired to them. This should be done every 10-to 20-feet of pipe length or so, depending on the size of the pipe and quantity of water to be diverted.
- Interceptor dikes 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 4.7, and shall be approved by 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, the headwall should be reinforced with compacted earth or sand-bags.
- The outlet point should be free of erosion and installed with appropriate outlet protection.
- For permanent installations, inspect pipe periodically for vandalism and physical distress such as slides and windthrow.
- 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.

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, or to reduce hydrostatic pressure to improve slope stability.

Conditions of Use

Use when excessive water must be removed 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.
    - Interceptor drains 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.
    - An adequate outlet for the drainage system must be available either by gravity or by pumping.
    - The quantity and quality of discharge needs to be accounted for in the receiving stream (additional detention may be required).
    - This standard does not apply to subsurface drains for building foundations or deep excavations.
    - 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.
- **Size of drain** – Size subsurface drains to carry the required capacity without pressure flow. Minimum diameter for a subsurface drain is 4-inches.

- The minimum velocity required to prevent silting is 1.4 feet/second. 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 feet/second.
- Filter material and fabric shall be used around all drains for proper bedding and filtration of fine materials. Envelopes and filters should surround the drain to a minimum of 3-inch thickness.
- The outlet of the subsurface drain shall empty into a sediment pond 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.
- 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 drainpipe 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.

Maintenance Standards

- Subsurface drains shall be checked periodically to assure that they are free-flowing and not clogged with sediment or roots.
- The outlet shall be kept clean and free of 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. Drain placement should be planned 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 consisting of an excavated depression constructed at zero grade across a slope. To convert concentrated runoff to sheet flow and release it onto areas stabilized by existing vegetation or an engineered filter strip.

Conditions of Use

Used 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?
3. Will most of the flow discharge to groundwater and not contribute to surface flow?
4. Is there an unstable area downstream that cannot accept additional groundwater?

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.
- 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 flatter than 5H:1V.
- Outlet to be constructed level in a stable, undisturbed soil profile (not on fill).
- The runoff shall not reconcentrate after release 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.
- A 6-inch high gravel berm placed across the level lip shall consist of washed crushed rock, 2 to 4inch or 0.75inch to 1.5inch size.
- The spreader length shall be determined by estimating the peak flow expected from the 10year, 24hour design storm event assuming a NRCS Type 1A rainfall distribution resolved to 10minute time steps. Alternatively, use the peak flow from a 10-year, 15minute time step using an approved continuous runoff model. The length of the spreader shall be a minimum of 15-feet for 0.1 cubic feet per second and shall increase by 10-feet for each 0.1 cubic feet per second thereafter to a maximum of 0.5 cubic feet per second per spreader. Use multiple spreaders for higher flows.
- The width of the spreader should be at least 6-feet.
- The depth of the spreader as measured from the lip should 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, logs, concrete, and pipe. To function properly, the material needs to be installed level and on contour. Figures 3.9 and 3.10 provide a cross-section and a detail of a level spreader. A capped perforated pipe could also be used as a spreader.

Figure 3.9. - Cross-Section of Level Spreader.

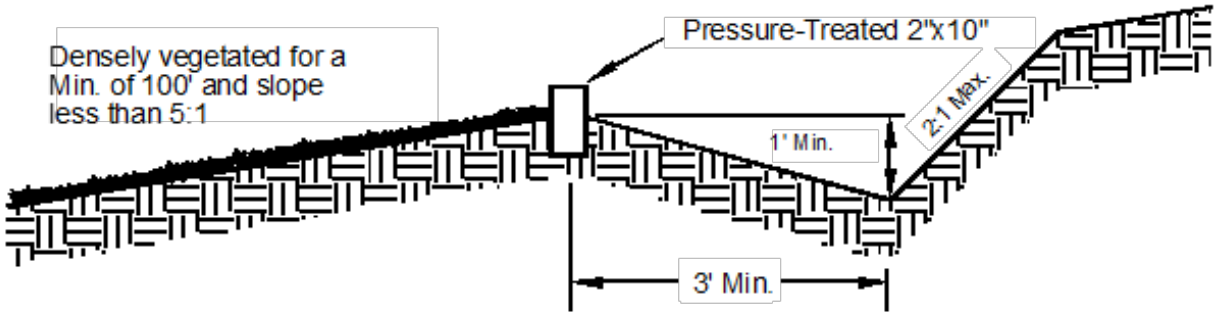
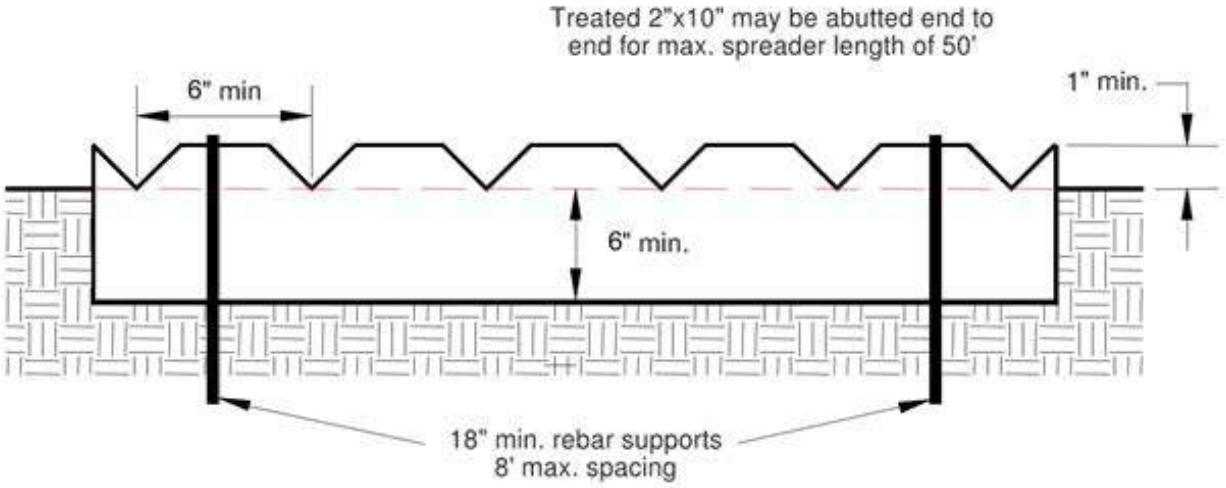


Figure 3.10. - Detail of Level Spreader.



Maintenance Standards

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

BMP C207: Check Dams

Purpose

Construction of small dams across a swale or ditch reduces the velocity of concentrated flow and dissipates energy at the check dam.

Conditions of Use

- Where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, and/or velocity checks are required.
- Check dams may not be placed in streams unless approved by the WDFW.
- Check dams may not be placed in wetlands without approval from the appropriate 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

- Construct rock check dams from appropriately sized rock. The rock used must be large enough to stay in place given the expected design flow through the channel. The rock must be placed 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.
- Check dams may also be constructed of either rock or pea-gravel filled bags. Numerous products are also available for this purpose. They tend to be reusable, quick and easy to install, effective, and cost efficient. Straw bales are not an allowed construction material.
- Place check dams perpendicular to the flow of water.
- 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 combined with sumps work more effectively at slowing flow and retaining sediment than just a check dam alone. A deep sump should be provided 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.
- 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 2H:1V 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, filter fabric 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. Attachments Section C, Detail 19.0 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.

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

Purpose

Triangular silt dikes may be used as check dams, for perimeter protection, for temporary soil stockpile protection, for drop inlet protection, or as a temporary interceptor dike. See Attachments Section C, Detail 14.0 for example details.

Conditions of Use

- May be used on soil or pavement with adhesive or staples
- TSDs have been used to build temporary:
  - Sediment ponds
  - Diversion ditches
  - Concrete washout facilities
  - Curbing
  - Water bars
  - Level spreaders
  - Berms.

Design and Installation Specifications

- Made of urethane foam sewn into a woven geosynthetic fabric.
- It is triangular, 10-inches to 14-inches high in the center, with a 20inch to 28inch 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 should be No. 11 gauge wire and should be 200 millimeters to 300 millimeters 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.
- Check dams should be located and installed as soon as construction will allow.
- Check dams should be placed perpendicular to the flow of water.
- When used as check dams, the leading edge 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

- Triangular silt dams shall be inspected 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 dam. Immediately repair any damage or any undercutting of the dam.

BMP C209: Outlet Protection

Purpose

Outlet protection prevents scour at conveyance outlets and minimizes 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, and where runoff is conveyed to a natural or manmade drainage feature such as a stream, wetland, lake, or ditch.

Design and Installation Specifications

- The receiving channel at the outlet of a culvert shall be protected from erosion by rock lining a minimum of 6-feet downstream and extending up the channel sides a minimum of 1-foot above the maximum tailwater elevation or 1foot 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 culvert.
- 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.)
- Organic or synthetic erosion blankets, with or without vegetation, are usually more effective than rock, cheaper, and easier to install. Materials can be chosen using manufacturer product specifications. ASTM test results are available for most products and the designer can choose the correct material for the expected flow.
- With low flows, vegetation (including sod) can be effective.
- The following guidelines shall be used for riprap outlet protection:
    - If the discharge velocity at the outlet is less than 5 feet per second (pipe slope typically less than 10 percent), use 2inch to 8inch riprap. Minimum thickness is 1-foot.
    - For outlets at the base of steep slope pipes (pipe slope greater than 10 percent), an engineered energy dissipater shall be used.
- Filter fabric or erosion control blankets should 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. See Volume III, Chapter 4 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

Storm drain inlet protection prevents coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

Conditions of Use

Use storm drain inlet protection at inlets that are 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 conveying runoff entering catch basins to a sediment pond or trap.

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. Consider erosion protection methods around each finished lawn and yard drain until area is stabilized.

Table 3.11 lists several options for inlet protection. All of the methods for storm drain inlet protection tend to plug and require a high frequency of maintenance. Limit drainage areas to 1 acre or less. Possibly provide emergency overflows with additional end-of-pipe treatment where stormwater ponding would cause a hazard.

Table 3.11. - 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-feet/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.
Lock and gravel curb inlet protection	Yes	Paved	Sturdy, but limited filtration.
Culvert Inlet Protection			
Culvert inlet sediment trap			18 month expected life.

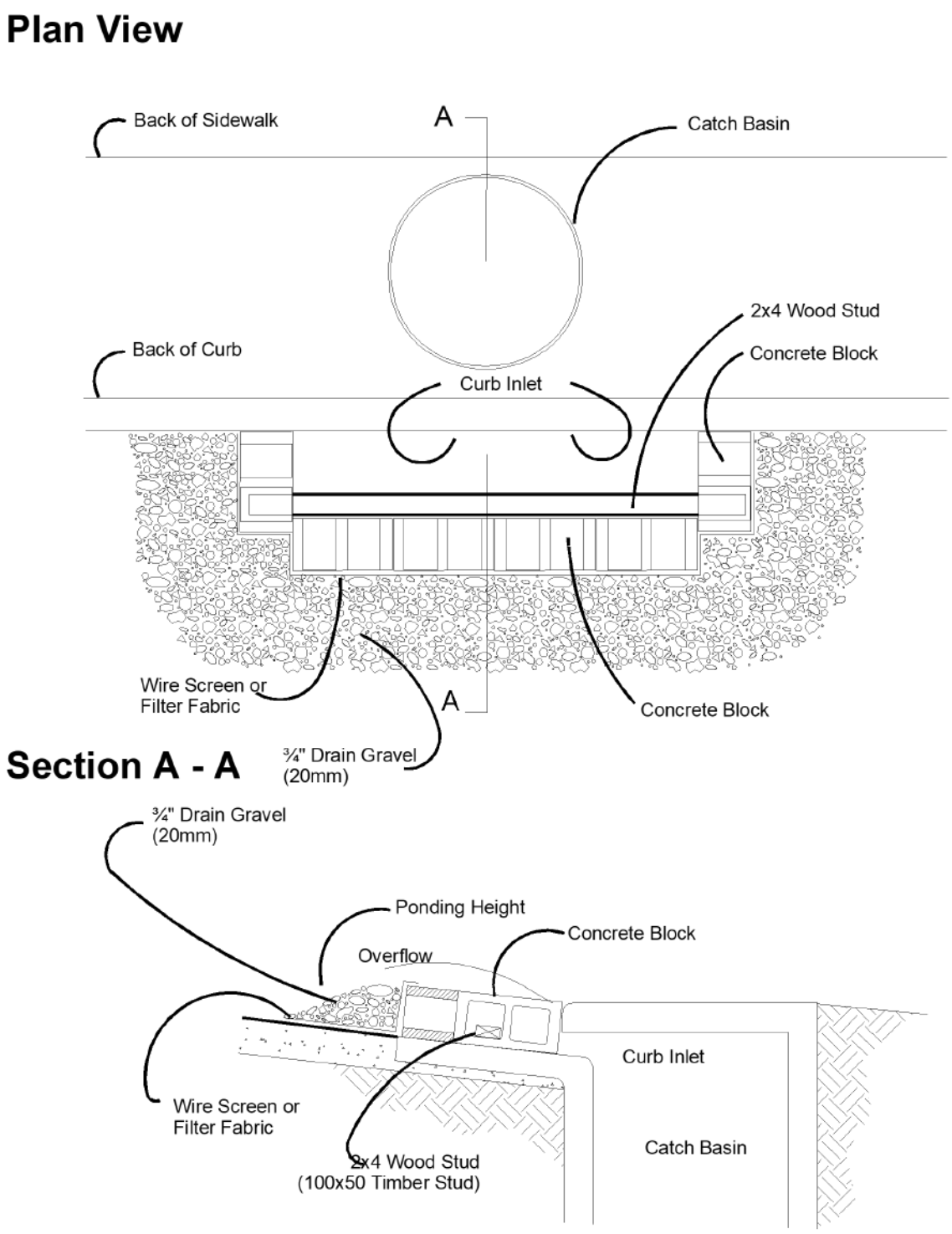
Design and Installation Specifications

- **Excavated Drop Inlet Protection:** An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.
  - Provide a depth of 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 basin 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
  - Build a temporary dike, if necessary, 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 also Attachments Section C, Detail 2.0.
  - Provide a height of 1-to 2-feet above inlet
  - Recess the first row 2-inches into the ground for stability
  - Support subsequent courses by placing a 2 x 4 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 one-half-inch openings over all block openings
  - Place washed rock, 0.75 to 3-inch diameter, just below the top of blocks on slopes of 2H:1V or flatter.
- **Gravel and Wire Mesh Filter:** A gravel barrier placed over the top of the inlet. This structure does not provide an overflow. See also Attachments Section C, Detail 3.0.
  - Use a hardware cloth or comparable wire mesh with one-half-inch openings
  - Use coarse aggregate
  - Provide a height 1-foot or more, 18-inches wider than inlet on all sides
  - 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 12inch depth of gravel over the entire inlet opening and extend at

least 18-inches on all sides.

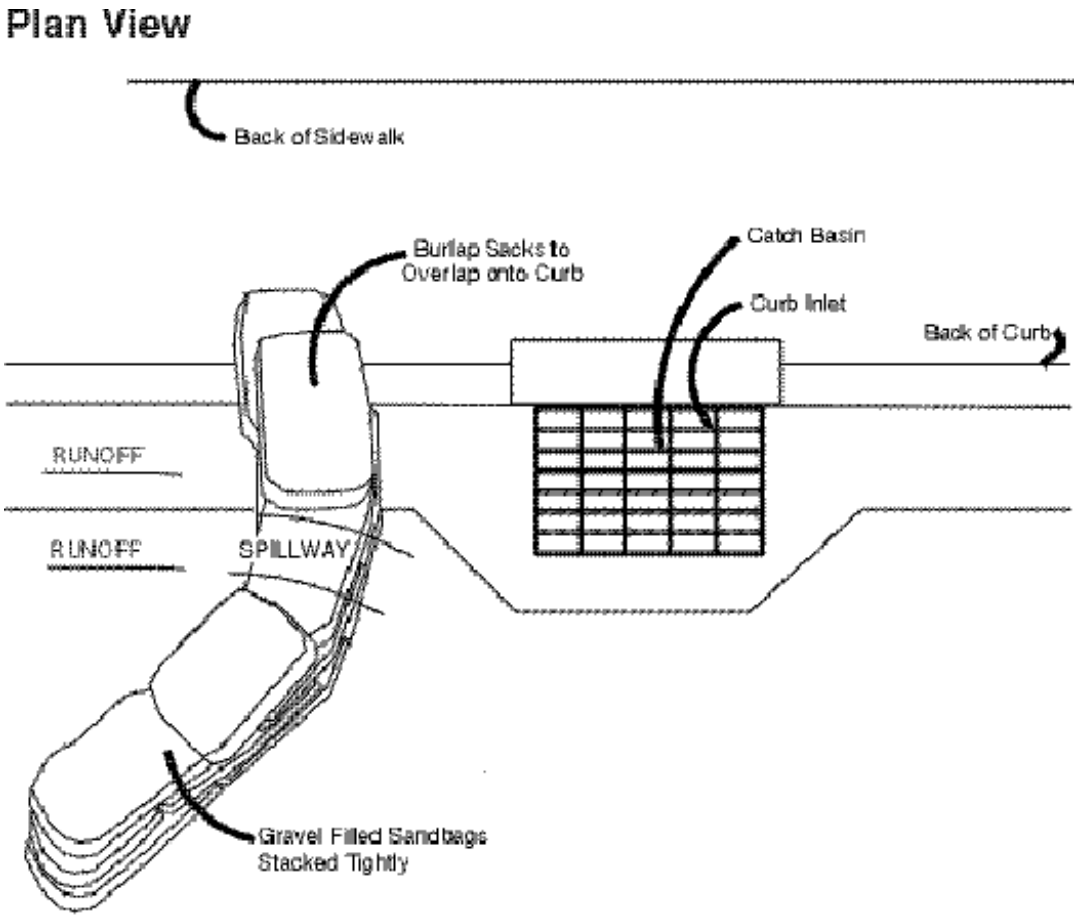
- **Catch Basin Filters:** Use inserts designed by manufacturers for construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. To reduce maintenance requirements, combine a catch basin filter with another type of inlet protection. The combination of inlet protection and filters may provide flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way.
  - 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.
  - Use wire mesh with one-half-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.
- **Block and Gravel Curb Inlet Protection:** Barrier formed around an inlet with concrete blocks and gravel. See Figure 3.11.
  - Use wire mesh with 0.5-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 2 x 4 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 3.12.
  - 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 outside of the berm sized to sediment trap standards for protecting a culvert inlet.
- **Inlet Fabric Fence Filter:** Attachments Section C, Detail 1.0 provides an illustration of the use of filter fabric as an inlet protection option.

Figure 3.11. - Block and Gravel Curb Inlet Protection.



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 3.12. - Curb and Gutter Barrier.



NOTES:
1. Place curb type sediment barriers on gently sloping street segments, where water can pond and allow sediment to separate from runoff.
2. Sandbags of either burlap or woven `geotextile' fabric, are filled with gravel, layered and packed tightly.
3. Leave a one sandbag gap in the top row to provide a spillway for overflow.
4. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

Maintenance Standards

- Inspect catch basin filters frequently, especially after storm events. Clean or replace clogged inserts. For systems with clogged stone filters pull away from the inlet and clean or replace. 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.

Approved as Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C220: Storm Drain Inlet Protection. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from Pierce County Planning and Public Works' (PPW) website. The

county website is updated routinely, but the latest list from Ecology is available on Ecology's website. Contact the county if a new Ecology approved product is not listed on the county website.

BMP C231: Brush Barrier

Purpose

The purpose of brush barriers is 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.

Conditions of Use

- Brush barriers may be used downslope of all disturbed areas 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 by 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, wood-based mulch (hog fuel), or other suitable mulch material 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. Attachments Section C, Detail 11.0 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.

BMP C233: Silt Fence

Purpose

Use of a silt fence reduces 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 Attachments Section C, Detail 8.0 for details on silt fence construction.

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.
- Do not construct silt fences in streams or use in V-shaped ditches. Silt fences do not provide an adequate method of silt control for anything deeper than sheet or overland flow.

Design and Installation Specifications

- Use in combination with sediment basins or other BMPs.
- Maximum slope steepness (normal [perpendicular] to fence line) 1H:1V.
- Maximum sheet or overland flow path length to the fence of 100-feet.
- Do not allow flows greater than 0.5 cubic feet per second.
- The geotextile used 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 3.12).
- Standard strength fabrics must be supported with wire mesh, chicken wire, 2inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the fabric to the 180 lbs minimum threshold. Silt fence materials are available that have synthetic mesh backing attached.
- Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0°F. to 120°F.

Table 3.12. - Geotextile Standards.

Polymeric Mesh AOS (ASTM D4751)	0.60 mm maximum for film wovens (US #30 sieve). 0.30 mm maximum for all other geotextile types (US #50 sieve). 0.15 mm minimum for all fabric types (US #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

- Include the following standard notes for silt fence on construction plans and specifications:
  - The contractor shall install and maintain temporary silt fences at the locations shown in the plans.
  - Construct silt fences in areas of clearing, grading, or drainage prior to starting those activities.
  - The silt fence shall have a 2-feet min. and 2.5-feet max. height above the original ground surface.
  - The filter fabric shall be sewn together at the point of manufacture to form filter fabric lengths as required. Locate all sewn seams at support posts. 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.
  - Attach the filter fabric on the up-slope side of the posts and secure with staples, wire, or in accordance with the manufacturer's recommendations. Attach the filter fabric to the posts in a manner that reduces the potential for tearing.
  - Support the filter fabric with wire or plastic mesh, dependent on the properties of the geotextile selected for use. If wire or plastic mesh is used, fasten the mesh securely to the up-slope side of the posts with the filter fabric up-slope of the mesh.
  - 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 pounds grab tensile strength. The polymeric mesh must be as resistant to the same level of ultraviolet radiation as the filter fabric it supports.
  - Bury the bottom of the filter fabric 8-inches min. below the ground surface. Backfill and tamp soil in place over the buried portion of the filter fabric, so that no flow can pass beneath the fence and scouring cannot occur. The wire or polymeric mesh shall extend into the ground 3-inches min.
  - Drive or place the fence posts into the ground 18-inches minimum. A 12inch minimum depth is allowed if topsoil or other soft subgrade soil is not present and 18-inches cannot be reached. Increase fence post min. depths 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.
  - Use wood, steel, or equivalent posts. The spacing of the support posts shall be a maximum of 6-feet. Posts shall consist of either:
    - Wood with dimensions of 2-inches by 2-inches wide min. and a 3-feet min. length. Wood posts shall be free of defects such as knots, splits, or gouges.
    - No. 6 steel reinforcement bar 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 pounds/feet.
    - Other steel posts having equivalent strength and bending resistance to the post

sizes listed above.

- Locate silt fences 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.
- If the fence must cross contours, with the exception of the ends of the fence, place gravel check dams perpendicular to the back of the fence to minimize concentrated flow and erosion. The slope of the fence line where contours must be crossed shall not be steeper than 3H:1V.
  - Gravel check dams shall be approximately 1-foot deep at the back of the fence. Gravel check dams 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.
  - Gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. Gravel check dams shall be located every 10-feet along the fence where the fence must cross contours.

- Silt fence installation using the slicing method specification details follow:
  - The base of both end posts must be at least 2- to 4-inches above the top of the filter fabric on the middle posts for ditch check dams to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.
  - Install posts 3-to 4-feet apart in critical retention areas and 6-to 7-feet apart in standard applications. Install posts 24-inches deep on the downstream side of the silt fence, and as close as possible to the filter fabric, enabling posts to support the filter fabric from upstream water pressure.
  - Install posts with the nipples facing away from the filter fabric.
  - Attach the filter fabric to each post with three ties, all spaced within the top 8-inches of the filter fabric. Attach each tie diagonally 45 degrees through the filter fabric, with each puncture at least 1-inch vertically apart. Each tie should be positioned to hang on a post nipple when tightening to prevent sagging.
  - Wrap approximately 6-inches of fabric around the end posts and secure with three ties.
  - No more than 24-inches of a 36-inch filter fabric is allowed above ground level, 12-inches must be buried.
- Compact the soil immediately next to the filter 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. Check and correct the silt fence installation for any deviation before compaction. Use a flat-bladed shovel to tuck fabric deeper into the ground if necessary.

Maintenance Standards

- Repair any damage immediately.
- Intercept and convey all evident concentrated flows uphill of the fence to a sediment pond.
- 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 or remove the trapped sediment.

- Remove sediment deposits when the deposit reaches approximately one-third the height of the silt fence, or install a second silt fence.
- Replace filter fabric that has deteriorated due to ultraviolet breakdown.

BMP C234: Vegetated Strip

Purpose

Vegetated strips 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.

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 a sediment pond. The only circumstance in which overland flow can be treated solely by a strip, rather than by a sediment pond, is when the following criteria are met (see Table 3.13):

Table 3.13. - Vegetated Strips.

Average Contributing Area Slope	Average Contributing Area Percent Slope	Max Contributing Area 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 25foot 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 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, surface water controls must be installed to reduce the flows entering the vegetated strip, or additional perimeter protection must be installed.

BMP C235: Wattles

Purpose

Wattles are temporary erosion and sediment control barriers consisting of straw, compost, or other material that is wrapped in biodegradable tubular plastic or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff, and can capture and retain sediment. Wattles are typically 8-to 10-inches in diameter and 25-to 30-feet in length. Wattles are placed in shallow trenches and staked along the contour of disturbed or newly constructed slopes. See Figure 3.13 for typical construction details.

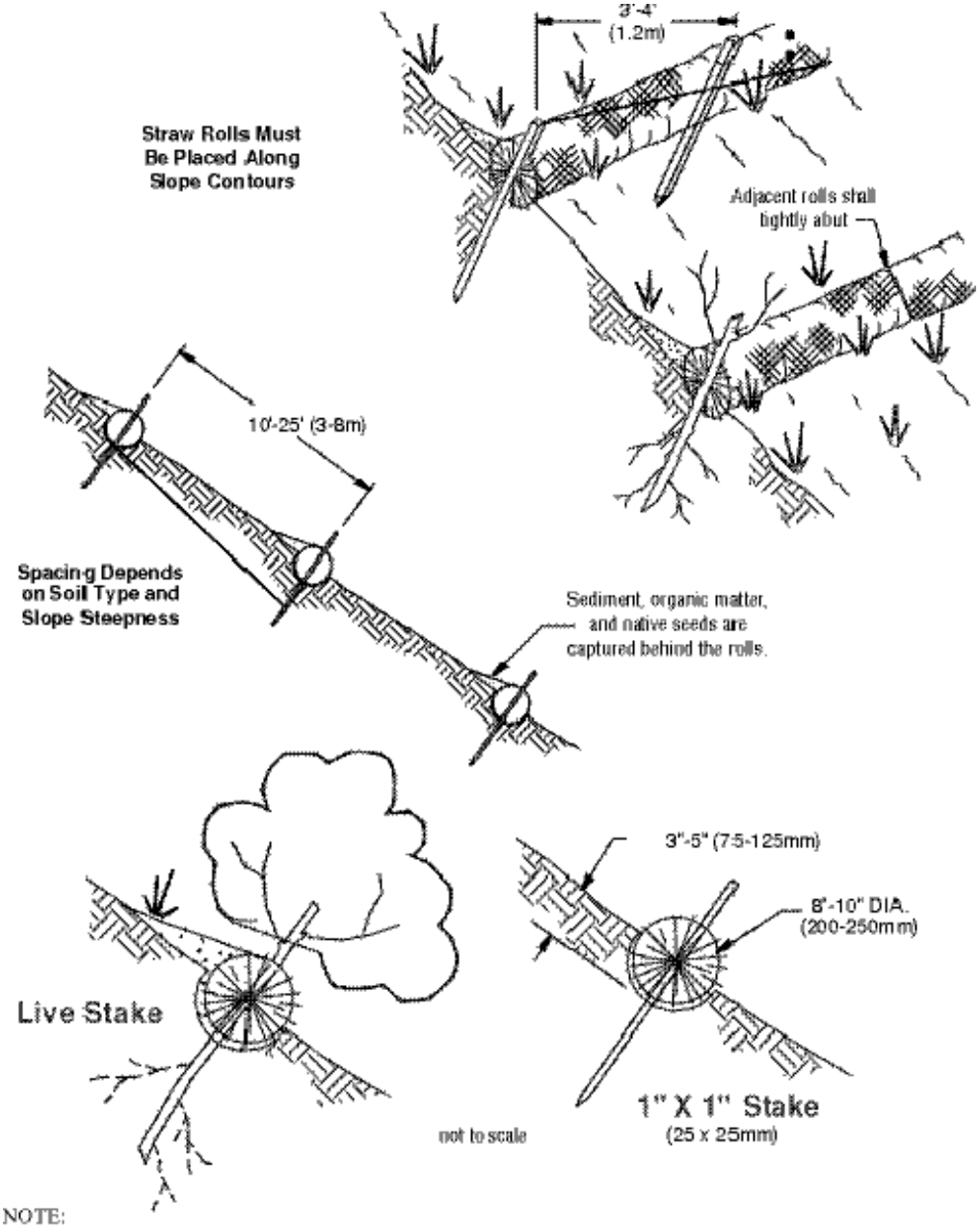
Conditions of Use

- Use wattles:
  - In disturbed areas that require immediate erosion protection
  - On exposed soils during the period of short construction delays, or over winter months
  - On slopes requiring stabilization until permanent vegetation can be established.
- The material used dictates the effectiveness period of the wattle. Typically, wattles are effective for one to two wet seasons.
- Prevent rilling beneath wattles by properly entrenching and abutting wattles together to prevent water from passing between them.

Design Criteria

- Install wattles perpendicular to the flow direction and parallel to the slope contour.
- Narrow trenches should be dug across the slope 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 one-half to two-thirds 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 compacted using hand tamping or other methods.
- Construct trenches on contours at intervals of 10-to 25-feet apart depending on the steepness of the slope, soil type, and rainfall. The steeper the slope, the closer together the trenches.

Figure 3.13. - Straw Wattles.



- 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 should be approximately 0.75 x 0.75 x 24 inches min. Willow cuttings or 0.375-inch rebar can also be used for stakes. Note: rebar must be removed at end of project if used, while other fasteners maybe permitted to remain if all parts of the wattles are

biodegradable and shown in plans for permanent erosion control.

- Stakes should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake protruding above the wattle.

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.

Approved as Equivalent

Ecology has approved specific products as able to meet the requirements of BMP C235: Wattles. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. The county has reviewed these products for application in Pierce County, and has developed a county-specific list of the approved and prohibited products. This county-specific list can be obtained from the Pierce County Planning and Public Works (PPW) website. The county website is updated routinely, but the latest list from Ecology is available on Ecology's website. Contact the county if a new Ecology approved product is not listed on the county website.

BMP C236: Vegetative Filtration

Purpose

Vegetative filtration may be used in conjunction with BMP C241: Temporary Sediment Ponds, BMP C206: Level Spreader, and a pumping system with surface intake 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. Vegetative filtration can also be used to infiltrate dewatering waste from foundations, vaults, and trenches as long as runoff does not occur.

Conditions of Use

- For every 5 acres of disturbed soil, use 1 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.
- Wetlands shall not be used for 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 the 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 need for this BMP.
- Stop distributing water into the vegetated area if standing water or erosion results.

Design Criteria

- Find land on the project site 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 an easement from adjacent landowners if conditions would allow for proper filtration. An easement is required for any offsite area used to meet the requirements of this BMP.
- 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 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-inch schedule 20, swaged-fit common septic tight-lined sewer line, or 6-inch fire hose, which can convey the turbid water out to various sections of the field. See Figure 3.14.

Figure 3.14. - Manifold and Branches in a Wooded, Vegetated Spray Field



- 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 that 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 drain pipe 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.
- 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.
- Since the operator is handling contaminated water, physically monitor the vegetated spray field all the way down to the nearest surface water, or furthest spray area, to ensure that the water has not caused overland or concentrated flows, and has not created erosion around the spray nozzle.
- Monitoring usually needs to take place 3 to 5 times per day to ensure sheet-flow into waters of the State. Do not exceed water quality standards for turbidity.
- The county recommends that a separate inspection log 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.

Maintenance Standards

- 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.

Flow Path Guidelines for Vegetative Filtration		
Average Slope	**Average Area Percent 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

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 cleared and/or graded 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 BMP. Non-engineered sediment traps may be used onsite upstream to an engineered sediment trap or sediment pond to provide additional sediment removal capacity.

It is 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.

Whenever possible, sediment-laden water shall be discharged into onsite, relatively level, vegetated areas (see BMP C234: Vegetated Strip). This is the only way to effectively remove fine particles from runoff unless chemical treatment or filtration is used. This can be particularly useful after initial treatment in a sediment trap. The areas of release must be evaluated on a site-by-site basis in order to determine appropriate locations for and methods of releasing runoff. Vegetated wetlands shall not be used for this purpose. Frequently, it may be possible to pump water from the collection point at the downhill end of the site to an upslope vegetated area. Pumping shall only augment the treatment system, not replace it, because of the possibility of pump failure or runoff volume in excess of pump capacity.

All projects that are constructing permanent detention facilities or infiltration basins and trenches can use the rough-graded permanent facilities for traps. If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to a minimum 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 facilities are used as temporary sedimentation facilities, the surface area requirement of a sediment trap or pond must be met. If the surface area requirements are larger than the surface area of the permanent facility, then the trap or pond shall be enlarged to comply with the surface area requirement. The permanent pond shall also be divided into two cells as required for sediment ponds.

Either a permanent control structure or the temporary control structure (described in BMP C241: Temporary Sediment Pond) can be used. If a permanent control structure is used, it may be advisable to partially restrict the lower orifice with gravel to increase residence time while still allowing dewatering of the pond. A shut-off valve may be added to the control structure to allow complete retention of stormwater in emergency situations. In this case, an emergency overflow weir must be added.

A skimmer may be used for the sediment trap outlet if approved by the county.

Design and Installation Specifications

- See Attachments Section C, Details 21.0 and 22.0 for details.
- If permanent runoff control facilities are part of the project, they should be used for sediment retention.
- 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:

$$SA = FS(Q_2 / VS_S)$$

Where: Q_2= Option 1 – Single Event Hydrograph Method:

Q_2=Peak volumetric flow rate calculated using a 10-minute step from a Type1A, 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 (Vs) 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 cubic feet per second 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 each 1foot interval above the bottom of the trap.
- Sediment traps may not be feasible on utility projects due to the limited work space 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 1foot in depth.
- Any damage to the trap embankments or slopes shall be repaired.

BMP C241: Temporary Sediment Pond

Purpose

Sediment ponds are temporary ponds used during construction to remove sediment from runoff originating from disturbed areas of the site. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they usually reduce turbidity only slightly.

Conditions of Use

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or other appropriate sediment removal BMP.

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

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. Also, sediment traps and ponds are attractive to children and can be very dangerous. Compliance with local ordinances regarding health and safety must be addressed. If fencing of the pond is planned, the type of fence and its location shall be shown on the Construction SWPPP.

- Sediment ponds having a maximum storage capacity at the top of the dam of 10 acre-feet (435,600 cubic feet) or more are subject to the Washington Dam Safety Regulations (Chapter 173175 WAC).
- See Attachments Section C, Details 5.0, 5.1, and 5.2 for details.
- Projects that are constructing permanent detention facilities or infiltration basins and trenches can use the rough-graded permanent facilities for ponds. The surface area requirements of the sediment pond must be met. This may require temporarily enlarging the permanent basin to comply with the surface area requirements. 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 structures may be used if it is temporarily modified by plugging any outlet holes below the riser. The permanent control structure must be installed as part of the permanent BMP after the site is fully stabilized.
- Use of infiltration facilities for sedimentation ponds during construction tends to clog the soils and reduce their capacity to infiltrate. If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to a minimum of 2-feet above final grade. Final grading of the infiltration facility shall occur only when all contributing drainage areas are fully stabilized. Any proposed infiltration pretreatment facility should be fully constructed and used with the sedimentation pond to help prevent clogging of the soils. See Element 13: Protect Low Impact Development BMPs for more information about protecting permanent infiltration BMPs.

Determining Pond Geometry:

- To determine the sediment pond geometry, first calculate the design surface area (SA) of the pond, measured at the top of the riser pipe. Use the following equation:

$$SA = 2 \times Q_2/0.00096$$

or

2,080 square feet per cubic feet per second (cfs) of inflow

- See *BMP C240: Sediment Trap* for more information on the above equation.
- 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 riser.
  - Minimum 3.5-foot depth from top of riser to bottom of 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 100year recurrence interval storm. If, due to site conditions and pond geometry, a separate emergency spillway is not feasible, the principal spillway must pass the entire peak runoff expected from the 100year recurrence interval storm. However, an attempt to provide a separate emergency spillway should always be made. Base the runoff calculations on the site conditions during construction. The flow through the dewatering orifice cannot be utilized when calculating the 100year 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 Minimum 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 3.15 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 conditions. Use Figure 3.15 to determine this diameter (h = 1-foot). Note: A permanent control structure may be used instead of a temporary riser.

- **Emergency Overflow Spillway:** Determine the required size and design of the emergency overflow spillway 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:

$$A_o = \frac{A_s\,(2h)^{0.5}}{0.6x3600\,Tg^{0.5}}$$

Where: A_o = orifice area (square feet)

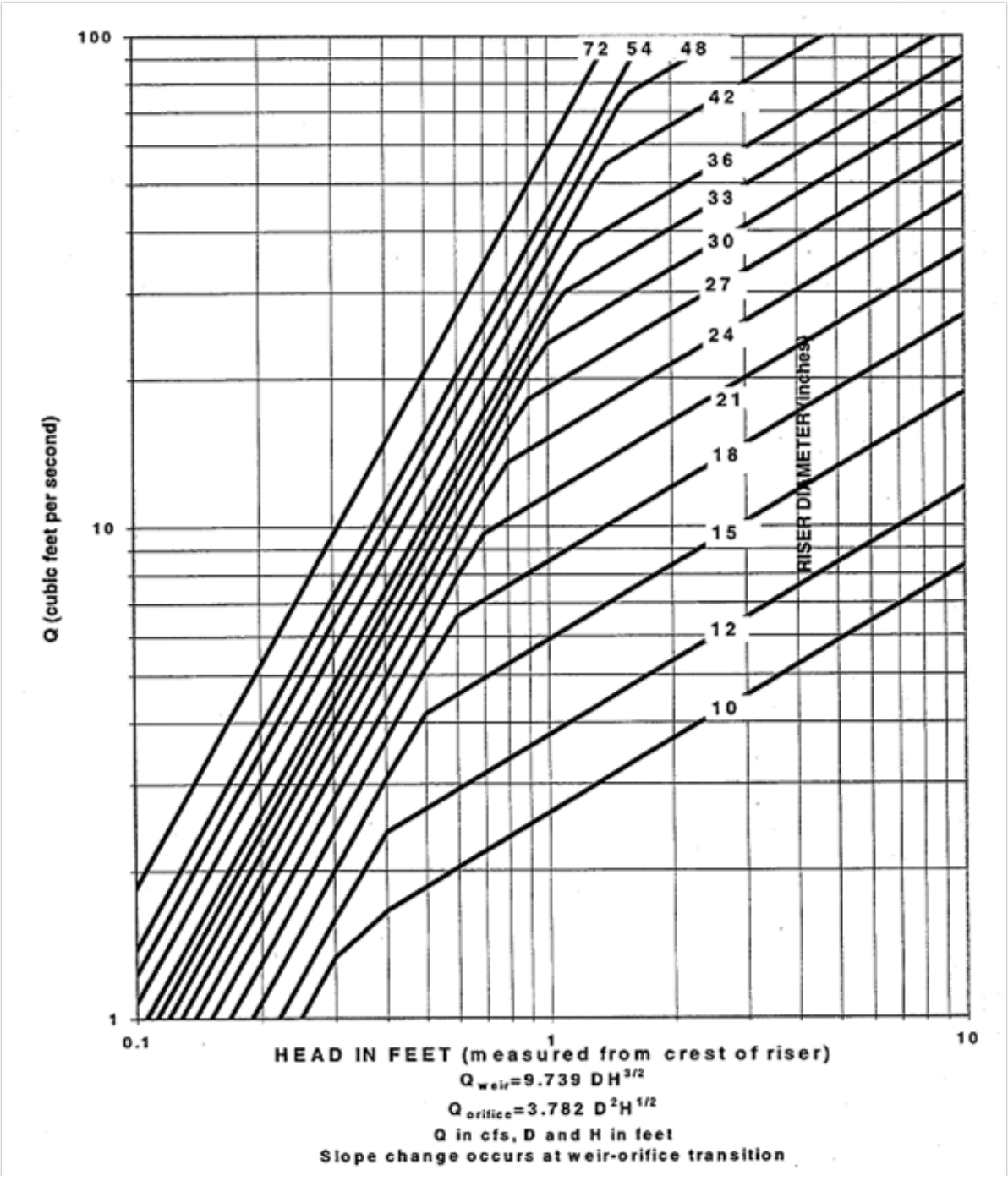
A_s = pond surface area (square feet)

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)

Figure 3.15. - Riser Inflow Curves.



Convert the required surface area to the required diameter *D* of the orifice:

$$D = 24x\sqrt{\frac{A_o}{\pi}} = 13.54x\sqrt{A_o}$$

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. The size and number of perforations in the tubing should be large enough so that the tubing does not restrict flow. The orifice should control the flow rate.

Additional Design Specifications:

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 3foot high, extra strength filter fabric supported by treated 4 x 4inches can be used as a divider. Alternatively, staked straw bales wrapped with geotextile fabric 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.

To aid in determining sediment depth, **1-foot intervals** above the pond bottom shall be prominently marked on the riser or a staff gauge.

If an **embankment** of more than 6-feet is proposed, the pond must comply with the criteria contained in Volume III, Section 3.12.1, regarding dam safety for detention BMPs. An electronic version of the Dam Safety Guidelines is available at Ecology's website.

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 sequences to prevent piping will be:

- Tight connections between riser and barrel and other pipe connections
- Adequate anchoring of riser
- Proper soil compaction of the embankment and riser footing
- Proper construction of anti-seep devices.

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. Traditional Construction SWPPP BMPs may not be adequate to ensure compliance with the water quality standards for turbidity in receiving water.

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants. Chemical treatment may be required to meet turbidity stormwater discharge requirements, especially when construction is to proceed through the wet season.

Conditions of Use

Formal written approval from both Ecology and Pierce County is required for the use of chemical treatment regardless of site size.

- Request for Chemical Treatment form

When authorized, the chemical treatment systems must be included in the Construction Stormwater Pollution Prevention Plan (SWPPP).

Chemically treated stormwater discharged from construction sites must be nontoxic to aquatic organisms. The Chemical Technology Assessment Protocol - Ecology (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.

Background on Chemical Treatment Systems

Coagulation and flocculation have been used for over a century to treat water. The use of coagulation and flocculation to treat stormwater is a very recent application. Experience with the treatment of water and wastewater has resulted in a basic understanding of the process, in particular factors that affect performance. This experience can provide insights as to 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. Thus, removal is not practical by gravity settling. 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 primary 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, 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), a 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 an 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 require special engineering analyses. The Ecology Dam Safety Section has specific design criteria for dams in Washington State.

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 as a part of chemical treatment.

Once the stormwater is within the desired pH range (dependent on coagulant being used), the stormwater is pumped from the untreated stormwater storage pond to a lined treatment cell as coagulant is added. The coagulant is added upstream of the pump to

facilitate rapid mixing.

After coagulant addition, 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 both 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 pond 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 cells 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 runoff volume of the 10-year, 24-hour storm event. Bypass should be provided around the chemical treatment system to accommodate extreme storm events. Runoff volume shall be calculated using the methods presented in Volume III, Chapter 2. 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).

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 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 Treatments 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 the 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 a batch treatment system, 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. 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.

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 onsite. 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 15minute 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 15minute 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 chemicals. 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 and Appendix G of *Whole Effluent Toxicity Testing Guidance and Test Review Criteria* (Marshall, 2016).

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. 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. 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

Filtration removes sediment from runoff originating from disturbed areas of the site.

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 approval from Ecology or Pierce County as long as treatment chemicals are not used. Filtration in conjunction with "BMP C101: Preserving Natural Vegetation" requires testing under the Chemical Technology Assessment Protocol – Ecology (CTAPE) before it can be initiated. Approval from Pierce County and the appropriate regional Ecology office must be obtained at each site where chemical use is proposed prior to use.

- Request for Chemical Treatment form

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/ ft^2, 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/ ft^2, because they do not have backwash systems. Slow filtration systems have generally been used as post construction BMPs to treat stormwater (see Volume V, Chapter 7, Filtration Treatment Facilities) Slow filtration is mechanically simple in comparison to rapid sand 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. Filters should be sequenced 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 an untreated stormwater sediment pond or tank for removal of large sediment and storage of the stormwater before it is treated by the filtration system. In a rapid filtration system, the untreated stormwater is pumped from the trap, pond, or tank through the filtration media . Slow filtration systems are designed using gravity to convey water from the trap, pond or tank to and through the filtration media.

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/ft^2. 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 preset pressure drop across the filter. If the backwash water volume is not large or substantially more turbid than the untreated stormwater stored in the holding pond or tank, backwash return to the untreated stormwater pond or tank may be appropriate. However, other means of treatment and disposal may be necessary.

- 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 range 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 washout, 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 discharge to watersof the State or stormwater collection systems.

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

- When carbon dioxide (CO_2) is added to water (H_2O H2O), carbonic acid (H_2CO_3) is formed which can further dissociate into a proton (H+) and a bicarbonate anion (HCO_3) as shown below:

  $CO_2 + H_2O \leftrightarrow H_2C0_3 \leftrightarrow H+ + HCO_3$

- 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:

1. Prior to treatment, Pierce County must be notified.
2. Every effort should be made to isolate the potential high pH water in order to treat it separately from other stormwater onsite.
3. Water should be stored in an acceptable storage facility, detention pond, or containment cell prior to pH treatment.
4. 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 structure completely, allow at least 2-feet of freeboard.
5. 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 CO2 is necessary for clearer water. The results of the samples and water clarity observations shall be recorded.
6. In the pH treatment structure, add CO2 until the pH falls into the range of 6.9 to 7.1. 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 pH treatment structure, this will allow carbon dioxide to bubble up through the water and diffuse more evenly.
7. 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 filitration to the treatment train. See BMP C251: Construction Stormwater Filtration.
8. Discharge treated water through a pond or drainage system.
9. 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 treatment structure for the next batch treatment. Dispose of sludge when it fills 50 percent of the treatment structure volume.
10. 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 CO_2 sparging, but add food grade vinegar instead of CO_2.

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 sanitary sewer.

Concrete Batch Plant Disposal:

- Only permitted facilities may accept high pH water.
- Contact the facility to assure they can accept the high pH water.

Maintenance Standards

Safety and materials handling:

- All equipment shall be handled in accordance with OSHA rules and regulations.

Follow manufacturer guidelines for materials handling.

Each operator shall 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 CO_2 or food grade vinegar 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 should be given to the client/contractor who should retain the record for 3 years

3.3 Protection of LID Facilities During Construction

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 Minimum 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.**

3.3.2 General Erosion and Sediment Control BMPs Applicable to LID

Overall Construction Stormwater Pollution Prevention Plan (SWPPP) requirements are specified in Volume I, Minimum 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 Minimum Requirement #2 that are proposing to construct LID BMPs.

Construction SWPPP BMP	Application	Section
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.)

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:

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 10foot 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.
Limit construction activity in areas designated for LID (continued)	General/primary contractor must inform other sub-contractors 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.
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).

Construction Site Planning and Sequencing Requirements	Construction Site Planning and Sequencing Techniques
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.

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:

Erosion Control Requirements	Erosion Control Techniques
Protect native topsoil during the construction phase, and reuse onsite	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.
Protect native topsoil during the construction phase, and reuse onsite (continued)	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.

Erosion Control Requirements	Erosion Control Techniques
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.

3.3.4 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.

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.

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 trackhoes 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).

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.

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 III, Section 3.4 and 3.8 for general bioretention and rain garden construction criteria.

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.

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

The following standard notes are suggested for use in Construction Stormwater Pollution Prevention Plans (SWPPPs). The county has other mandatory notes for construction plans that are applicable. Plans should also identify with phone numbers and email addresses the person or firm responsible for the preparation of and maintenance of the Construction SWPPP.

Standard Notes

Approval of this Construction SWPPP does not constitute an approval of permanent road or drainage design (e.g., size and location of roads, pipes, restrictors, channels, retention/ detention/ infiltration facilities, utilities, etc.).

The implementation of this Construction SWPPP and the construction, maintenance, replacement, and upgrading of these Construction SWPPP facilities is the responsibility of the applicant/ contractor until all construction is completed and approved and vegetation/landscaping is established.

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.

The Construction SWPPP 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 do not enter the drainage system, roadways, or violate applicable water standards.

The Construction SWPPP facilities shown on this plan are the minimum requirements for anticipated site conditions. During the construction period, these Construction SWPPP facilities shall be upgraded as needed for unexpected storm events and to ensure that sediment and sediment-laden water do not leave the site.

The Construction SWPPP facilities shall be inspected daily by the applicant/contractor and maintained as necessary to ensure their continued functioning.

The Construction SWPPP 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.

At no time shall more than 1-foot 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.

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.

Pierce County
Stormwater Management and Site Development Manual

Volume III
Hydrologic Analysis and Flow Control BMPs

Prepared by: Pierce County Planning and Public Works

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Table of Contents

Volume III Hydrologic Analysis and Flow Control BMPs

Chapter 1. Introduction **1-1**

1.1 Purpose of This Volume **1-1**

1.2 Content and Organization of This Volume **1-2**

1.3 How to Use This Volume **1-2**

Chapter 2. Hydrologic Analysis and Design Standards **2-1**

2.1 Minimum Computational Standards **2-1**

2.1.1 Discussion of Hydrologic Analysis Methods Used for Designing BMPs 2-2

2.2 Western Washington Hydrology Model **2-4**

2.2.1 Limitations to the WWHM 2-5

2.2.2 Assumptions Made in Creating the WWHM 2-5

2.3 Closed Depression Analysis **2-7**

2.4 Flow Control Criteria **2-8**

2.5 Infiltration Facilities for Flow Control **2-8**

2.5.1 Purpose 2-8

2.5.2 Procedures 2-9

2.5.3 General Criteria for Infiltration Basins and Trenches 2-13

2.6 Underground Injection Control **2-17**

Chapter 3. Flow Control Design **3-1**

3.1 Soil Preservation and Amendment (Ecology BMP T5.13) **3-1**

3.1.1 Description 3-1

3.1.2 Applications and Limitations 3-1

3.1.3 Modeling and Sizing 3-2

3.1.4 Soil Preservation and Amendment Design Criteria 3-2

3.1.5 Construction Criteria 3-6

3.1.6 Operations and Maintenance Criteria 3-6

3.2 Dispersion Facilities **3-6**

3.2.1 General Dispersion Facility Design Criteria 3-6

3.2.2 Full Dispersion (Ecology BMP T5.30) 3-7

3.2.3 Sheet Flow Dispersion (Ecology BMP T5.12) 3-7

3.2.4 Concentrated Flow Dispersion (Ecology BMP T5.11) 3-9

3.3 Tree Planting and Tree Retention (for Flow Control Credit, Ecology BMP T5.16) **3-13**

3.3.1 Description ... 3-13
3.3.2 Applications and Limitations ... 3-13
3.3.3 Modeling and Sizing ... 3-14
3.3.4 Tree Planting and Tree Retention Design Criteria ... 3-14
3.3.5 Construction Criteria ... 3-18
3.3.6 Operations and Maintenance Criteria ... 3-19
3.4 Bioretention Cells, Swales, and Planter Boxes (Ecology BMPs T5.14 and T7.30) ... 3-19
3.4.1 Description ... 3-19
3.4.2 Applications and Limitations ... 3-20
3.4.3 Infeasibility Criteria ... 3-22
3.4.4 Modeling and Sizing ... 3-24
3.4.5 Field and Design Procedures ... 3-26
3.4.6 Bioretention Design Criteria ... 3-29
3.4.7 Bioretention Construction Criteria ... 3-40
3.4.8 Operations and Maintenance Criteria ... 3-40
3.5 Permeable Paving (Ecology BMP T5.15) ... 3-40
3.5.1 Description ... 3-40
3.5.2 Applications and Limitations ... 3-41
3.5.3 Infeasibility Criteria ... 3-42
3.5.4 Modeling and Sizing ... 3-44
3.5.5 Field and Design Procedures ... 3-46
3.5.6 Paving Surface Design Criteria ... 3-48
3.5.7 Construction Criteria ... 3-55
3.5.8 Operations and Maintenance Criteria ... 3-56
3.6 Infiltration Trenches (Ecology BMP T7.20) ... 3-57
3.6.1 Description ... 3-57
3.6.2 Applications and Limitations ... 3-57
3.6.3 Modeling and Sizing ... 3-58
3.6.4 Infiltration Trench Design Criteria ... 3-58
3.6.5 Construction Criteria for Trenches ... 3-59
3.6.6 Operations and Maintenance Criteria for Trenches ... 3-59
3.7 Infiltration Basins (Ecology BMP T7.10) ... 3-59
3.7.1 Description ... 3-59
3.7.2 Applications and Limitations ... 3-59

3.7.3 Infiltration Basin Design Criteria 3-60
3.7.4 Construction Criteria 3-60
3.7.5 Operations and Maintenance Criteria 3-60
3.8 Rain Gardens (Ecology BMP T5.14A) 3-61
3.8.1 Description 3-61
3.8.2 Applications and Limitations 3-61
3.8.3 Infeasibility Criteria 3-62
3.8.4 Modeling and Sizing 3-62
3.8.5 Field and Design Procedures 3-62
3.8.6 Rain Garden Design Criteria 3-63
3.8.7 Rain Garden Construction Criteria 3-65
3.9 Roof Downspout Controls 3-65
3.9.1 Selection of Roof Downspout Controls 3-65
3.9.2 Applications to Minimum Requirements 3-65
3.9.3 Downspout Infiltration Systems (Ecology BMP T5.10A) 3-66
3.9.4 Downspout Dispersion Systems (Ecology BMP T5.10B) 3-71
3.9.5 Perforated Stub-Out Connections (Ecology BMP T5.10C) 3-76
3.10 Vegetated Roofs (Ecology BMP T5.17) 3-78
3.10.1 Description 3-78
3.10.2 Applications and Limitations 3-79
3.10.3 Modeling and Sizing 3-80
3.10.4 Vegetated Roof Design Criteria 3-80
3.10.5 Construction Criteria 3-82
3.10.6 Operations and Maintenance Criteria 3-82
3.11 Roof Rainwater Collection Systems (Ecology BMP T5.20) 3-82
3.11.1 Description 3-82
3.11.2 Applications and Limitations 3-83
3.11.3 Modeling and Sizing 3-83
3.11.4 General Roof Rainwater Collection System Design Criteria 3-84
3.11.5 Construction Criteria 3-84
3.11.6 Operations and Maintenance Criteria 3-85
3.12 Detention Facilities 3-85
3.12.1 Detention Ponds 3-86
3.12.2 Detention Tanks 3-97

3.12.3 Detention Vaults 3-98
3.12.4 Control Structures 3-100
3.12.5 Other Detention Options 3-109
3.12.6 Use of Roofs for Detention 3-109
Chapter 4. Conveyance Systems and Hydraulic Structures 4-1
4.1 Overview 4-1
4.2 Design Event Storm Frequency 4-1
4.3 Determination of Design Flows 4-2
4.4 Backwater Analysis 4-2
4.5 Conveyance System Route Design 4-2
4.6 Easements, Access, and Dedicated Tracts 4-3
4.6.1 Natural Channels and Stormwater Facilities 4-3
4.6.2 Maintenance Access 4-3
4.6.3 Access to Conveyance Systems 4-3
4.7 Pipe System Design Criteria 4-4
4.7.1 Analysis Methods 4-4
4.7.2 Acceptable Pipe Sizes 4-5
4.7.3 Pipe Materials 4-5
4.7.4 Pipe Slope and Velocity 4-5
4.7.5 Pipes on Steep Slopes 4-6
4.7.6 Pipe System Layout Criteria 4-6
4.7.7 Pipe Structure Criteria 4-7
4.8 Outfalls 4-12
4.8.1 General Design Criteria for Outfall Features 4-12
4.8.2 Tightline Systems 4-14
4.9 Flow Spreading Options 4-14
4.9.1 General Design Criteria 4-15
4.10 Culvert Criteria 4-20
4.10.1 Culvert Design Criteria 4-20
4.10.2 Fish Passage Criteria 4-22
4.11 Open Conveyances 4-22
4.12 Private Drainage Systems 4-22
4.12.1 Discharge Locations 4-22
4.12.2 Drainage Stub-Outs 4-22

Volume III References and Information Sources **Ref-1**

Appendix III-A –Methods for Determining Design Infiltration Rates **A-1**

Determine Design Infiltration Rate: **A-1**

Method 1 – Field Testing Procedures **A-1**

Safety Factor for Field Measurements A-2

Falling Head Percolation Test Procedure (as Modified for Pierce County) (Source: U.S. EPA, On-site Wastewater Treatment and Disposal Systems, 1980) A-3

Alternative Washington Department of Ecology Infiltration Pit Method A-5

Method 2 – USDA Soil Textural Classification **A-7**

Method 3 – Soil Grain Size Analysis Method **A-9**

Recommended Modifications to ASTM D 2434 When Measuring Hydraulic Conductivity for Bioretention Soil Mixes **A-10**

Appendix III-B –Design Aids: Design Storm Precipitation Values, Isopluvial Maps, SCS Curve Numbers, Roughness Coefficients, and Soil Types **B-1**

Single Event Model Guidance **B-1**

SBUH or SCS Methods B-1

Appendix III-C –Nomographs for Various Culvert Sizing Needs **C-1**

Appendix III-D –Onsite Stormwater Management BMP Infeasibility Criteria **D-1**

List of Tables

Table 2.1. - Summary of the Application Design Methodologies. 2-2
Table 3.1. - Flow Control Credits for Retained Trees. 3-14
Table 3.2. - Flow Control Credits for Newly Planted Trees. 3-14
Table 3.3. - Continuous Modeling Assumptions for Bioretention Cells. 3-25
Table 3.4. - Aggregate for Bioretention Soil. 3-34
Figure 3.8. - Porous Asphalt or Pervious Concrete Section. 3-51
Table 3.5. - Sizing Table for Downspout Infiltration Trenches. 3-70
Table 3.6. - Continuous Modeling Assumptions for Vegetated Roofs. 3-80
Table 3.7. - Pierce County Monthly Average Rainfall. 3-84
Table 3.8. - Stormwater Tract "Low Grow" Seed Mix. 3-96
Table 3.9. - Values of C_d for Sutro Weirs. 3-107
Table 4.1. - Minimum Easement Widths for Conveyance Systems for Access, Inspection and Maintenance. 4-4
Table 4.2. - Recommended Manning's "n" Values for Preliminary Pipe Design. 4-5
Table 4.3. - Maximum Pipe Slopes and Velocities. 4-6
Table 4.4. - Rock Protection at Outfalls. 4-13
Table 4.5. - Open Conveyance Protection. 4-21
Table A.1. - Recommended Infiltration Rates Based on USDA Soil Textural Classification. A-7
Table B.1. - Design Storm Precipitation Values. B-4
Table B.2. - "n" and "k" Values Used in Time Calculations for Hydrographs. B-8
Table B.3. - Values of the Roughness Coefficient "n". B-9
Table B.4. - Runoff Curve Numbers for Selected Agricultural, Suburban, and Urban Areas. B-10
Table B.5. - Major Soil Groups in Pierce County. B-12

Table of Figures

Figure 3.1. - Cross-section of Soil Amendment. 3-3
Figure 3.2. - Sheet Flow Dispersion for Driveways. 3-10
Figure 3.3. - Typical Concentrated Flow Dispersion for Steep Driveways. 3-11
Figure 3.4. - Critical Root Zone (CRZ) 3-16
Figure 3.5. - Root Bridge 3-17
Figure 3.6. - Bioretention Area (shown with optional underdrain) 3-22
Figure 3.8. - Permeable Paver Section 3-50
Figure 3.9a. - Typical Downspout Dispersion Trench. 3-74
Figure 3.9b. - Typical Downspout Dispersion Trench. 3-75
Figure 3.10. - Typical Downspout Splashblock Dispersion 3-76
Figure 3.11. - Perforated Stub- Out Connection. 3-78
Figure 3.12. - Vegetated Roof. 3-79
Figure 3.13. - Cistern. 3-85
Figure 3.14. - Simple Orifice. 3-103
Figure 3.15. - Rectangular, Sharp-Crested Weir. 3-104
Figure 3.16. - V-Notch, Sharp-Crested Weir. 3-105
Figure 3.17. - Sutro Weir. 3-106
Figure 3.18. - Riser Inflow Curves. 3-108
Figure 4.1. - Flow Splitter, Option A. 4-10
Figure 4.2. - Flow Splitter, Option B. 4-11
Figure 4.3. - Flow Spreader Option A: Anchored Plate. 4-17
Figure 4.4. - Flow Spreader Option B: Concrete Sump Box. 4-18
Figure 4.5. - Flow Spreader Option C: Notched Curb Spreader. 4-19
Figure 4.6. - Flow Spreader Option D: Through-Curb Port. 4-19
Figure A.1. - USDA Textural Triangle A-8
Figure C.1. - Headwater Depth for Smooth Interior Pipe Culverts with Inlet Control C-1
Figure C.2. - Headwater Depth for Corrugated Pipe Culverts with Inlet Control. C-2
Figure C.3. - Critical Depth of Flow for Circular Culverts. C-3
Figure C.4. - Circular Channel Ratios. C-4

Chapter 1. Introduction

1.1 Purpose of This Volume

Best management practices (BMPs) are schedules of activities, prohibitions of practices, maintenance procedures, managerial practices, or structural features that prevent or reduce adverse impacts to waters of Washington State. As described in Volume I of this stormwater manual, BMPs for long-term management of stormwater at developed sites can be divided into three main categories:

- BMPs addressing the volume and timing of stormwater flows
- BMPs addressing prevention of pollution from potential sources
- BMPs addressing treatment of runoff to remove sediment and other pollutants.

This volume of the stormwater manual focuses mainly on the first category. It presents techniques for hydrologic analysis, and BMPs related to management of the amount and timing of stormwater flows from developed sites. The purpose of this volume is to provide guidance on the estimation and control of stormwater runoff quantity.

BMPs for preventing pollution of stormwater runoff and for treating contaminated runoff are presented in Volumes IV and V, respectively.

This chapter details Pierce County's policies regarding the quantity control of runoff from developed or artificially altered sites. The scope of this chapter includes:

- Design criteria and specifications for the construction of runoff quantity control facilities
- Approved methods for estimating peak flow rates, volume of runoff, required input data, and required storage volumes based on site conditions
- Approved materials for use in private and public drainage facilities.

The intent of this chapter is to prescribe approved methods and requirements for runoff control to prevent impacts to downstream properties or natural resources to the maximum extent practical. The county recognizes that it is not always possible to fully prevent any impacts downstream; in these extreme cases, the project applicant may be required to provide offsite mitigation as determined by the county.

These regulations and criteria are based on fundamental principles of drainage, hydraulics, hydrology, environmental considerations and publications, manuals, and texts accepted by the professional engineering community. The engineer is responsible for being knowledgeable and proficient with the necessary design methodologies identified within this manual. A partial listing of publications which may be used as reference documents follows:

- The Washington State Department of Ecology (Ecology) Stormwater Management Manual for Western Washington
- Any Ecology-approved stormwater management manual
- The Low Impact Development Technical Guidance Manual for Puget Sound (Washington State University Extension and the Puget Sound Partnership)
- "Applied Handbook of Hydrology," by Chow
- "Handbook of Hydraulics," by E.G. Brater and H.W. King

- The following references published by the Washington State Department of Transportation (WSDOT):
  - "Hydraulics Manual"
  - "Standard Specifications for Road, Bridge, and Municipal Construction"
  - "Standard Plans"
- "Soil Survey of Pierce County Area, Washington," published by the Soil Conservation Service, U.S. Department of Agriculture (USDA)
- "Pierce County Road Standards, Ordinance 2010-70s," or the latest amendment
- Other information sources acceptable to the county and based on general use by the professional engineering community.

The most current edition of all publications shall be used.

1.2 Content and Organization of This Volume

Volume III of the stormwater manual contains four chapters:

- **Chapter 1** serves as an introduction.
- **Chapter 2** discusses hydrologic design standards and methods of hydrologic analysis, including the use of hydrograph methods for designing BMPs, an overview of various computerized modeling methods, and analysis of closed depressions.
- **Chapter 3** describes flow control BMPs and provides design specifications for infiltration, detention, and retention facilities. This volume's focus is on flow control. Additional water quality design considerations are addressed in Volume V.
- **Chapter 4** describes natural and constructed conveyance systems and acceptable analysis methods. It also includes sections on hydraulic structures which link the conveyance system to the runoff treatment and flow control facilities.

This volume includes four appendices. Appendix IIIA details infiltration testing procedures. Additionally, the USDA soil textural triangle has been included to support determining alternative infiltration rates. Appendix IIIB discusses Santa Barbara Urban Hydrograph (SBUH)/Natural Resources Conservation Service (NRCS) computer models and includes number of charts and tables useful in designing conveyance systems with non-continuous hydrologic models. This includes: design storm rainfall totals, isopluvial maps for western Washington, common Pierce County soil types and hydrologic groupings, NRCS curve numbers, roughness coefficients. Appendix IIIC includes several nomographs that may be useful for culvert sizing. Appendix III-D summarizes the infeasibility criteria that can be used to justify not using various onsite stormwater management BMPs for consideration in the List #1 or List #2 option of Minimum Requirement #5. This information is also presented under the description of each BMP, but is summarized in Appendix III-D as a quick reference point.

1.3 How to Use This Volume

Volume I should be consulted to determine minimum requirements for flow management (e.g., Minimum Requirements #4, #5, and #7 in Volume I, Chapter 2). After the minimum requirements have been determined, this volume should be consulted to design flow management facilities. These facilities can then be included in any required stormwater plan submittals (see Volume I,

Chapter 3). This volume also includes information on the design of stormwater conveyance systems (Chapter 4).

Chapter 2. Hydrologic Analysis and Design Standards

The broad definition of hydrology is "the science which studies the source, properties, distribution, and laws of water as it moves through its closed cycle on the earth (the hydrologic cycle)." As applied in this manual, however, the term "hydrologic analysis" addresses and quantifies only a small portion of this cycle. That portion is the relatively short-term movement of water over the land resulting directly from precipitation and called surface water or stormwater runoff. Localized and long-term groundwater movement must also be of concern, but generally only as this relates to the movement of water on or near the surface, such as stream baseflow or infiltration systems.

The purpose of this chapter is to define the minimum computational standards required, to outline how these may be applied, and to reference where more complete details may be found, should they be needed. This chapter also provides details on the hydrologic design process; that is, what are the steps required in conducting a hydrologic analysis, including flow routing.

Due to the inseparable interdependent nature of stormwater runoff quantity and quality, it is important that the design professional keep foremost the concept of water quality when designing for water quantity and vice versa. Water quantity and quality goals can often be accomplished in one facility. For instance, bioretention areas can be designed to provide both quantity and quality control. Many onsite stormwater management BMPs can also provide both quantity and quality control. Acceptable water quality design practices and methods are detailed in Volume V.

Site planning and layout play an important role in the amount of stormwater runoff generated by a project site. It is important to keep stormwater issues in mind when laying out the project. Reductions in impervious areas result in smaller treatment and quantity control facilities, thereby reducing the costs of managing the stormwater. Low impact development (LID) directly addresses this idea and can benefit the designer by limiting the runoff and creating more appealing sites. Most of the common LID BMPs (also referred to as onsite stormwater management BMPs in this manual) are presented in this volume. Additional information on general LID site design and the County's specific requirements for Comprehensive LID Site Design (per PCC 18A and 18J) are provided in Volume VI.

Some of the things that must be considered during site planning and layout include: minimizing creating hard and impervious surfaces, clustering buildings and preserving larger areas of open space, minimizing directly connected hard and impervious areas (try to separate impervious surfaces with areas of turf, or other vegetation), incorporation of low maintenance landscaping that doesn't need frequent applications of fertilizers, herbicides and pesticides and minimizing the impact area and soil compaction during construction.

2.1 Minimum Computational Standards

The minimum computational standards depend on the type of information required and the size of the drainage area to be analyzed, as follows:

- For the purpose of designing runoff treatment BMPs, a calibrated continuous simulation hydrologic model based on the U.S. Environmental Protection Agency's (U.S. EPA) Hydrological Simulation Program-Fortran (HSPF) program, or an approved equivalent model (e.g., using the latest version of the Western Washington Hydrology Model [WWHM]), must be used to calculate runoff and determine the water quality design flow rates and volumes.

Design standard and sizing of water quality BMPs can be found in Volume V.

- For conveyance system design the designer may use an approved continuous simulation runoff model or a single event hydrologic model to determine the peak flow rate. The peak flow rate from a continuous runoff model will vary depending on the time step used in the model. Therefore, the length of the time step must be sufficiently short relative to the time of concentration of the watershed to provide for reasonable conveyance system design flows. For most situations in Pierce County, a 15minute (maximum) time step will be sufficient for conveyance system design. If the project is in a predominantly urbanized watershed with a time of concentration less than about 15 minutes (roughly 10 acres in size), the conveyance design must either use a 5minute time step (if available), or use an event-based model for conveyance sizing. Conveyance design is discussed in detail in Chapter 4.
- For the purpose of designing flow control BMPs, a calibrated continuous simulation runoff model, based on the U.S. EPA's HSPF, must be used. Flow control BMP criteria are discussed in detail in Chapter 3. The circumstances under which different methodologies apply are summarized in Table 2.1 below.

Table 2.1. - Summary of the Application Design Methodologies.

Method	BMP/Conveyance Designs in Western Washington		
	Treatment	**Flow Control**	**Conveyance**
Continuous Runoff Models: (WWHM or approved alternatives. See below.)	Method applies to all BMPs	Method applies throughout Western Washington	Method applies throughout Western Washington
Soil Conservation Service Unit Hydrograph (SCSUH)/ Santa Barbara Unit Hydrograph (SBUH)	Not Applicable	Not Applicable	Acceptable
Rational Method	Not Applicable	Not Applicable	Acceptable for Certain Conveyance Design Only (see below)

- If a basin plan is being prepared, then a hydrologic analysis shall be performed using a continuous simulation runoff model such as the U.S. EPA's HSPF model, the U.S. EPA's Stormwater Management Model (SWMM), or an equivalent model as approved by Pierce County.
- Ecology has developed the HSPF-based WWHM. By default, WWHM uses rainfall/runoff relationships developed for specific basins in the Puget Sound region to all parts of western Washington. **Pierce County has developed a 158-year precipitation time series specific to the county that must be used when modeling with WWHM. These data are included in WWHM2012.**
- Use of other continuous simulation runoff models must be approved by Ecology and receive prior concurrence from the County before being used for facility design.

Where large master-planned developments are proposed, the county may require a basin-specific calibration of HSPF rather than use of the default parameters in the above-referenced models. Basin-specific calibrations may be required for projects that will occupy more than 320 acres.

2.1.1 Discussion of Hydrologic Analysis Methods Used for Designing BMPs

This section provides a discussion of the methodologies to be used for calculating stormwater runoff from a project site. It includes a discussion of estimating stormwater runoff with single

event models, such as the Santa Barbara Unit Hydrograph (SBUH), versus continuous simulation models.

Single Event and Continuous Simulation Runoff Model

A continuous simulation runoff model has considerable advantages over the single event-based methods such as the SCSUH, SBUH, or the rational method. HSPF is a continuous simulation model that is capable of simulating a wider range of hydrologic responses than the single event models such as the SBUH method. Single event models cannot take into account storm events that may occur just before or just after the single event (the design storm) that is under consideration. In addition, the runoff files generated by the HSPF models are the result of a considerable effort to introduce local parameters and actual rainfall data into the model and therefore produce better estimations of runoff than the SCSUH, SBUH, or rational methods which tend to overestimate peak runoff.

A major weakness of the single event model is that it is used to model a 24hour storm event, which is too short to model longer-term storms in western Washington. The use of a longer-term (e.g., 3- or 7day storm) is perhaps better suited for western Washington.

Related to the last concern is the fact that single event approaches, such as SBUH, assume that flow control ponds are empty at the start of the design event. Continuous runoff models are able to simulate a continuous long-term record of runoff and soil moisture conditions. They simulate situations where ponds are not empty when another rain event begins.

Finally, single event models do not allow for estimation and analyses of flow durations nor water level fluctuations. Flow durations are necessary for discharges to streams. Estimates of water level fluctuations are necessary for discharges to wetlands and for tracking influent water elevations and bypass quantities to properly size treatment facilities.

Guidance for Flow Control Standards

Flow control standards are used to determine whether or not a proposed stormwater facility will provide a sufficient level of mitigation for the additional runoff from land development.

There are three flow-related standards stated in Volume I of this manual: Minimum Requirement #5: Onsite Stormwater Management; Minimum Requirement #7: Flow Control; and Minimum Requirement #8: Wetlands Protection.

Minimum Requirement #5 allows the user to demonstrate compliance with the LID Performance Standard of matching developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 8 percent of the 2-year peak flow to 50 percent of the 2-year peak flow. If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 8 percent and 50 percent of the 2year predevelopment peak flow values, then the LID performance standard has not been met.

Minimum Requirement #7 specifies that stormwater discharges to streams shall match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50 percent of the 2year recurrence interval peak flow up to the full 50year peak flow.

- The continuous runoff models compute the predevelopment 2- through 100year recurrence interval flow values and compute the postdevelopment runoff 2year through 100year recurrence interval flow values from the outlet of the proposed stormwater facility
- The model uses pond discharge data to compare the predevelopment and postdevelopment durations and determines if the flow control standards have been met

- There are three criteria by which flow duration values are compared:
    1. If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 50 percent and 100 percent of the 2year recurrence interval predevelopment peak flow values (100 percent threshold) then the flow duration requirement has not been met
    2. If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 100 percent of the 2year and 100 percent of the 50year recurrence interval predevelopment peak flow values more than 10 percent of the time (110 percent threshold) then the flow duration requirement has not been met
    3. If more than 50 percent of the flow duration levels exceed the 100 percent threshold then the flow duration requirement has not been met.

Minimum Requirement #8 includes measures to protect the hydroperiod of the wetland. Flow components feeding the wetland under both pre- and post-development scenarios are assumed to be the sum of the surface, interflow, and groundwater flows from the project site. Ecology has added the capability to model flows to wetlands and analyze the daily and monthly flow deviations (per these requirements) to WWHM2012.

As of July 1, 2019, the algorithms needed to perform the analysis associated with the hydroperiod protection guidelines described in I-B.4 Wetland Hydroperiod Protection are not available in WWHM. However, WWHM can be used to provide model simulation of flows to wetlands under both predevelopment condition and postdevelopment condition. The analysis and comparisons of those flows (under predevelopment and postdevelopment conditions) must be conducted outside WWHM; for example, by using a spreadsheet.

Single Event Storms – Hydrograph

Hydrograph analysis utilizes the standard plot of runoff flow versus time for a given single event design storm, thereby allowing the key characteristics of runoff such as peak, volume, and phasing to be considered in the design of drainage facilities. All storm event hydrograph methods require input of parameters that describe physical drainage basin characteristics. These parameters provide the basis from which the runoff hydrograph is developed. Because the only application for single event methods in this volume is to size conveyance systems, only a limited discussion of design storms, curve numbers and calculating peak runoffs are presented in Appendix IIIB. If single event methods are used to size temporary and permanent conveyances, the reader should reference other texts and software for assistance. Conveyance systems can be designed using unit hydrograph analysis methods for estimating storm runoff rates. All storage facilities shall be designed to meet the Minimum Requirement #7 for frequency and duration control using a continuous runoff model. If the engineer decides to use a single event runoff model for conveyance design the preferred method is the SBUH method; or the SCSUH method as a second choice. The rational method may be used for conveyance sizing on sites of 25 acres or less, and having a time of concentration of less than 100 minutes. See also Chapter 4.

2.2 Western Washington Hydrology Model

This section summarizes the assumptions made in creating the WWHM and discusses limitations of the model. Note that the WWHM is being updated regularly and much of the following information is for background and overview only. However, since the first version of WWHM was developed and released to public in 2001, the WWHM program has gone through several upgrades incorporating new features and capabilities including LID modeling capability. For

example, WWHM2012 now includes modeling elements for stormwater LID BMPs. WWHM users should periodically check Ecology's WWHM website for the latest releases of WWHM, user manuals, and any supplemental instructions.

More information on the WWHM can be found on Ecology's website.

2.2.1 Limitations to the WWHM

The WWHM has been created for the specific purpose of sizing stormwater control facilities for new developments and redevelopments in western Washington. The WWHM can be used for a range of conditions and developments; however, certain limitations are inherent in this software. In addition, note that the model is frequently updated and some of the following limitations may change with subsequent updates.

WWHM uses the U.S. EPA HSPF software program to do all of the rainfall-runoff and routing computations. Therefore, HSPF limitations are included in the WWHM. For example, backwater or tailwater control situations are not explicitly modeled by HSPF. This is also true in the WWHM.

Earlier versions of WWHM, WWHM1, and WWHM2 had limited routing capabilities. The routing capabilities of WWHM3 and WWHM2012 have improved and the user can input multiple stormwater control facilities and runoff is routed through them. If the proposed development site involves routing through a natural lake or wetland in addition to multiple stormwater control facilities, WWHM2012 can be used to do the routing computations and additional analysis.

2.2.2 Assumptions Made in Creating the WWHM

Precipitation Data

- By default, the WWHM uses long-term (over 50 years) precipitation data to simulate the potential impacts of land use development in western Washington. A minimum period of 20 years is required to simulate enough peak flow events to produce accurate flow frequency results.
- **As noted previously, Pierce County has developed an extended precipitation time series specific to the county that must be used when modeling with WWHM.** Note that WWHM2012 includes this county-specific information within the model.
- WWHM2012 incorporates and uses 15minute precipitation data. This data is used in WWHM2012 computations to generate runoff hydrographs. The computations include generating design flows and volumes for sizing water quality treatment facilities. The 15-minute water quality design flows are used for the design of water quality treatment facilities that are expected to have a hydraulic residence time of less than one hour.

Pan Evaporation Data

- WWHM uses pan evaporation coefficients to compute the actual evapotranspiration potential for a site, based on the potential evapotranspiration and available moisture supply. Actual evapotranspiration potential accounts for the precipitation that returns to the atmosphere without becoming runoff.
- The pan evaporation coefficients have been placed in the WWHM database and linked to each county's map. They will be transparent to the general user. The advanced user will have the ability to change the coefficient for a specific site (subject to County approval). These changes will be recorded in the WWHM output.

Soil Data

- WWHM uses three predominant soil types to represent the soils of western Washington – till, outwash, and saturated.
- The user determines actual local soil conditions for the specific development planned and inputs that data into the WWHM. The user inputs the number of acres of outwash (A/B), till (C/D), and saturated (wetland) soils for the site conditions.
- Additional soils will be included in the WWHM if appropriate HSPF parameter values are found to represent other major soil groups.

Vegetation Data

- WWHM will represent the vegetation of western Washington with three predominate vegetation categories: forest, pasture, and lawn (also known as grass).
- The predevelopment land conditions are generally assumed as forest (the default condition), however, the user has the option of specifying pasture if there is documented evidence that pasture vegetation was native to the predevelopment site. In highly urbanized basins (see Minimum Requirement #7 in Volume I, Chapter 2), it is possible to use the existing land cover as the predeveloped land condition.

Development Land Use Data

- Development land use data are used to represent the type of development planned for the site and are used to determine the appropriate size of the required stormwater mitigation facility.
- Earlier version of WWHM included a standard residential development which made specific assumptions about the amount of impervious area per lot and its division between driveways and rooftops. Streets and sidewalk areas are input separately. Ecology has selected a standard impervious area of 4,200 square feet per residential lot, with 1,000 square feet of that as driveway, walkways, and patio area, and the remainder as rooftop area. The more recent versions of WWHM (e.g., WWHM3 or WWHM2012) no longer have the Standard residential development category. Users can use the above land use assumptions for a modeling runoff from Standard residential development or, where better land use information is available, use that information to model and estimate runoff from the residential development.
- WWHM distinguishes between effective impervious area and non-effective impervious area in calculating total impervious area.
- Credits are given for infiltration and dispersion of roof runoff and for use of permeable pavement for driveway areas. Unlike earlier version of WWHM, newer versions (e.g., WWHM2012) now includes LID modeling features, calculate credits directly in the model, and comes with a user manual that provides modeling instructions for LID BMPs. Explicit elements representing bioretention, green roofs, permeable pavement, and compost amended vegetated filter strips can be modeled in WWHM to determine the flow control credits obtained. WWHM is actively being updated to include options for obtaining credits for the use of permeable pavements on streets, sidewalks, and parking. Designers should also look to the LID credit guidance associated with each BMP for determining modeling credits for all LID BMPs.
- Forest and pasture vegetation areas are only appropriate for separate undeveloped parcels

dedicated as open space, wetland buffer, or park within the total area of the development. **Development areas must only be designated as forest or pasture where legal restrictions can be documented that protect these areas from future disturbances.**

- WWHM can model bypassing a portion of the runoff from the development area around a stormwater detention facility and/or having offsite inflow enter the development area.

Application of WWHM in Redevelopments Projects

Redevelopment requirements may allow, for some portions of the redevelopment project area, the predeveloped condition to be modeled as the existing condition rather than forested or pasture condition. For instance, where the replaced impervious areas do not have to be served by updated flow control facilities because area or cost thresholds in Volume I, Section 2.3 are not exceeded.

Pervious and Impervious Land Categories (PERLND and IMPLND Parameter Values)

- In WWHM (and HSPF) pervious land categories are represented by PERLNDs; impervious land categories by IMPLNDs.
- WWHM includes multiple default PERLND and IMPLND parameters that describe various hydrologic factors that influence runoff. Some of these parameters can be modified as site conditions require. All changes from the default WWHM settings will be flagged in the output and will require written justification by the engineer.
- These values are based on regional parameter values developed by the U.S. Geological Survey (USGS) for watersheds in western Washington (Dinicola, 1990) plus additional HSPF modeling work conducted by AQUA TERRA Consultants.
- Surface runoff and interflow are computed based on the PERLND and IMPLND parameter values. Groundwater flow can also be computed and added to the total runoff from a development if there is a reason to believe that groundwater would be surfacing (such where there is a cut in a slope). However, the default condition in WWHM assumes that no groundwater flow from small catchments reaches the surface to become runoff.

2.3 Closed Depression Analysis

The analysis of closed depressions requires careful assessment of the existing hydrologic performance in order to evaluate the impacts a proposed project will have. Discharge criteria are described in Volume I, Chapter 2. The applicable requirements (see Minimum Requirements #5 and #7) and the county's critical areas ordinance and rules (if applicable) must be thoroughly reviewed prior to proceeding with the analysis.

Closed depressions generally facilitate infiltration of runoff. If a closed depression is classified as a wetland or the discharge path flows through a wetland, then the Minimum Requirement #8 for wetlands applies. If there is an outflow from this wetland to a surface water (such as a creek), then the flow from this wetland must also meet the Minimum Requirement #7 for flow control. A calibrated continuous simulation runoff model must be used for closed depression analysis and design of mitigation facilities. If a closed depression is not classified as a wetland, model the ponding area at the bottom of the closed depression as an infiltration pond using the latest version of WWHM or an Ecology approved continuous runoff model.

2.4 Flow Control Criteria

Refer to Volume I, Chapter 2 for thresholds, exemptions, and specific criteria for runoff quantity control. Minimum Requirement #7 contains the primary flow control criteria, including the county's four categories of project requirements. However, project proponents must assess the potential impact of all 10 Minimum Requirements on project flow control designs, with particular attention to Minimum Requirements #5, #6, and #8.

2.5 Infiltration Facilities for Flow Control

Unless otherwise specified within a specific subsection, the information outlined in Section 2.5 applies to infiltration basins and trenches. Information and procedures specific to other infiltration facilities (e.g., bioretention areas, permeable pavement surfaces, rain gardens, and downspout infiltration systems) are included in those BMP sections in Chapter 3.

2.5.1 Purpose

The purpose of this section is to describe the steps required to evaluate the suitability of a site for infiltration facilities, establish a design infiltration rate, and design facilities for infiltration.

Infiltration is the percolation of surface water into the ground. While other flow control facilities, such as detention ponds, reduce peak flow rates associated with developed areas, infiltration facilities also reduce surface water runoff volumes. When properly sited and designed, infiltration facilities can help to decrease runoff, recharge groundwater, and protect downstream receiving waters.

Infiltration for water quality treatment is permitted within Pierce County. However, the requirements for infiltration for water quality treatment are substantially different from those for flow control and are outlined in Volume V, Chapter 6. To be used for runoff treatment, soils must include sufficient organic content and sorption capacity to remove pollutants. Examples of suitable soils are silty and sandy loams. Coarser soils, such as gravelly sands, can provide flow control but are not suitable for providing runoff treatment. The use of coarser soils to provide flow control for runoff from pollution generating surfaces must be preceded by treatment to protect groundwater quality. Thus, there will be instances when soils are suitable for treatment but not flow control, and vice versa. As a result, it is not recommended that large infiltration facilities be designed as combined flow control and water quality treatment facilities. The space requirements and maintenance needs generally make these facilities undesirable in Pierce County. However, smaller onsite stormwater management BMPs (e.g., rain gardens/bioretention) can work well as combined flow control and treatment BMPs. The following guidelines are applicable for stormwater runoff quantity and flow control only.

Also note that although infiltration is one of the preferred methods for disposing of excess stormwater, infiltration is regulated by Ecology and the Underground Injection Control (UIC) Program (WAC 173218). Additional information, requirements, site suitability criteria, prohibitive activities and conditions on UIC and how it applies to infiltration and stormwater management is included in Section 2.6, Volume I, Appendix I-C – Underground Injection Control (UIC) Program Guidelines and Ecology's web page for the UIC program.

This section also highlights design criteria that are applicable to infiltration facilities serving a treatment function.

2.5.2 Procedures

The following procedures must be followed when considering and designing an infiltration basin or trench. Each step is outlined in more detail in the subsequent sections. All pertinent information must be reported in the soils report portion of the Drainage Control Plan (see Volume I, Section 3.3).

Step 1 – Conduct general site reconnaissance, and review survey and other information to identify existing drinking water wells or aquifers, existing and proposed buildings, steep slopes, and septic systems in the vicinity of the proposed facility.

Step 2 – Evaluate minimum requirements for infiltration facilities to determine whether infiltration is feasible for the site. For additional information on site suitability criteria, prohibitive activities and conditions see Volume I, Appendix I-C.

Step 3 – Determine whether the simple or detailed method of analysis is required. Consultation with Pierce County is required at this stage to obtain approval of the proposed method of analysis (simple or detailed).

Step 4 – Complete simple analysis.

Step 5 – Complete detailed analysis, if necessary.

Step 1: General Site Characterization

The first step in designing an infiltration facility is to select a location, and assess the site suitability. The information to be reviewed as part of this initial site characterization will vary from site to site, but may include:

- Topography within 500 feet of the proposed facility
- Anticipated site use (street/highway, residential, commercial, high-use site)
- Location of water supply wells within 500 feet of proposed facility
- Location of groundwater protection areas and/or 1-, 5-, and 10year time of travel zones for municipal well protection areas
- Location of steep slope, erosion hazard, or landslide hazard areas
- Location of septic systems in the vicinity of the proposed facility
- A description of local site geology, including soil or rock units likely to be encountered, the groundwater regime, and geologic history of the site.

This information, along with additional geotechnical information necessary to design the facility, shall be summarized in the soils report prepared under Step 4.

Step 2: Minimum Requirements for Infiltration Facilities

Infiltration is not permissible unless all of the following criteria are met. Note: not all sites that meet the following criteria will be suitable for infiltration – these are minimum requirements only.

- The base of all infiltration basins or trench systems (without a perforation pipe) shall be a minimum of 3 feet above seasonal high groundwater levels, bedrock (or hardpan), or other low permeability layer. Infiltration basins may not be constructed within a floodplain area.
- The base of a trench system, that is considered a Class V UIC well shall be a minimum of 5 feet above the seasonal high groundwater levels, bedrock (or hardpan), or other low

permeability layer , unless a demonstrative approach confirms that a separation of 3 feet will meet the non-endangerment standard. See Volume I, Appendix I-C for requirements to meet the non-endangerment standard.

- Refer to Setbacks in Section 2.5.3 for setbacks that apply to all infiltration ponds/basins and trenches. Refer to Section 3.6 and 3.7 for additional setbacks listed for these BMPs. Refer to other sections in Chapter 3 for setbacks that apply to other infiltration BMPs (i.e., bioretention areas, permeable pavement surfaces, rain gardens, and downspout infiltration systems.
- Infiltration facilities up gradient of drinking water supplies and within the 1-, 5-, and 10year time of travel zones must comply with PCC Title 18E.50, as well as any applicable Washington Department of Health requirements.
- If the depth of the infiltration facility being considered is greater than the largest surface dimension, it is considered an injection well and is subject to the requirements of the UIC Program, Chapter 173218 WAC and must be registered with Ecology. See also Section 2.6 and Volume I, Appendix I-C – Underground Injection Control (UIC) Program Guidelines.
- The maximum depth of an infiltration facility is 20 feet below the surrounding finished (developed) ground elevation, in order to provide for long-term maintenance access to the facility.

Step 3: Determine Method of Analysis

Pierce County encourages consideration of infiltration facilities for sites where conditions are appropriate. However, some sites may not be appropriate for infiltration due to soil characteristics, groundwater levels, steep slopes, or other constraints. All proposed infiltration basins and trenches are required, at a minimum, to perform the simple analyses specified below. For those sites that present a risk of infiltration system failure, a more detailed method of analysis is required in addition to the simple analysis.

The sections below outline the criteria to be considered when determining whether a project is subject to the simplified or the detailed method of analysis. The chosen method of analysis must be approved by Pierce County. Moreover, the county may require that the detailed method of analysis be conducted based on the results of the simple method. (See Section 3.4, Bioretention Cells, Swales, and Planter Boxes, and Section 3.8, Rain Gardens, for methods specific to bioretention and rain gardens. See Section 3.5, Permeable Pavement, for methods specific to permeable pavement.)

Simple Method

Projects considering using the simplified method generally will have the following characteristics:

- For individual small facilities serving short plats or commercial developments less than one acre of contributing area
- High infiltration capacity soils (NRCS [SCS] soil types A or B)
- Other infiltration facilities performing successfully at nearby locations
- No septic systems, drinking water wells, steep slopes, or other sensitive features within 500 feet
- Low risk of flooding and property damage in the event of clogging or other failure of the

infiltration system.

Detailed Method

Where there is not clear evidence that a site is well-suited to infiltration, a more detailed method of analysis will be required. The detailed method of analysis, described below, includes more intensive field testing and soils investigation and analyses than the simplified method. Site conditions that will likely require use of the detailed method may include:

- Low infiltration capacity soils (NRCS [SCS] soil types C or D)
- History of unsuccessful infiltration facility performance, or no history of successful infiltration performance at nearby locations
- A large contributing drainage area
- High groundwater levels
- High risk of flooding in the event of clogging or other failure.

Step 4: Simple Analysis for all Proposed Infiltration Projects

The following analyses are required for all proposed infiltration basins and trenches.

Conduct Soils Testing

- Test hole or test pit explorations shall be conducted during mid to late in the wet season (December 1 through April 30) to provide accurate groundwater saturation and groundwater information.

  Collect representative samples from each soil type and/or unit to a depth below the base of the infiltration facility of 2.5 times the maximum design ponded water depth, but not less than 6 feet.

- If proposing to estimate the infiltration rate using the soil grain size analysis method, obtain samples adequate for the purposes of that gradation/classification testing.

  For infiltration basins, there shall be one test pit or test hole per 5,000 square feet of basin infiltrating surface with a minimum of two per basin, regardless of basin size. For infiltration trenches, there shall be one test pit or test hole per 200 feet of trench length with a minimum of two required per trench, regardless of length.

- Prepare detailed logs for each test pit or test hole and a map showing the location of the test pits or test holes. Logs must include the depth, soil descriptions, depth to water, evidence of seasonal high groundwater elevation, existing ground surface elevation, proposed basin bottom elevation, and presence of stratification that may impact the infiltration design.

  If using the soil Grain Size Analysis Method for estimating infiltration rates, include laboratory testing as necessary to establish the soil gradation characteristics and other properties to complete the infiltration facility design. At a minimum, conduct one grain size analysis per soil stratum in each test hole to a depth of 6 feet below the proposed base of the infiltration facility. When assessing the hydraulic conductivity characteristics of the site, soil layers at greater depths must be considered if the licensed professional conducting the investigation determines that deeper layers will influence the rate of infiltration for the facility, requiring soil gradation/classification testing for layers deeper than indicated above.

- Determine Design Infiltration Rate:

There are three acceptable methods for estimating initial infiltration rates. Each is described in detail in Appendix IIIA.

Prepare Soils Report

A report must be prepared that is stamped by a professional engineer with geotechnical expertise, a licensed geologist, a hydrogeologist, or an engineering geologist registered in the State of Washington that summarizes site characteristics and demonstrates that sufficient permeable soil for infiltration exists at the proposed facility location. At a minimum, the report must contain the following:

- Figure showing the following:
  - Topography within 500 feet of the proposed facility
  - Locations of any water supply wells within 500 feet of the proposed facility
  - Location of groundwater protection areas, aquifer recharge areas, or 1-, 5-, and 10year times of travel zones for wellhead protection areas
  - Locations of test pits or test holes.
- Results of soils tests including but not limited to: detailed soil logs, visual grain size analysis, grain-size distribution (required if using the grain size analysis method to estimate infiltration rates), percent clay content (include type of clay, if known), color/ mottling, variations and nature of stratification
- Description of local site geology, including soil or rock units likely to be encountered at soil sampling depths and the seasonal high groundwater elevation
- Detailed documentation of the design infiltration rate determination, as specified above
- State whether location is suitable for infiltration and recommend a design infiltration rate. Note that the maximum allowable design infiltration rate is 30 inches per hour.

Estimate Volume of Stormwater

Use the latest version of the Western Washington Hydrology Model (WWHM), or other approved continuous runoff model to generate an influent file that will be used to size the infiltration facility. The facility must infiltrate either all of the flow volume as specified by the influent file, or a sufficient amount of the flow volume such that any overflow/bypass meets the flow duration standard in Minimum Requirement #7. In addition, the overflow/bypass must meet the LID performance standard if it is the option chosen to meet Minimum Requirement #5, or if it is required of the project.

Step 5: Detailed Analysis – Additional Requirements

In addition to the simple method requirements outlined above, projects subject to the detailed analysis method shall include infiltration receptor characterization.

Infiltration Receptor Characterization

Monitor Groundwater Levels

- A minimum of three groundwater monitoring wells shall be installed per infiltration facility that will establish a three-dimensional relationship for the groundwater table, unless the highest groundwater level is known to be at least 50 feet below the proposed base of the infiltration facility.

- Seasonal groundwater levels must be monitored at the site during at least one wet season (December 1 through April 30).
- Normalize the single wet season observation to historic groundwater records in the region.

Characterize Infiltration Receptors in Soils Report

Address the following:

- Depth to groundwater and to bedrock/impermeable layers.
- Seasonal variation of groundwater table based on well water levels and observed mottling of soils.
- Existing groundwater flow direction and gradient.
- Volumetric water holding capacity of the infiltration receptor soils. The volumetric water holding capacity is the storage volume in the soil layer directly below the infiltration facility and above the seasonal high groundwater mark, bedrock, hardpan, or other low permeability layer.
- Horizontal hydraulic conductivity of the saturated zone to assess the aquifer's ability to laterally transport the infiltrated water.
- Approximation of the lateral extent of infiltration receptor.
- Impact of the infiltration rate and proposed added volume from the project site on local groundwater mounding, flow direction, and water table determined by hydrogeologic methods.
- The County may require a groundwater mounding analysis on projects where an infiltration facility has a drainage area exceeding one acre and has less than 6 feet depth to seasonal high groundwater (as measured from the bottom of the infiltration basin or trench) or other low permeability stratum. Groundwater mounding analysis methods are subject to county approval, and may include an analytical groundwater model (such as MODERET) to investigate the effects of the local hydrologic conditions on facility performance.
- State whether location is suitable for infiltration and recommend a design infiltration rate. Note that the maximum allowable design infiltration rate is 30 inches per hour.

Construct the Facility and Conduct Performance Testing:

To demonstrate that the facility performs as designed, the constructed facility must be tested and monitored per the Verification of Performance requirements in Section 2.5.3, and documented as part of the Engineer's Inspection Report Form (obtainable from Pierce County Planning and Public Works' website).

2.5.3 General Criteria for Infiltration Basins and Trenches

This section covers design, construction, and maintenance criteria that apply to infiltration basins and trenches. Similar information for other infiltration BMPs (i.e., bioretention areas, permeable pavement surfaces, rain gardens, and downspout infiltration systems) is included under the detailed BMP descriptions in Chapter 3.

Design Criteria – Sizing Facilities

The size of infiltration basins and trenches can be determined by routing the influent runoff file generated by the continuous runoff model through it. In general, an infiltration facility would have

two discharge modes. The primary mode of discharge from an infiltration facility is infiltration into the ground. However, when the infiltration capacity of the facility is reached, additional runoff to the facility will cause the facility to overflow. Overflows from an infiltration basin or trench must comply with the Minimum Requirement #7 for flow control in Volume I. Infiltration facilities used for runoff treatment must not overflow more than 9 percent of the influent runoff file. All infiltration basins are required to include a crest gauge that will record maximum basin water surface elevation after a storm event. The designer may submit alternative crest recording device for county approval. See Attachments Section A, Detail 25.0 for crest gauge details. In addition, project submittals must include a table that identifies the design stage/storage/ discharge expected for the 2-, 5-, 10-, 25-, 50-, and 100year recurrence interval flows.

In order to determine compliance with the flow control requirements, the latest version of WWHM, or an approved Ecology appropriately calibrated continuous simulation runoff model based on HSPF, must be used. When using WWHM for simulating flow through an infiltrating facility, the facility is represented by using a pond element and entering the predetermined infiltration rates. Below are the procedures for sizing a basin to completely infiltrate 100 percent of runoff.

For 100 percent Infiltration

- Input dimensions of your infiltration basin.
- Input infiltration rate and safety (rate reduction) factor. See Appendix III-A for methods for determining infiltration rates.
- Input a riser height and diameter (any flow through the riser indicates that you have less than 100 percent infiltration and must increase your infiltration basin dimensions).
- Run only HSPF for developed mitigated scenario (if that is where you put the infiltration basin).
- Go back to your infiltration basin and look at the percentage infiltrated at the bottom right. If less than 100 percent infiltrated, increase basin dimension until you get 100 percent.

Pretreatment

A facility to remove a portion of the influent suspended solids must precede infiltration basins and trenches. Use either an option under the basic treatment facility menu (see Volume V, Chapter 2), or a pretreatment option from Volume V, Chapter 5. The lower the influent suspended solids loading to the infiltration facility, the longer the infiltration facility can infiltrate the desired amount of water or more, and the longer interval between maintenance activity.

Reduction in infiltration capability can have significant maintenance or replacement costs in infiltration basins and trenches, therefore selection of a reliable treatment device with high solids removal capability is preferred. In facilities that allow easier access for maintenance and less costly maintenance activity (e.g., infiltration basins with gentle side slopes), there is a trade-off between using a treatment device with a higher solids removal capability and a device with a lower capability. Generally, treatment options on the basic treatment menu are more capable at solids removal than pretreatment devices listed in Volume V, Chapter 5. Though basic treatment options may be higher in initial cost and space demands, the infiltration facility should have lower maintenance costs. If designed as a pretreatment facility and a water quality treatment facility (in compliance with Minimum Requirement #6), the pretreatment facility must be designed to treat runoff from the water quality design storm event, but must also safely convey or bypass the developed 100year recurrence interval peak flow. Note that pretreatment is not required for roof

runoff.

100year Overflow Conveyance

An overflow route must be identified for stormwater flows that overtop the infiltration basin/trench when infiltration capacity is exceeded or the facility becomes plugged and fails. The overflow route must be able to convey the 100year recurrence interval developed peak flow to the downstream conveyance system or other acceptable discharge point without posing a health or safety risk or causing property damage.

Spill Control Device

All infiltration basins and trenches must have a spill control device upstream of the facility to capture oil or other floatable contaminants before they enter the infiltration facility. If a Tsection is used for spill control, the top of the spill control riser must be set above the facility's 100year overflow elevation to prevent oils from entering the infiltration facility.

Access Road

Access roads are needed to all drainage structures, and at least one access point per cell, and they may be designed and constructed as specified for detention ponds in Section 3.12.1.

Signage

See the signage requirements under Section 3.12.1 for infiltration basin sign requirements.

Setbacks

All infiltration basins/trenches shall maintain minimum setback distances as follows. All setbacks shall be horizontal unless otherwise specified or modified with written approval by the TPCHD for wells and septic:

- 1 foot positive vertical clearance from any open water maximum surface elevation to structures within 25 feet.
- 5 feet from septic tank, holding tank, containment vessel, pump chamber, and distribution box.
- 10 feet from open water maximum surface elevation or edge of infiltration facility to property lines and onsite structures.
- 10 feet from open water maximum surface elevation or edge of infiltration facility to building sewer.
- 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on the slope. The soils report may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.
- 300 feet from an erosion hazard, or landslide hazard area (as defined by PCC Title 18E.80) unless the slope stability impacts of such systems have been analyzed and mitigation proposed by a geotechnical professional, and appropriate analysis indicates that the impacts are negligible.
- Infiltration basins and trenches with a maximum design flow less than 0.5cfs must be at least 30 feet upgradient, or 10 feet downgradient, of the drainfield primary and reserve areas. Infiltration basins and trenches with a maximum design flow of 0.5cfs or greater must be at least 100 feet from of the drainfield primary and reserve areas.

- Infiltration basins and trenches shall be set back at least 100 feet from drinking water wells and springs used for public drinking water supplies.

Projects within Groundwater Protection Areas

The applicant must check the critical aquifer recharge area map, sole source aquifer designations, and wellhead protection areas mapped by the Washington State Department of Health to determine if the project lies within a groundwater protection area. A site is not suitable if the infiltration facility will cause a violation of groundwater quality standards. At a minimum, projects located within groundwater protection areas may be required to meet one of the soil requirements for infiltration for water quality treatment outlined in Volume V, Chapter 6.

Infiltration Near Water Supply Wells

In no case should infiltration basins or trenches be placed closer than 100 feet from drinking water wells and springs used for drinking water supplies. Where water supply wells exist nearby, it is the responsibility of the applicant's engineer to locate such wells, meet any applicable protection standards, and assess possible impacts of the proposed infiltration facility on groundwater quality. If negative impacts on an individual or community water supply are possible, additional runoff treatment must be included in the facility design, or relocation of the facility should be considered.

All infiltration basins or trenches located within the 1year capture zone of any well must be preceded by a water quality treatment facility. Infiltration basins or trenches upgradient of drinking water supplies and within 1, 5, and 10-year time of travel zones must comply with Washington State Wellhead Protection Program Guidance Document, DOH, 6/2010. Infiltration systems that qualify as Underground Injection Control Wells must comply with Chapter 173-218 WAC and follow the Washington Department of Ecology's "Guidance for UIC Wells that Manage Stormwater," Publication No. 0510067 and Volume I, Appendix I-C - Underground Injection Control (UIC) Program Guidelines.

The soils report must be updated to demonstrate and document that the above criteria are met and to address potential impacts to water supply wells or springs.

Infiltration Near Steep Slopes or Landslide Hazard Areas

Along with the setback restrictions listed above for the design of infiltration basins and trenches located near a slope greater than 20 percent; a geotechnical assessment must be performed to demonstrate and document that the above criteria and PCC Title 18E.80 requirements are met and to address potential impacts to steep slopes, erosion hazard, or landslide hazard areas.

Construction Criteria

During construction, it is critical that the subgrade soils be protected from clogging and compaction to maintain the soil properties identified during infiltration testing (e.g., infiltration capacity) and ensure facility performance. Most of the construction requirements for small scale infiltration facilities included in Volume II, Section 3.3 apply to all infiltration facilities. Any additional BMP specific construction requirements are included in the infiltration BMP "Construction Criteria" sections of Chapter 3.

Operations and Maintenance Criteria

Adequate access for operation and maintenance (O&M) must be included in the design of infiltration basins and trenches. Provisions must be made for regular and perpetual

maintenance of the infiltration basin/trench, including replacement and/or reconstruction of the any media that are relied upon for treatment purposes. A county approved Maintenance and Source Control Manual shall ensure maintaining the desired infiltration rate.

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.

Verification of Performance

The project engineer or designee shall inspect infiltration basins and trenches before, during, and after construction as necessary to ensure facilities are built to design specifications (including the design infiltration rate), that proper procedures are employed in construction, that the infiltration surface is not compacted, and that protection from sedimentation is in place. Before release of the financial guarantee, the project engineer shall perform a sufficient number of modified falling-head percolation tests (a minimum of two) after construction to determine that the facility will operate as designed. The county must be notified of the scheduled infiltration testing at least 2 working days in advance of the test. See Appendix IIIA for testing requirements. If the tests indicate the facility will not function as designed, this information must be brought to the immediate attention of the county along with any reasons as to why not and how it can be remedied.

In addition, before release of the financial guarantee the completed facility must be monitored through a minimum of one storm season, October to April, to demonstrate that the facility performs as designed. The monitoring must occur after permanent erosion control and site stabilization measures have been installed. If tests indicate that the facility will not function as designed (as per the Maintenance and Source Control Manual developed for the project), this information must be brought to the immediate attention of the county along with reasons and potential remedies.

2.6 Underground Injection Control

The following information on UIC is excerpted from the 2006 Ecology document titled “Guidance for UIC Wells that Manage Stormwater” (Ecology 2006). This document is available online at Ecology’s website.

The UIC program in the State of Washington is administered by Ecology. In 1984, Ecology adopted Chapter 173218 WAC – UIC to implement the program. A UIC well is a manmade subsurface fluid distribution system designed to discharge fluids into the ground and consists of an assemblage of perforated pipes, drain tiles, or other similar mechanisms, or a dug hole that is deeper than the largest surface dimension (WAC 173218030).

UIC systems include drywells, pipe or french drains, drainfields, and other similar devices that are used to discharge stormwater directly into the ground. Infiltration trenches with perforated pipe used to disperse and inject flows (as opposed to collect and route to surface drainage, as in an underdrain) are considered to be UIC wells. This type of infiltration trench must be registered with Ecology (60 days prior to construction).

The following are not UIC wells; therefore, this guidance does not apply:

- Buried pipe and/or tile networks that serve to collect water and discharge that water to a conveyance system or to surface water
- Surface infiltration basins and flow dispersion stormwater infiltration facilities, unless they contain additional infiltration structures at the bottom of the basin/system such as

perforated pipe, or additional bored, drilled, or dug shafts meant to inject water further into the subsurface greater than 20 feet deeper than the bottom of the pond (or deeper than the largest surface dimension per above)

- Infiltration trenches designed without perforated pipe or a similar mechanism
- A system receiving roof runoff from a single family home (or duplex).

The two basic requirements of the UIC Program are:

- Register UIC wells with Ecology (60 days prior to construction) unless the wells are located on tribal land (Those wells should be registered with the Environmental Protection Agency.)
- Make sure that current and future underground sources of groundwater are not endangered by pollutants in the discharge (non-endangerment standard).

UIC wells must either be rule-authorized or covered by a state waste discharge permit to operate. If a UIC well is rule-authorized, a permit is not required. Rule authorization can be rescinded if a UIC well no longer meets the non-endangerment standard. Ecology can also require corrective action or closure of a UIC well that is not in compliance. Additional information on UIC systems can be found online at Ecology's website and Volume I, Appendix I-C.

In order to find adequate infiltration rates, an engineer may propose to excavate through a till layer or low permeability layer when designing a stormwater facility. Since excavating through this low permeability layer creates a new condition, more extensive geotechnical assessments, water quality BMPs, and monitoring may be required including but not limited to groundwater monitoring through a wet season (December 1 through April 30).

Chapter 3. Flow Control Design

3.1 Soil Preservation and Amendment (Ecology BMP T5.13)

3.1.1 Description

Most projects require that site soils meet minimum quality and depth requirements at project completion. Requirements may be achieved by either retaining and protecting undisturbed soil or restoring the soil (e.g., amending with compost) in disturbed areas.

Additional guidance for this BMP can be found in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13* (Stenn et al.2016), which is available at www.buildingsoil.org.

Naturally occurring (undisturbed) soil, soil organisms, and vegetation provide the following important stormwater management functions:

- Water infiltration
- Nutrient, sediment, and pollutant adsorption
- Sediment and pollutant biofiltration
- Water interflow storage and transmission
- Pollutant decomposition.

These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal soil and sod. Not only are these important stormwater management functions lost, but such landscapes themselves can become pollution-generating pervious surfaces due to compaction; increased use of pesticides, fertilizers, and other landscaping and household/industrial chemicals; the concentration of pet wastes; and pollutants that accompany roadside litter.

Soil preservation and amendment requirements help to regain greater stormwater functions in the post development landscape, provide increased treatment of pollutants and sediments that result from development and habitation, and minimize the need for some landscaping chemicals (thus reducing pollution through prevention).

3.1.2 Applications and Limitations

- When used in combination with other onsite stormwater management BMPs, soil preservation and amendment can help achieve compliance with the Performance Standard option of Minimum Requirement #5.

  On sites that are underlain by cemented till layers, which are nearly impermeable, the upper soil horizon (native topsoil) processes the majority of stormwater on the site. Ensure that the existing depth of the upper soil horizon is either left in place or removed and replaced (according to the requirements herein) during the grading process.
- On sites which are underlain by outwash soils, the existing topsoil is not usually as deep (as with till soils), but must still be preserved or replaced.
- Portions of the site comprised of till soils with slopes greater than 33 percent need not implement this BMP.

3.1.3 Modeling and Sizing

Lawn and landscaped areas that meet the requirements of this section may be modeled, using approved runoff models, as "pasture" rather than "lawn" surface over the underlying soil (till or outwash).

In addition, flow control credit is given in runoff modeling when soil preservation and amendment BMP requirements are met and used as part of a dispersion design under the conditions described in:

- Full Dispersion (Section 3.2.2 and Volume VI, Section 2.3)
- Sheet Flow Dispersion (Section 3.2.3)
- Concentrated Flow Dispersion (Section 3.2.4)
- Downspout Dispersion (Section 3.9.4).

3.1.4 Soil Preservation and Amendment Design Criteria

This section describes the implementation options and design requirements for soil preservation and amendment. Typical cross-sections of compost-amended soil in planting bed and turf applications are shown in Figure 3.1. Design criteria are provided in this section for the following elements:

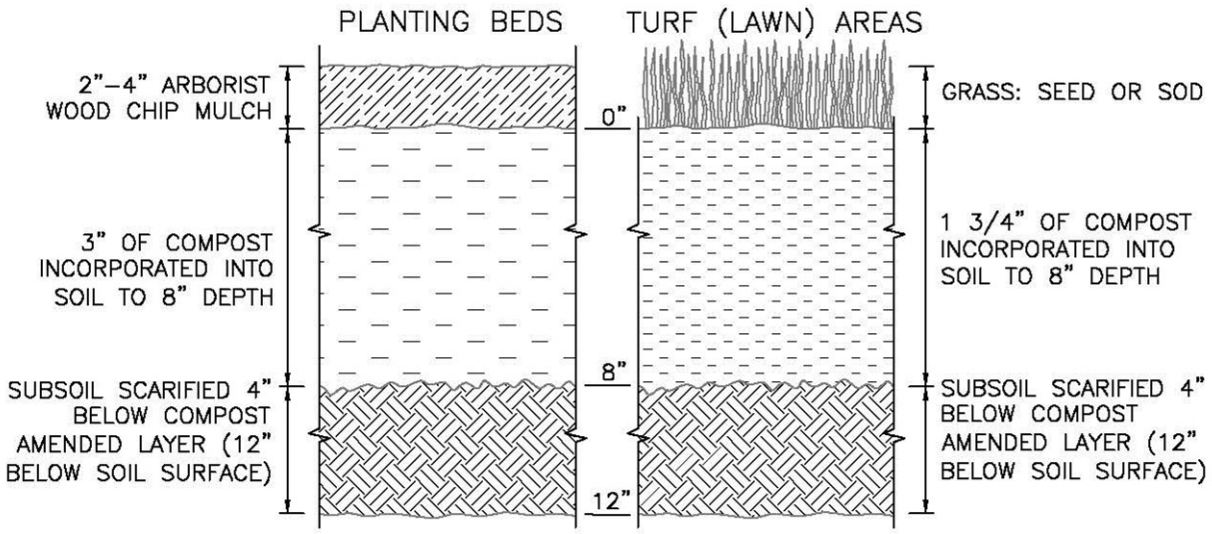
- Implementation options
- Soil retention
- Soil amendment
- Soil stockpiling
- Soil importing
- Soil Preservation and Amendment Plan.

Implementation Options

The soil quality design requirements can be met by using one of the four options listed below. Additional details for each option are provided in the subsequent subsections:

1. **Retain and Protect Undisturbed Soil:**
    - Leave undisturbed vegetation and soil, and protect from compaction by fencing and keeping materials storage and equipment off these areas during construction.
    - For all areas where soil or vegetation are disturbed, use option 2, 3, or 4.

Figure 3.1. - Cross-section of Soil Amendment.



Source: City of Seattle (reproduced with permission)

2. **Amend Soil:**
   - Soil amendments shall be applied to all areas which are being set aside as non-buildable areas (open space or natural resource protection areas) and are in need of rehabilitation because of past land use disturbances such as clearing and intrusion of invasive species. The purpose is to enhance and accelerate the rehabilitation of the soil structure. The application will be non-destructive to the existing vegetation that is retained by taking care to taper depths of soil amendment near the surface roots.
   - Amend existing site topsoil or subsoil either at default "pre-approved" rates, or at custom calculated rates to meet the soil quality guidelines based on engineering tests of the soil and amendment. (Refer to the Building Soil manual [Stenn et al. 2016] or website buildingsoil.org, for custom calculation methods.)
3. **Stockpile Soil:**
   - Stockpile existing topsoil during grading and replace it prior to planting. Amend stockpiled topsoil if needed to meet the organic matter or depth requirements either at the default "pre-approved" rate or at a custom calculated rate (refer to the *Building Soil manual* [Stenn et al.2016] or buildingsoil.org, for custom calculation method). Scarify subsoil and mulch planting beds, as described under the Soil Amendment heading below.
4. **Import Soil:**
   - Import topsoil mix of sufficient organic content and depth to meet the requirements. Imported soils should not contain excessive clay or silt fines (more than 5 percent passing the US #200 sieve) because that could restrict stormwater infiltration. Use imported topsoil that meets default "pre-approved" rates.
   - Scarify subsoil and mulch planting beds, as described under the Soil Amendment heading below.

Note: more than one method may be used on different portions of the same site.

Soil Retention

In buildable areas where minimal excavation foundation systems may be applied, existing topsoils shall be left in place to the greatest extent feasible and shaped or feathered only with tracked grading equipment not exceeding 650 pounds per square foot machine loads. Where some re-grading is required, re-compaction of placed materials, which may include topsoils free of vegetated matter, shall be limited to the minimum densities required by the foundation system engineering.

Soil Amendment

If soil retention and protection is not feasible, disturbed soil must be amended. Soil organic matter is often missing from disturbed soils. Replenish organic matter by amending with compost. It is important that the materials used to meet the soil preservation and amendment BMP are appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay or silt fines.

Amend existing site topsoil or subsoil either at default "pre-approved" soil amendment rates or at custom calculated rates to meet the soil quality guidelines based on engineering tests of the soil and amendment. Both options are described in further detail below.

All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility, or engineered as structural fill or slope must, at project completion, demonstrate the following:

- A topsoil layer meeting these requirements:
    - Turf areas: Place 1.75 inches of compost and till in to an 8 inch depth. Achieve an organic matter content, as measured by the loss-on-ignition test, of a minimum 4 percent (target 5 percent) organic matter content[1].
    - Planting beds: Place 3 inches of compost and till in to an 8 inch depth. Achieve an organic matter content, as measured by the loss-on-ignition test, of a minimum 8 percent (target 10 percent) dry weight1.
    - A pH from 6.0 to 8.0 or matching the pH of the original undisturbed soil.
    - A minimum depth of 8 inches.
- Root zones where tree roots limit the depth of incorporation of amendments are exempted from this requirement. Fence and protect these root zones from stripping of soil, grading, or compaction to the maximum extent practical.
- Scarify (loosen) subsoils below the topsoil layer at least 4 inches for a finished minimum depth of 12 inches of uncompacted soil. Incorporate some of the upper material to avoid stratified layers, where feasible.
- For turf installations: water or roll to compact to 85 percent of maximum dry density, rake to level, and remove surface woody debris and rocks larger than 1 inch diameter (*Building Soil manual* [Stenn et al.2016] or buildingsoil.org).

1 Acceptable test methods for determining loss-on-ignition soil organic matter include the most current version of ASTM D2974 "Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils" and TMECC 05.07A "Loss-On-Ignition Organic Matter Method"

- After planting: mulch planting beds with 2 to 4 inches of organic material such as arborist wood chips, bark, shredded leaves, compost, etc. Do not use fine bark because it can seal the soil surface.
- Use compost and other materials that meet the following organic content requirements:
    - The organic content for "pre-approved" amendment rates can only be met using compost meeting the compost specification for bioretention (see Section 3.4), with the exception that the compost may have up to 35 percent biosolids or manure. The compost must have an organic matter content of 40 percent to 65 percent, and a carbon to nitrogen ratio below 25:1. The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region.
    - Calculated amendment rates may be met through use of composted materials as defined above, or other organic materials amended to meet the carbon to nitrogen ratio requirements, and not exceeding the contaminant limits identified in Table 220-B, Testing Parameters, in WAC 173-350-220.

Assure that the resulting soil is conducive to the type of vegetation to be established.

Soil Stockpiling

In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, which is not adjacent to public resources and critical areas. Reapply to other portions of the site where feasible.

- In buildable areas of the site, where conventional grading is required, the areas requiring cuts shall have the upper native topsoil removed and stockpiled for replacement to areas of the development utilized for stormwater and/or vegetation management (yards, bioretention areas, interflow pathways, vegetated channels, or degraded natural resource protection areas).
- The depth of upper native topsoil required to be stockpiled and replaced shall be the entire depth of the native topsoil horizon up to a maximum of 3 feet.
- Over-excavation of cut sections may be necessary if the cut is in a location that will be utilized for stormwater management. Cut to a depth that will allow replacement of stockpiled native topsoil to the entire depth that was on the site post-development up to a maximum of 3 feet.
- Cut sections where native topsoil replacement is required shall require ripping of any cemented till layers to a depth of 6 inches. Subsequently the replacement of stockpiled topsoil shall be thoroughly mixed into the ripped till to provide a gradual transition between the cemented till layer and the topsoil.
- Stockpiled topsoil shall be replaced in lifts no greater than 1 foot deep and compacted by rolling to a density that matches existing conditions.

Importing Soil

The default pre-approved rates for imported topsoils are:

- For planting beds: use a mix by volume of 35 percent compost with 65 percent mineral soil to achieve the requirement of a minimum 8 percent (target 10 percent) organic matter by loss-on-ignition test

- For turf areas: use a mix by volume of 20 percent compost with 80 percent mineral soil to achieve the requirement of a minimum 4 percent (target 5 percent) organic matter by loss-on-ignition test.

Soil Preservation and Amendment Plan

A Soil Preservation and Amendment Plan must be included in the project submittal, i.e., the Construction SWPPP, and Drainage Control Plan or Abbreviated Plan. The Soil Preservation and Amendment Plan must include the following:

- A site map showing areas to be fenced and left undisturbed during construction, and areas that will be amended at the turf or planting bed rates
- Calculations of the amounts of compost, compost amended topsoil, and mulch to be used on the site.

General guidance on these procedures can be found in the Building Soil manual (Stenn et al. 2016), available at buildingsoil.org.

3.1.5 Construction Criteria

Most of the construction requirements for small scale infiltration and dispersion facilities included in Volume II, Section 3.3 also apply to soil preservation and amendment areas. Minimum construction requirements for disturbed areas include the following:

- Install soil to meet soil preservation and amendment BMP requirements toward the end of construction, and once established, protect from compaction and erosion
- Plant soil with appropriate vegetation and mulch planting beds installation.

3.1.6 Operations and Maintenance Criteria

The most important maintenance issue is to replenish the soil organic matter by leaving leaf litter and grass clippings onsite (or by adding compost and mulch regularly). This BMP is designed to reduce the need for irrigation, fertilizers, herbicides, and pesticides.

3.2 Dispersion Facilities

3.2.1 General Dispersion Facility Design Criteria

General Site Considerations

The following are key considerations in determining the feasibility of dispersion BMPs for a particular site:

- **Dispersion flow path area:** Dispersion BMPs generally require large areas of vegetated ground cover to meet flow path requirements and are not feasible in many urban settings, and some rural settings
- **Erosion or flooding potential:** Dispersion is not allowed in settings where the dispersed flows might cause erosion or flooding problems, either onsite or on adjacent properties
- **Site topography:** Dispersion flow paths are prohibited in and near certain sloped areas (refer to detailed flow path requirements below).

General Design Criteria

Flow path design requirements that are common to all dispersion BMPs are listed below. Additional requirements that are specific to the individual dispersion types are provided in each BMP section.

- Natural resource protection areas and critical area buffers may count towards flow path lengths. This does not include steep slopes. However, the natural resource protection area must be permanently protected from modification through a covenant or easement, or a tract dedicated by the proposed project.
- Dispersion facilities shall be placed no closer than 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high, and a vegetated flow path must be maintained between the outlet of the facility and the slope. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on the slope. The geotechnical assessment may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope. For sites unable to meet the above setbacks, a geotechnical assessment recommending dispersion on a slope may be allowed. Approval will be at the discretion of Pierce County.
- The dispersion discharge point for the facility is not permitted within 300 feet of an erosion hazard, or landslide hazard area (as defined by PCC Title 18E.80) unless the slope stability impacts of such systems have been analyzed and mitigated by a geotechnical professional, and appropriate analysis indicates that the impacts are negligible.
- For sites with onsite or adjacent septic systems, the discharge point must be at least 30 feet upgradient, or 10 feet downgradient, of the drainfield primary and reserve areas. In addition, the entire flow path must be oriented so as to not intersect with the primary or reserve areas. These requirements may be modified by the Tacoma-Pierce County Health Department if site topography clearly prohibits flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that a shorter setback is feasible.
- The vegetated flow path must consist of either undisturbed native landscape, or well-established lawn, landscape, groundcover over soil that meets the soil preservation and amendment BMP requirements outlined in Section 3.1. The groundcover must be dense to help disperse and infiltrate flows and prevent erosion.
- The dispersion flow path is not permitted over contaminated sites or abandoned landfills.

3.2.2 Full Dispersion (Ecology BMP T5.30)

This BMP allows projects to disperse runoff from impervious surfaces and cleared areas of development sites into areas preserved as forest or native vegetation. See Volume VI, Section 2.3 for design requirements and other information on Full Dispersion. Projects that meet the requirements for Full Dispersion will have fully met the requirements of Volume I, Minimum Requirements #5, #6, and #7.

3.2.3 Sheet Flow Dispersion (Ecology BMP T5.12)

Description

Sheet flow dispersion is the simplest method of runoff control. This BMP can be used for any impervious or pervious surface that is graded so as to avoid concentrating flows. Because

flows are already dispersed as they leave the surface, they need only traverse a narrow band of adjacent vegetation for effective attenuation and treatment.

Applications and Limitations

- Use for flat or moderately sloping (less than 15 percent slope) surfaces such as driveways, sport courts, patios, roofs without gutters, lawns, pastures; or any situation where concentration of flows can be avoided.
- Where the contributing surface is flat to moderately sloped, and cross-sloped at a minimum of 2 percent (to convey runoff across the contributing surface), a transition zone shall be used to route runoff to a vegetated buffer.
- Where the contributing surface is of variable slope, berms and dispersion trenches shall be used to route runoff to the vegetated buffer.
- Modeling credits for sheet flow dispersion (see Modeling and Sizing below) can be applied to help meet the flow control standards of Minimum Requirement #7 as well as to achieve compliance with the Performance Standard option of Minimum Requirement #5.

Modeling and Sizing

Where sheet flow dispersion is used to disperse runoff into an undisturbed native landscape area or an area that meets the requirements of Section 3.1, the impervious area may be modeled as grass/lawn area.

Sheet Flow Dispersion Design Criteria

Refer to Section 3.2.1 for general dispersion design criteria. This section provides additional design criteria specific to sheet flow dispersion:

- See Figure 3.2 for required setbacks and flow path lengths. Figure 3.2 is applicable for non-driveway surfaces.
- Transition Zones
    - A 2-foot wide transition zone to discourage channeling must be provided between the edge of the contributing surface (or building eaves) and the downslope vegetation. This transition zone may consist of subgrade material (crushed rock), modular pavement, drain rock, or other material approved by Pierce County.
    - Provide a 10-foot wide vegetated buffer for up to 20 feet of width of contributing surface. Provide an additional 10 feet of width for each additional 20 feet of contributing area width or fraction thereof. (For example, if a driveway is 30 feet wide and 60 feet long, provide a 15-foot wide by 60-foot long vegetated buffer, with a 2-foot by 60-foot transition zone).
- Berms
    - Berms must be diagonal to surface flow to intercept and convey runoff to dispersion trenches.
    - Dispersion trenches must be designed in accordance with Section 3.9.4.
    - Provide a 25-foot vegetated flow path between the discharge point of the dispersion trench and any property line, structure, steep slope (greater than 20 percent), stream, lake, wetland, or other impervious surface.

Construction Criteria

Protect the dispersion flow path from sedimentation and compaction during construction. If the flow path area is disturbed during construction, restore the area to meet the soil amendment BMP requirements in Section 3.1 and establish a dense cover of lawn, landscape, or groundcover. See Volume II, Section 3.3 for additional dispersion facility construction requirements.

Operations and Maintenance Criteria

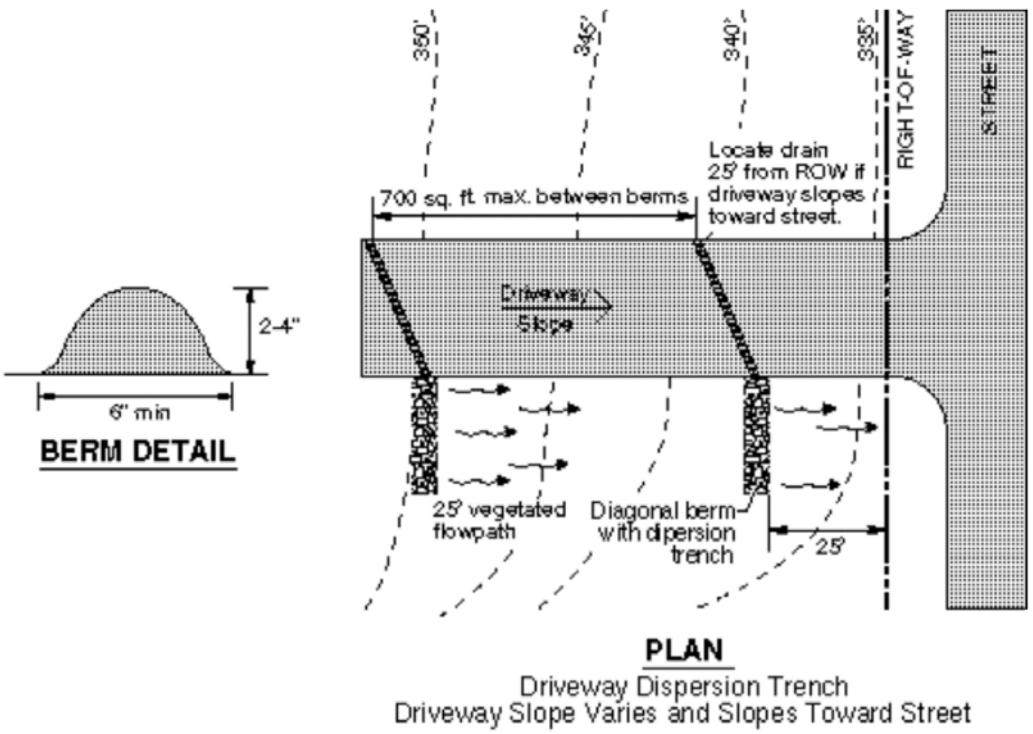
See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.

3.2.4 Concentrated Flow Dispersion (Ecology BMP T5.11)

Description

Dispersion of concentrated flows from driveways or other pavement through a vegetated pervious area attenuates peak flows by slowing entry of the runoff into the conveyance system, allows for some infiltration, and provides some water quality benefits. See Figures 3.2 and 3.3.

Figure 3.2. - Sheet Flow Dispersion for Driveways.



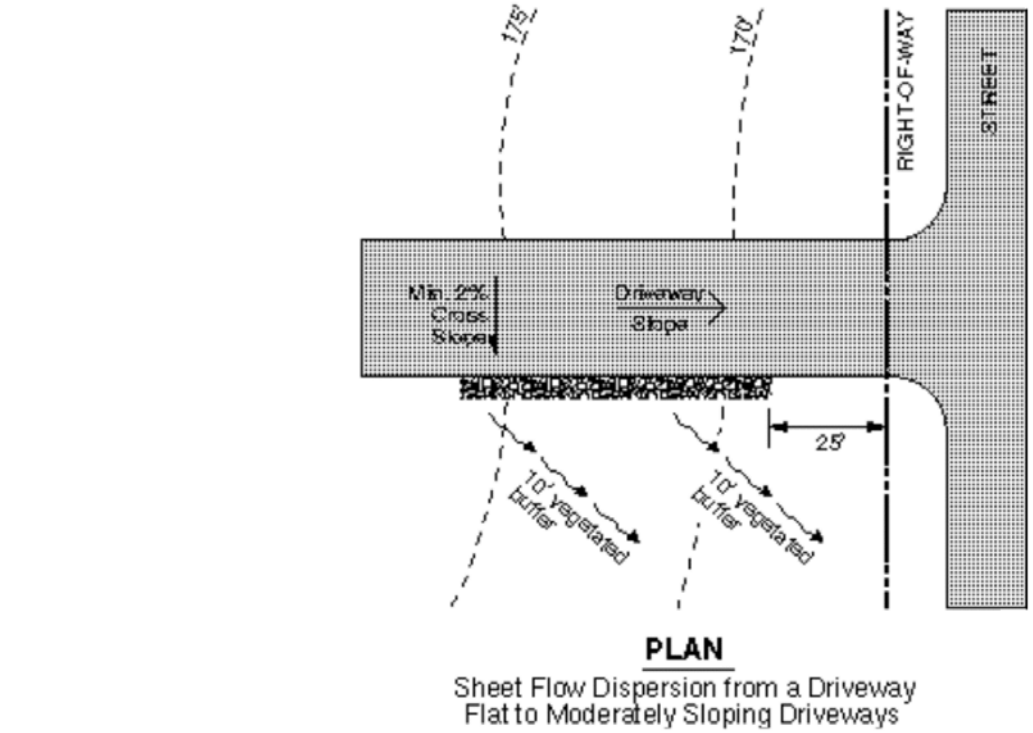
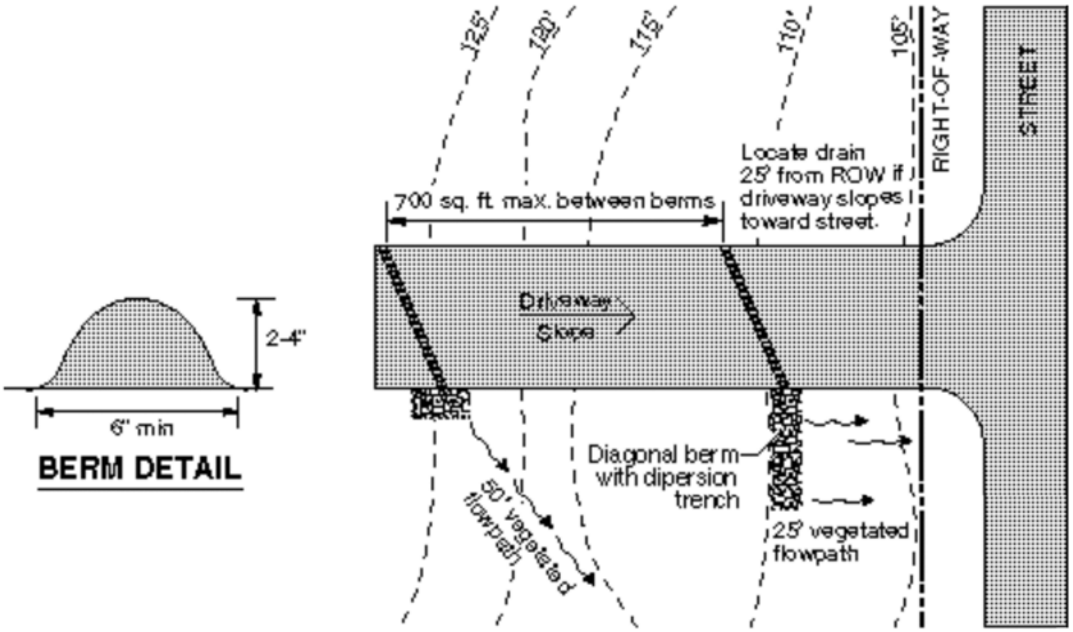
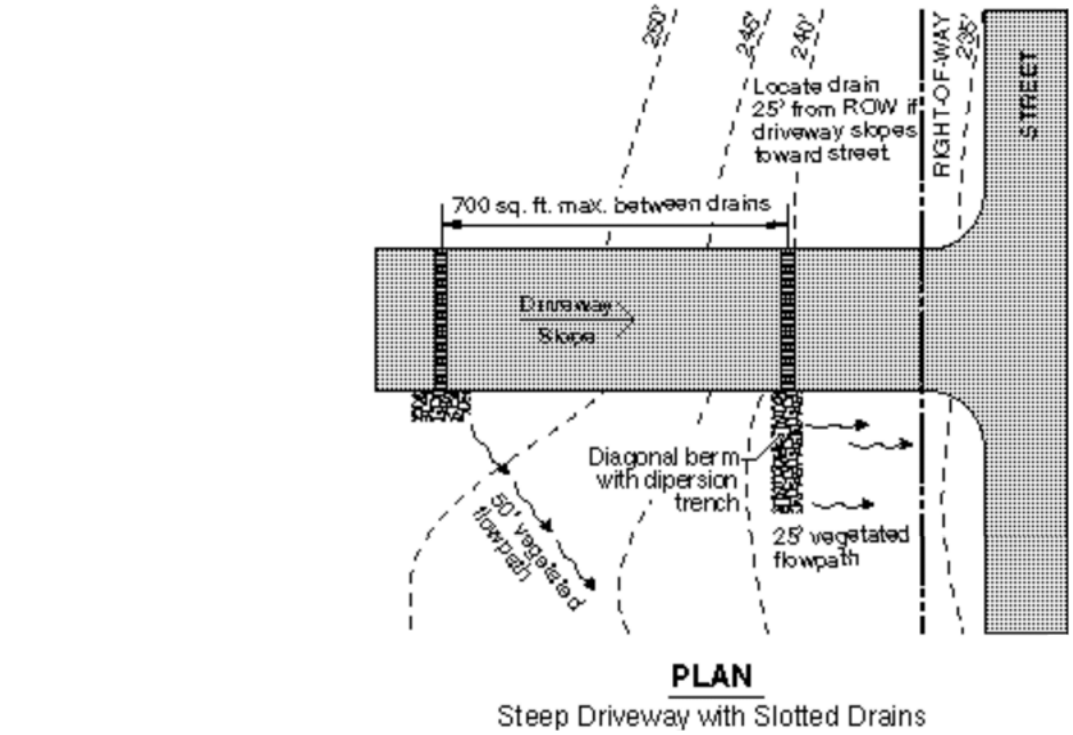


Figure 3.3. - Typical Concentrated Flow Dispersion for Steep Driveways.





Applications and Limitations

- Concentrated flow dispersion can be used in any situation where concentrated flow can be dispersed through vegetation.
- Modeling credits for concentrated flow dispersion (see below) can be applied to help meet the flow control standards of Minimum Requirement #7, as well as to help achieve compliance with the Performance Standard option of Minimum Requirement #5.
- Dispersion for driveways will generally only be effective for single-family residences on large lots and in rural short plats. Lots proposed by short plats in urban areas will generally be too small to provide effective dispersion of driveway runoff.
- Figure 3.3 shows two possible ways of spreading flows from steep driveways.

Modeling and Sizing

Where concentrated flow dispersion is used to disperse runoff into an undisturbed native landscape area or an area that meets the requirements of Section 3.1, the impervious area may be modeled as a lateral flow impervious area. Do this in WWHM on the Mitigated Scenario screen by connecting the lateral flow impervious area element (representing the area that is dispersed) to the lawn/landscape lateral flow soil basin element (representing the area that will be used for dispersion). The design must adhere to the flow path lengths and dispersion trench/rock pad options described below as a prerequisite to using the lateral flow elements. In situations where multiple instances of concentrated flow dispersion will occur, the County allows the following options:

- When a pad of crushed rock or dispersion trenches are used per the guidance above, and the length of the vegetated flow path is at least 50 feet, the impervious area may be modeled as a landscaped area (grass) so that the project schematic in the approved continuous runoff model becomes manageable.
- When dispersion trenches are used per the guidance above, and the length of the vegetated flow path is 25 - 50 feet, the impervious area may be modeled as 50 percent landscaped and 50 percent impervious so that the project schematic in the approved continuous runoff model becomes manageable.

Concentrated Flow Dispersion Design Criteria

Refer to Section 3.2.1 for general dispersion design criteria. This section provides additional design criteria specific to concentrated flow dispersion:

- Maintain a vegetated flow path of at least 50 feet (if using rock pads), or 25 feet (if using dispersion trenches) between the discharge point and any property line, structure, steep slope (greater than 20 percent), stream, lake, wetland, or other impervious surface. The flowpath length is measured perpendicular to site contours.
- A slotted drain, diagonal berm, or similar measure must be provided to direct flow to the rock pad or dispersion trench.
- A maximum of 700 square feet of impervious area may drain to each concentrated flow dispersion device.
- Provide a pad of crushed rock (2 feet wide by 3 feet long by 6 inches deep) or dispersion trench (per Section 3.9.4) at each discharge point.

- No erosion or flooding of downstream properties may result.
- Each dispersion device must have a separate flow path. For the purpose of maintaining adequate separation of flows discharged from adjacent dispersion devices, vegetated flow paths must be at least 20 feet apart at the upslope end and must not overlap with other flow paths at any point along the minimum required flow path lengths.

Construction Criteria

Protect the dispersion flow path from sedimentation and compaction during construction. If the flow path area is disturbed during construction, restore the area to meet the soil preservation and amendment BMP requirements in Section 3.1 and establish a dense cover of lawn, landscape, or groundcover. See Volume II, Section 3.3 for additional dispersion facility construction requirements.

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

3.3 Tree Planting and Tree Retention (for Flow Control Credit, Ecology BMP T5.16)

3.3.1 Description

Trees provide flow control via interception, transpiration, and increased infiltration. Additional environmental benefits include improved air quality, carbon sequestration, reduced heat island effect, pollutant removal, and habitat preservation or formation.

3.3.2 Applications and Limitations

- When used in combination with other low impact development techniques, retained and newly planted trees can help achieve compliance with the Minimum Requirement #5.
- When implemented in accordance with the criteria outlined below, retained and newly planted trees receive credits toward meeting the flow control standards of Minimum Requirement #7. The degree of flow control provided by a tree depends on the tree type (i.e., evergreen or deciduous), canopy area, and proximity to hard surfaces. Flow control credits may be applied to project sites of all sizes.
- Site considerations specific to retained and newly planted trees are provided below.

Retained Trees

Setbacks of proposed infrastructure from existing trees are critical considerations. Tree protection requirements limit grading and other disturbances in proximity to the tree.

Newly Planted Trees

Mature tree height, size, and rooting depth must be considered to ensure that new tree planting locations are appropriate given adjacent above- and below-ground infrastructure. Although setbacks will vary by species, some general recommendations include:

- Minimum 5 foot setback from structures

- Minimum 2 foot setback from edge of any paved surface.

3.3.3 Modeling and Sizing

Retained Trees

Flow control credits for retained trees are provided in Table 3.1 by tree type. These credits can be applied to reduce the hard surface area requiring flow control. Credits are given as a percentage of the existing tree canopy area. The minimum credit for existing trees ranges from 50 to 100 square feet.

Table 3.1. - Flow Control Credits for Retained Trees.

Tree Type	Credit
Evergreen	20% of canopy area (minimum of 100 sq. ft./tree)
Deciduous	10% of canopy area (minimum of 50 sq. ft./tree)

Impervious/Hard Surface Area Mitigated = (Σ Evergreen Canopy Area x .2) + (Σ Deciduous Canopy Area x 0.1)

Tree credits are not applicable to trees in native vegetation areas used for flow dispersion or other flow control credit. Credits are also not applicable to trees in planter boxes. The total tree credit for retained and newly planted trees shall not exceed 25 percent of the hard surface requiring mitigation.

Newly Planted Trees

Flow control credits for newly planted trees are provided in Table 3.2 by tree type. These credits can be applied to reduce the hard surface area requiring flow control. Credits range from 20 to 50 square feet per tree.

Table 3.2. - Flow Control Credits for Newly Planted Trees.

Tree Type	Credit
Evergreen	50 sq. ft. per tree
Deciduous	20 sq. ft. per tree

Impervious/Hard Surface Area Mitigated = Σ Number of Trees x Credit (sq. ft.)

Tree credits are not applicable to trees in native vegetation areas used for flow dispersion or other flow control credit. Credits are also not applicable to trees in planter boxes. The total tree credit for retained and newly planted trees shall not exceed 25 percent of the hard surface requiring mitigation.

3.3.4 Tree Planting and Tree Retention Design Criteria

Retained Trees

The following design criteria are specific to projects proposing to retain onsite trees for flow control credits:

Tree Species and Condition

- Existing tree species and location must be clearly shown on submittal drawings.
- Trees must be viable for long-term retention (i.e., in good health and compatible with proposed construction).

Tree Size

- To receive flow control credit, retained trees shall have a minimum 6 inches diameter at breast height (DBH). DBH is defined as the outside bark diameter at 4.5 feet above the ground on the uphill side of a tree. For existing trees smaller than this, the newly planted tree credit may be applied as presented below.

Tree Canopy Area

- The retained tree canopy area shall be measured as the area within the tree drip line. A drip line is the line encircling the base of a tree, which is delineated by a vertical line extending from the outer limit of a tree's branch tips down to the ground (see also Figure 3.4). If trees are clustered, overlapping canopies are not double counted.

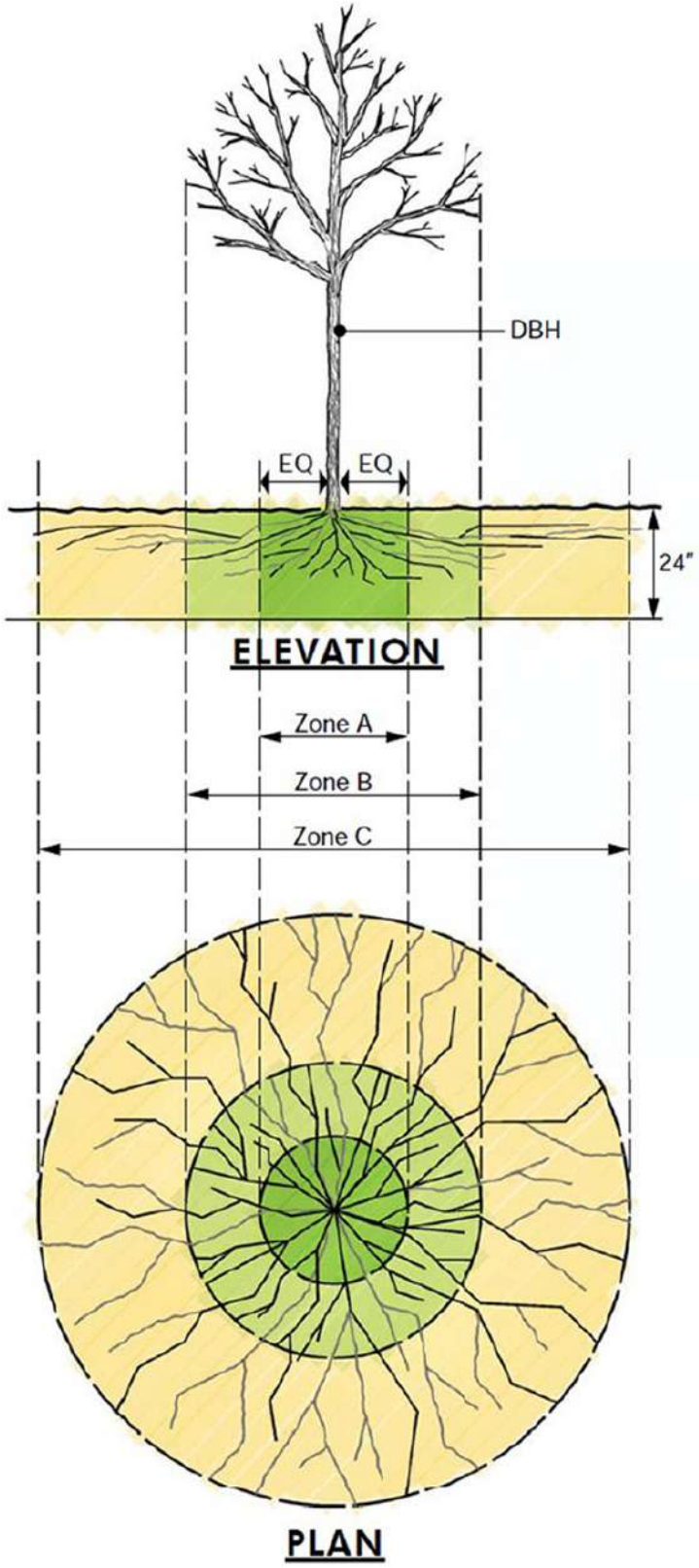
Tree Location

- Flow control credit for retained trees depends upon proximity to ground level impervious or other hard surfaces. To receive a credit, the existing tree must be on the development site and within 20 feet of new and/or replaced ground level hard surfaces (e.g., driveway or patio) on the development site. Distance from hard surfaces is measured from the tree trunk center.
- An arborist report shall be required if impervious surface is proposed within the critical root zone of the existing tree. The critical root zone is defined as the line encircling the base of the tree with half the diameter of the dripline (see also Figure 3.4). If the arborist report concludes that impervious surface should not be placed within 20 feet of the tree, and canopy overlap with impervious surface is still anticipated given a longer setback, the tree flow control credit may still be approved.
- Minimize the installation of any impervious surfaces in critical root zone areas. Where road or sidewalk surfaces are needed under a tree canopy, unmortared permeable pavers or flagstone (rather than concrete or asphalt) or bridging techniques should be used (see Figure 3.5).

Newly Planted Trees

The following design criteria are specific to projects proposing to plant new onsite trees for flow control credits.

Figure 3.4. - Critical Root Zone (CRZ)



TREE PROTECTION ZONES:

Zone A - *Critical Root Zone*
The area under a tree whose diameter at breast height (DBH) measures 1 foot per 1 inch of DBH from the trunk outwards and twenty-four inches in depth. See table below for examples:

Tree Diameter	CRZ radius	CRZ diameter (including tree trunk)
2 inches	2 feet	4.5 feet
6 inches	6 feet	13 feet
20 inches	20 feet	42 feet
50 inches	50 feet	105 feet

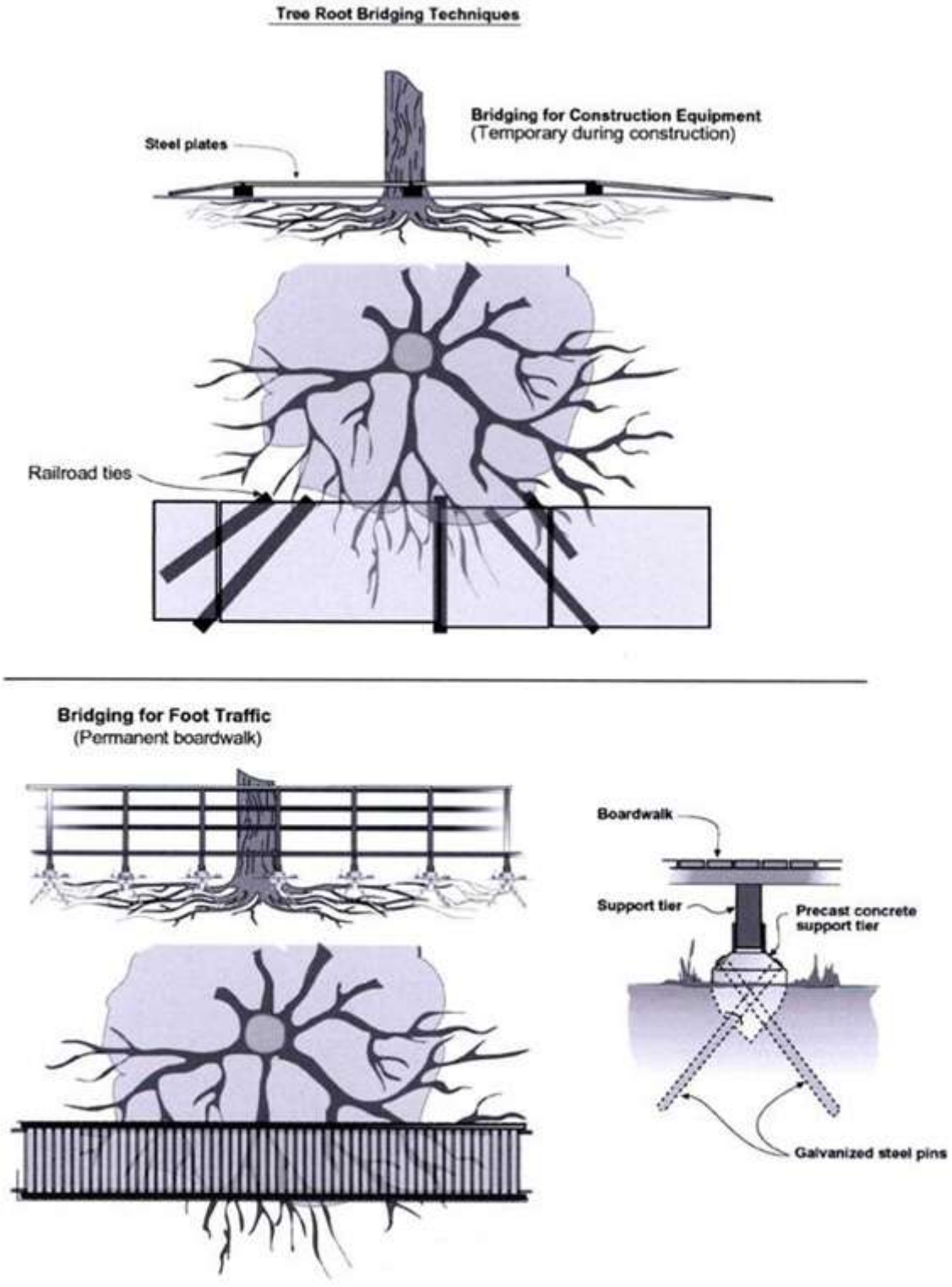
Zone B - *Drip Line*
The area on the ground below the tree in which the boundary is designed by the edge of the tree's crown. For young trees, Zone A and B may be one and the same.

Zone C - *Feeder Root Zone*
The area under a tree whose diameter measures 2 feet per one inch of DBH from the trunk outwards and 24 inches in depth. For example, for a 10 inch DBH tree, the Feeder Root Zone is at least 20 feet in diameter and 24 inches deep.

Tree Protection Zone (TPZ)
"Tree Protection Zone" is an arborist defined area surrounding the trunk intended to protect the roots and soil to ensure future tree health and stability. A TPZ consists of a minimum Zone A or B, whichever is greater, or other area as defined by a project arborist or urban forester.

Source: LID Technical Guidance Manual for Puget Sound

Figure 3.5. - Root Bridge



Source: LID Technical Guidance Manual for Puget Sound

Tree Species

It is recommended that a landscape architect or other trained professional guide plant selection for each unique location and/or application. An approved list of tree species is provided in PCC Title 18J.

Tree Size

To receive flow control credit, new deciduous trees at the time of planting shall be at least 1.5 inches in diameter measured 6 inches above the ground. New evergreen trees shall be at least 4 feet tall.

Tree Location

- Similar to retained trees, flow control credit for newly planted trees depends upon proximity to ground level hard surfaces. To receive a credit, the tree must meet tree location requirements listed in retained tree design criteria above. Distance from hard surfaces is measured from the edge of the surface to the center of the tree at ground level.
- Trees shall be sited according to sun, soil, and moisture requirements. Planting locations shall be selected to ensure that sight distances and appropriate setbacks are maintained given mature height, size, and rooting depths.
- To help ensure tree survival and canopy coverage, the minimum tree spacing for newly planted trees shall accommodate mature tree spread. Onsite stormwater management and/or flow control credit must not be given for new trees with on-center spacing less than 10 feet.

Plant Material and Planting Specifications

- Standard practices for planting materials and methods are provided in Pierce County Standard Drawings PC.M1.2.

3.3.5 Construction Criteria

- Protect trees and tree root systems utilizing the following methods:
- The existing tree roots, trunk, and canopy shall be fenced and protected during construction activities.
- Trees that are removed or die shall be replaced with like species during the next planting season (typically in fall). Trees shall be pruned according to industry standards (ANSI A 300 standards).
- Reduce soil compaction during the construction phase by protecting critical tree root zones that usually extend beyond the trees canopy or drip line. The critical tree root zone should be factored using the tree's diameter breast height (see Figure 3.4).
- Prohibit any excavation within the critical tree root zone.
- Prohibit the stockpiling or disposal of excavated or construction materials in the tree planting areas to prevent contaminants from damaging vegetation and soils.
- Avoid excavation or changing the grade near trees that have been designated for protection. If the grade level around a tree is to be raised, a dry rock wall or rock well shall be constructed around the tree. The diameter of this wall or well should be at least equal to the diameter of the tree canopy plus 5 feet.

- Prevent wounds to tree trunks and limbs during the construction phase.
- Tree root systems tend to overlap and fuse among adjacent trees. Trees or woody vegetation that will be removed and that are next to preserved trees should be cut rather than pushed over with equipment. Where construction operations unavoidably require temporary access over tree root zones or other soil protection areas, provide protection as follows:
    - For foot access or similar light surface impacts, apply a 6-inch layer of arborist wood chip mulch and water regularly to maintain moisture, control erosion and protect surface roots.
    - For any vehicle or equipment access, apply a minimum 1-inch steel plate or 4-inch thick timber planking over 2-3 inches of arborist wood chip mulch, or a minimum 0.75-inch plywood over 6-8 inches of arborist wood chip mulch to protect roots and root zone soil from disturbance or compaction.
- Prep tree conservation areas to better withstand the stresses of the construction phase by pruning and applying a 1 inch layer of compost covered with a 2 inch layer of mulch around them well in advance of construction activities.

3.3.6 Operations and Maintenance Criteria

Trees shall be retained, maintained and protected on the site after construction and for the life of the development or until any approved redevelopment occurs in the future. Replace trees that are removed or die with like species during the next appropriate planting season (typically in the fall).

Prune, when necessary for compatibility with other infrastructure and/or to preserve the health and longevity of trees. Meet industry standards for pruning (ANSI A300 standards).

For newly planted trees, provide supplemental irrigation during the first three growing seasons after installation to help ensure tree survival.

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

3.4 Bioretention Cells, Swales, and Planter Boxes (Ecology BMPs T5.14 and T7.30)

3.4.1 Description

Bioretention areas are shallow stormwater systems with a designed soil mix and plants adapted to the local climate and soil moisture conditions. Bioretention areas are designed to mimic a forested condition by controlling stormwater through detention, infiltration, and evapotranspiration. Bioretention areas also provide water quality treatment through sedimentation, filtration, adsorption, and phytoremediation.

Bioretention areas function by storing stormwater as surface ponding before it filters through the underlying amended soil. Stormwater that exceeds the surface storage capacity overflows to an adjacent drainage system. Treated water is infiltrated into the underlying soil.

The terms bioretention and rain garden are sometimes used interchangeably. Bioretention areas and rain gardens are applications of the same LID concept and can be highly effective for reducing surface runoff and removing pollutants. However, in Pierce County (in accordance with

the Department of Ecology's distinction), the term bioretention is used to describe an engineered facility that includes designed soil mixes and perhaps underdrains and control structures. The term, rain garden, is used to describe a shallow landscaped depression on small project sites that only trigger Minimum Requirements #1-#5. Rain gardens have less restrictive design criteria for the soil mix and do not include underdrains or other control structures. See Section 3.8 for more information on rain garden design.

The term, bioretention, is used to describe various designs using soil and plant complexes to manage stormwater. The following terminology is used in this manual:

- Bioretention cells: Shallow depressions with a designed planting soil mix and a variety of plant material, including trees, shrubs, grasses, and/or other herbaceous plants. Bioretention cells may or may not have an underdrain and are not designed as a conveyance system.
- Bioretention swales: Incorporate the same design features as bioretention cells; however, bioretention swales are designed as part of a system that can convey stormwater when maximum ponding depth is exceeded. Bioretention swales have relatively gentle side slopes and ponding depths that are typically 6 to 12 inches.
- Bioretention planters and planter boxes: Designed soil mix and a variety of plant material including trees, shrubs, grasses, and/or other herbaceous plants within a vertical walled container usually constructed from formed concrete, but could include other materials. Planter boxes are completely impervious and include a bottom (must include an underdrain). Planters have an open bottom and allow infiltration to the subgrade. These designs are often used in ultra-urban settings.

Note: Ecology has approved use of certain patented treatment systems that use specific, high rate media for treatment. Such systems are not considered onsite stormwater management BMPs and are not options for meeting the requirements of Minimum Requirement #5. The Ecology approval (General Use Level Designations only) is meant to be used to meet Minimum Requirement #6, where appropriate.

Figure 3.6 provides an example illustration of a bioretention area. See Attachments Section A, Details 26.0, 26.1, and 26.2 for examples of bioretention areas in various configurations and site settings.

3.4.2 Applications and Limitations

Bioretention provides effective removal of many stormwater pollutants by passing stormwater through a soil profile that meets specified characteristics. Bioretention areas that infiltrate stormwater into the ground can also serve a significant flow reduction function.

- Bioretention areas are an onsite stormwater management BMP option for 1) projects that only have to comply with Minimum Requirements #1 through #5, and 2) projects that trigger Minimum Requirements #1 through #10
- Bioretention can achieve the Performance Standard option or can be applied from List #1 or List #2 option of Minimum Requirement #5.

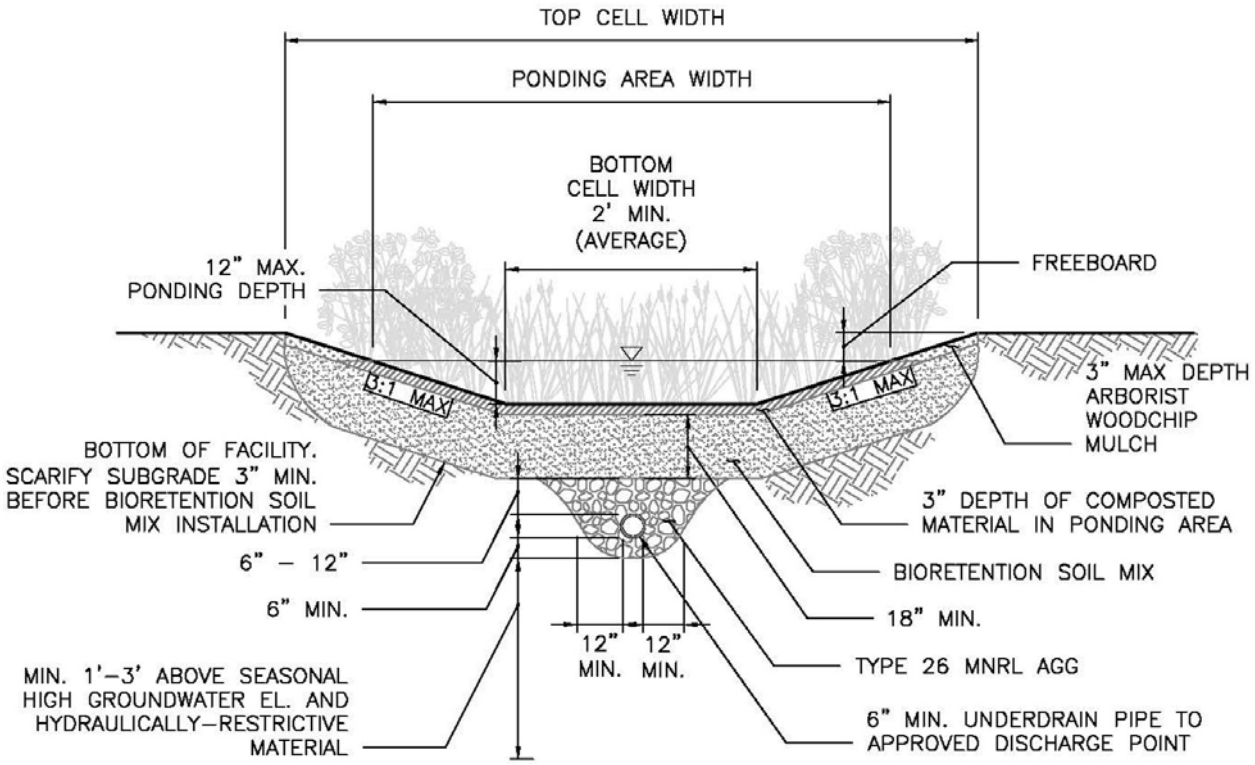
Bioretention areas may meet the Minimum Requirement #6 requirements for basic and enhanced treatment (see Volumes I and V) when the bioretention soil meets the requirements outlined in Section 3.4.6.

- Bioretention can be designed to fully meet the flow control duration standard of Minimum

Requirement #7. Because they typically do not have an orifice restricting overflow or underflow discharge rates, they typically don't fully meet Minimum Requirement #7. However, their performance contributes to meeting the standard, and that can result in much smaller flow control facilities at the bottom of the project site.

- Because bioretention areas use an imported soil mix that has a moderate design infiltration rate, they are best applied for small drainage areas, and near the source of the stormwater. Cells may be scattered throughout a subdivision; a swale may run alongside the access road; or a series of planter boxes may serve the road.
- Bioretention areas are particularly effective where the underlying soil has a high infiltration rate. Where the native soils have low infiltration rates, underdrain systems can be installed and the facility used to filter pollutants and detain flows that exceed infiltration capacity of the surrounding soil. However, designs utilizing underdrains provide less flow control benefits.
- Bioretention areas are applicable to new development, redevelopment and retrofit projects. Typical applications with or without underdrains include:
    - Individual lots for rooftop, driveway, and other on-lot impervious surface.
    - Shared facilities located in common areas for individual lots.
    - Areas within loop roads or cul-de-sacs.
    - Landscaped parking lot islands (i.e., situated lower than the height of the parking lot surface so that stormwater runoff is directed as sheet flow into the bioretention area.). This application, in concert with permeable surfaces in the parking lot, can greatly attenuate stormwater runoff.
    - Within rights-of-ways along roads (often linear bioretention swales and cells).
    - Common landscaped areas in apartment complexes or other multifamily housing designs.
    - Planters on building roofs, patios, and as part of streetscapes.

Figure 3.6. - Bioretention Area (shown with optional underdrain)



Source: City of Seattle (reproduced with permission)

3.4.3 Infeasibility Criteria

The following criteria describe conditions that make bioretention not required for consideration in the List #1 or List #2 option of Minimum Requirement #5. In addition, other bioretention design criteria and site limitations that make bioretention areas infeasible (e.g., setback requirements) may also be used to demonstrate infeasibility, subject to approval by the county. See also Appendix III-D for a summary of infeasibility criteria for all BMPs. If a project proponent wishes to use a bioretention BMP though not required to because of these feasibility criteria, they may propose a functional design to the county.

Note: Criteria with setback distances are as measured from the bottom edge of the bioretention soil mix.

Citation of any of the following infeasibility criteria must be based on an evaluation of site-specific conditions and a written recommendation from an appropriate licensed professional (e.g., engineer, geologist, hydrogeologist):

- Where professional geotechnical evaluation recommends infiltration not be used due to reasonable concerns about erosion, slope failure, or downgradient flooding
- In accordance with PCC Title 18E limitations may exist and reports may be required when bioretention area is within 300 feet of a landslide hazard area or within 200 feet of an erosion hazard area

- Where the only area available for siting would threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures, or pre-existing road or parking lot surfaces
- Where the only area available for siting does not allow for a safe overflow pathway to a stormwater drainage system
- Where there is a lack of usable space for bioretention areas at re-development sites, or where there is insufficient space within the existing public right-of-way on public road projects
- Where infiltrating water would threaten existing below grade basements
- Where infiltrating water would threaten shoreline structures such as bulkheads.

The following criteria can be cited as reasons for infeasibility without further justification (though some require professional services to make the observation):

- Within setbacks provided in Section 3.4.6.
- Where they are not compatible with a surrounding drainage system as determined by the county (e.g., project drains to an existing stormwater collection system whose elevation or location precludes connection to a properly functioning bioretention area).
- Where land for bioretention is within an erosion hazard, or landslide hazard area (as defined by PCC Title 18E.80).
- Where the site cannot be reasonably designed to locate bioretention areas on slopes less than 8 percent.
- For properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)):
    - Within 100 feet of an area known to have deep soil contamination
    - Where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in the groundwater
    - Wherever surface soils have been found to be contaminated unless those soils are removed within 10 horizontal feet from the bioretention area
    - Any area where these facilities are prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW.
- Within 100 feet of a closed or active landfill.
- For sites with onsite or adjacent septic systems, the discharge point must be at least 30 feet upgradient, or 10 feet downgradient, of the drainfield primary and reserve areas. This requirement may be modified by the Tacoma-Pierce County Health Department if site topography clearly prohibits flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary.
- Within 10 feet of an underground storage tank and connecting underground pipes when the capacity of the tank and pipe system is 1,100 gallons or less. (As used in these criteria, an underground storage tank means any tank used to store petroleum products, chemicals, or liquid hazardous wastes of which 10 percent or more of the storage volume (including volume in the connecting piping system) is beneath the ground surface.

- Within 100 feet of an underground storage tank and connecting underground pipes when the capacity of the tank and pipe system is greater than 1,100 gallons.
- Where the field testing indicates potential bioretention area sites have a measured (a.k.a., initial) native soil saturated hydraulic conductivity less than 0.30 inches per hour. A small-scale or large-scale PIT in accordance with Appendix III-A shall be used to demonstrate infeasibility of bioretention areas. If the measured native soil infiltration rate is less than 0.30 in/hour, this option is not required to be evaluated as an option in List #1 or List #2 of Minimum Requirement #5. In these slow draining soils, a bioretention area with an underdrain may be used to treat pollution-generating surfaces to help meet Minimum Requirement #6, Runoff Treatment. If the underdrain is elevated within a base course of gravel, it will also provide some modest flow reduction benefit that will help achieve Minimum Requirement #7.

Other Site Suitability Factors:

- Utility conflicts: Consult Pierce County requirements for horizontal and vertical separation required for publicly-owned utilities, such as sewer. Consult the appropriate franchise utility owners for separation requirements from their utilities, which may include communications, water, power, and gas. When separation requirements cannot be met, designs should include appropriate mitigation measures, such as impermeable liners over the utility, sleeving utilities, fixing known leaky joints or cracked conduits, and/or adding an underdrain to the bioretention.
- Transportation safety: The design configuration and selected plant types should provide adequate sight distances, clear zones, and appropriate setbacks for roadway applications in accordance with the County's requirements.
- Ponding depth and surface water draw-down: Flow control needs, as well as location in the development, and mosquito breeding cycles will determine draw-down timing. For example, front yards and entrances to residential or commercial developments may require rapid surface dewatering for aesthetics.
- Impacts of surrounding activities: Human activity influences the location of the facility in the development. For example, locate bioretention areas away from traveled areas on individual lots to prevent soil compaction and damage to vegetation or provide elevated or bermed pathways in areas where foot traffic is inevitable and provide barriers, such as wheel stops, to restrict vehicle access in roadside applications.
- Visual buffering: Bioretention areas can be used to buffer structures from roads, enhance privacy among residences, and for an aesthetic site feature.
- Site growing characteristics and plant selection: Appropriate plants should be selected for sun exposure, soil moisture, and adjacent plant communities. Native species or hardy cultivars are recommended and can flourish in the properly designed and placed bioretention soil mix with no nutrient or pesticide inputs and 2 to 3 years irrigation for establishment. Invasive species control may be necessary.

3.4.4 Modeling and Sizing

Bioretention areas receiving runoff from roads or a combination of roads and other impervious/pervious surfaces will be larger than rain gardens. For bioretention areas designed to meet Minimum Requirement #5, the bioretention area shall have a horizontally projected surface

area below the overflow which is at least 5 percent of the total surface area draining to it. If lawn/landscape area will also be draining to the bioretention area, the horizontally projected surface area below the overflow shall be increased by 2 percent of the lawn/landscape area. For bioretention areas designed to meet Minimum Requirement #6 or #7, the bioretention area must be sized using an approved continuous simulation model.

When using continuous modeling to size bioretention areas, the assumptions listed in Table 3.3 shall be applied. It is recommended that bioretention cells be modeled as a layer of soil (with specified infiltration rate) with infiltration to underlying soil, ponding, and overflow. The bioretention soil is designed in accordance with the treatment soil requirements outlined in the design criteria below. To meet Minimum Requirement #6, at least 91 percent of the influent runoff file produced using a continuous simulation model must be infiltrated. Applicable water quality design storm volume drawdown requirements must also be met (see Volume V, Section 6.3).

If 91 percent of the influent runoff file cannot be infiltrated, the percent infiltrated may be subtracted from the 91 percent volume that must be treated, and downstream treatment facilities may be significantly smaller as a result.

The tributary areas, cell bottom area, and ponding depth should be iteratively sized until the duration curves and/or peak values meet the applicable flow control requirements (see Volume I).

At the time of publication of this volume, the latest version of WWHM includes a bioretention module that can be used to size the cell with or without an underdrain as a function of tributary area, land use type, native soil infiltration rate, side slopes, etc. It is anticipated that other modeling programs will develop similar modules to represent bioretention cells in the future.

Infiltration rates of the native soil (i.e., the undisturbed soil below the imported and/or amended facility soil) and bioretention soil mix infiltration rate must be used when sizing and modeling bioretention areas. The native infiltration rate shall be determined using the methods outlined above. The method for determining infiltration rate of bioretention soil mix is described in Section 3.4.6.

Table 3.3. - Continuous Modeling Assumptions for Bioretention Cells.

Variable	Assumption
Precipitation Series	Pierce County
Computational Time Step	15 minutes
Inflows to Facility	Surface flow and interflow from drainage area routed to facility
Precipitation and Evaporation Applied to Facility	Yes. If model does not apply precipitation and evaporation to facility, include the facility area in the basin area (note that this will underestimate the evaporation of ponded water).
Default Bioretention Soil Mix Measured Infiltration Rate	The infiltration rate is 12.0 inch per hour before applying the correction factor.
Bioretention Soil Porosity	30 percent
Bioretention Soil Depth	Minimum of 18 inches
Native Soil Infiltration Rate	Measured infiltration rate, including applicable safety factors (see Volume III, Appendix III-A)
Infiltration Across Wetted Surface Area	Only if side slopes are 3:1 or flatter

Underdrain (optional)	If an underdrain is placed at bottom extent of the bioretention soil layer, all water that filters through the bioretention soil must be routed through the underdrain (i.e., no losses to infiltration). If there is no liner or impermeable layer and the underdrain is elevated above the bottom extent of the bioretention soil or aggregate layer, water stored in the bioretention soil or aggregate below the underdrain invert may be allowed to infiltrate.
Overflow	Overflow elevation set at maximum ponding elevation (excluding freeboard). May be modeled as weir flow over riser edge or riser notch. Note that the total facility depth (including freeboard) must be sufficient to allow water surface elevation to rise above the overflow elevation to provide head for discharge.

3.4.5 Field and Design Procedures

Geotechnical analysis is an important first step to develop an initial assessment of the variability of site soils, infiltration characteristics and the necessary frequency and depth of infiltration tests. This section includes infiltration testing requirements and application of appropriate safety factors specific to bioretention areas.

Refer to Appendix III-A for detailed descriptions of methods for infiltration rate testing procedures; however, note that the subgrade safety factors in Appendix III-A may not apply to bioretention (additional details provided below).

If the bioretention area includes a liner and does not infiltrate into the underlying soils, they are not considered infiltration facilities and are not subject the infiltration procedures or the setbacks provided in this section. Adhere to setbacks and site constraints for detention vaults included in Section 3.12.3 for these facilities.

Determining Design Infiltration Rate

Determining the infiltration rate of the site soils is necessary to determine feasibility of designs that intend to infiltrate stormwater on site. Infiltration rates are also necessary to estimate bioretention performance using the latest version of the Western Washington Hydrology Model (WWHM).

Determining Initial Soil Infiltration Rate

Initial (measured) infiltration rates are determined through soil infiltration tests. Infiltration tests should be run at the anticipated elevation of the top of the native soil beneath the bioretention area. Test hole or test pit explorations shall be conducted during mid to late in the wet season (December 1 through April 30) to provide accurate groundwater saturation and groundwater information. The soil log shall extend a minimum of 4 feet below feet below the bottom of the subgrade (which is the lowest point of excavation where soil is to be amended). The following provides recommended test procedures for analysis of the soils underlying bioretention areas.

- Projects subject to Minimum Requirement #1 through #5:
    - One small-scale PIT, or other methods outlined in Appendix III-A, shall be performed at each potential bioretention site. Tests at more than one site could reveal the advantages of one location over another.
    - Note that to demonstrate infeasibility of bioretention areas for Minimum Requirement #5, a small-scale PIT or large-scale PIT in accordance with Appendix III-A must be used

(i.e., measured infiltration rate of less than 0.3 inches per hour).

- Confirm that the site has the required 1- or 3-foot minimum clearance to the seasonal high groundwater or other impermeable layer (refer to Setbacks and Site Constraints below).

- Projects subject to Minimum Requirements #1 through #10:
  - For small bioretention cells (bioretention areas receiving water from one or two individual lots or < 0.25 acre of pavement or other impervious surface), a small-scale PIT, or other methods outlined in Appendix III-A, shall be performed at each potential bioretention site. Tests at more than one site could reveal the advantages of one location over another.
  - For large bioretention cells (bioretention areas receiving water from several lots or 0.25 acre or more of pavement or other impervious surface), a small-scale PIT, or other methods outlined in Appendix III-A shall be performed every 5,000 square feet. The more test pits/borings used, and the more evidence of consistency in the soils, the less of a safety factor may be used. If soil characteristics across the site are consistent, a geotechnical professional may recommend a reduction in the number of tests.
    - If using the PIT method, multiple small-scale or one large-scale PIT can be used. If using the small-scale test, measurements should be taken at several locations within the area of interest.
  - For bioretention swales or long, narrow bioretention areas (i.e., one following the road right-of-way), small-scale Pilot Infiltration Test (PIT), or other methods outlined in Appendix III-A shall be performed every 200 lineal feet and within each length of road with varying subsurface characteristics, i.e., groundwater elevation, soils type, infiltration rates. However, if the site subsurface characterization, including soil borings across the development site, indicate consistent soil characteristics and depths to seasonal high groundwater conditions, the number of test locations may be reduced to a frequency recommended by a geotechnical professional.
  - Note that to demonstrate infeasibility of bioretention areas for Minimum Requirement #5, only the small-scale or large-scale PIT methods may be used (i.e., measured infiltration rate of less than 0.3 inches per hour).
  - Confirm that the site has the required 1- or 3-foot minimum clearance to the seasonal high groundwater or other impermeable layer (refer to Setbacks and Site Constraints below).
  - If a single bioretention area serves a drainage area exceeding one acre, infiltration receptor analysis and performance testing may be necessary. See Section 2.5.2, Step 5 for specific requirements for infiltration receptor characterization.

Assignment of Appropriate Safety Factor

- If deemed necessary by a qualified professional engineer, a safety factor may be applied to the measured Ksat of the subgrade soils to estimate its design (long-term) infiltration rate. Depending on the size of the facility, the variability of the underlying soils, and the number of infiltration tests performed, a safety factor may be advisable. (Note: This is a separate design issue from the assignment of a safety factor to the overlying, designed bioretention soil mix. See the "Bioretention Soil Mix" subsection below).

- The overlying bioretention soil mix provides excellent protection for the underlying native soil from sedimentation. Accordingly, a safety factor for the native soil (i.e., Fplugging used in Appendix III-A) does not have to take into consideration the extent of influent control and clogging over time.

Prepare Soils Report

For projects subject to Minimum Requirements #1 through #5, a soils report must be prepared by a professional soil scientist certified by the Soil Science Society of America (or an equivalent national program), a locally licensed onsite sewage designer, or by other suitably trained persons working under the supervision of a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington. Refer to Volume I, Section 3.2.8 for Abbreviated Plan Soils Report requirements.

For projects subject to Minimum Requirements #1 through #10, a soils report must be prepared that is stamped by a professional engineer with geotechnical expertise, a licensed geologist, a hydrogeologist, or an engineering geologist registered in the State of Washington that summarizes site characteristics and demonstrates that sufficient permeable soil for infiltration exists at the proposed facility location. At a minimum, the report must contain the following:

- Figure showing the following:
  - Topography within 500 feet of the proposed facility
  - Locations of any water supply wells within 500 feet of the proposed facility
  - Location of groundwater protection areas, aquifer recharge areas, or 1-, 5-, and 10year times of travel zones for wellhead protection areas
  - Locations of test pits or test holes. A minimum of one soil log or test pit is required at each bioretention area location.
- Results of soils tests including but not limited to: detailed soil logs, visual grain size analysis, grain-size distribution (required if using the grain size analysis method to estimate infiltration rates), percent clay content (include type of clay, if known), color/ mottling, variations and nature of stratification.
- Description of local site geology, including soil or rock units likely to be encountered at soil sampling depths and the seasonal high groundwater elevation.
- Detailed documentation of the design infiltration rate determination, as specified above.
- State whether location is suitable for infiltration and recommend a design infiltration rate.
- A primary pathway for stormwater discharge from a bioretention area with less permeable (Type C) soils can be through interflow in the upper soil structure. The soil investigation should include a detailed description of the condition of the upper soil structure, including the pathway the discharged stormwater will take.

Estimate Volume of Stormwater

Use the latest version of the Western Washington Hydrology Model (WWHM), or other approved continuous runoff model to generate an influent file that will be used to size the bioretention area. The facility must infiltrate either all of the flow volume as specified by the influent file, or a sufficient amount of the flow volume such that any overflow/bypass meets the flow duration standard in Minimum Requirement #7. In addition, the overflow/bypass must meet the LID

performance standard if it is the option chosen to meet Minimum Requirement #5, or if it is required of the project.

3.4.6 Bioretention Design Criteria

The following provides a description, recommendations, and requirements for the components of bioretention. Some or all of the components may be used for a given application depending on the site characteristics and restrictions, pollutant loading, and design objectives. Submittal for facility review must include documentation of the following elements, discussed in detail below:

- Setbacks and site constraints
- Flow entrance / presettling
- Ponding area
- Bottom area and side slopes
- Overflow
- Bioretention soil mix
- Underdrain (if included)
- Check dams and weirs
- Planting
- Mulch layer
- Hydraulic restriction layer.

Setbacks and Site Constraints

For setbacks and site constraints for non-infiltrating bioretention (lined bioretention cells or planter boxes), refer to the setbacks for detention vaults in Section 3.12.3. See Infeasibility Criteria in Section 3.4.3 for setbacks and site constraints used to evaluate the bioretention option of List #1 and List #2 (Minimum Requirement #5). (See also Appendix III-D for a summary of infeasibility criteria for all BMPs.) The following minimum setbacks and site constraints apply to all infiltrating bioretention areas (bioretention without a liner or planter box).

- All bioretention areas shall be a minimum of 1 foot positive vertical clearance from any open water maximum surface elevation to structures within 25 feet.
- All bioretention areas shall be a minimum of 10 feet away from any structure or property line. This setback may be reduced by the County for facilities within or adjacent to the right-of-way.
- All bioretention areas shall be set back at least 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on the slope. The soils report may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.
- All bioretention areas shall be a minimum of 5 feet from septic tanks and distribution boxes.
- For sites with onsite or adjacent septic systems, the edge of the design water surface must be at least 30 feet upgradient, or 10 feet downgradient, of the drainfield primary and reserve areas. This requirement may be modified by the Tacoma-Pierce County Health

Department if site topography clearly prohibits flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary.

- All bioretention areas shall be a minimum of 3 feet from the lowest elevation of the bioretention soil, or any underlying gravel layer, and the seasonal high groundwater elevation or other impermeable layer if the area tributary to the facility meets or exceeds any of the following thresholds:
  - 5,000 square feet of pollution-generating impervious surface (PGIS)
  - 10,000 square feet of impervious area
  - 0.75 acres of lawn and landscape.
- For bioretention systems with a contributing area less than the above thresholds, a minimum of 1 foot of clearance from seasonal high groundwater or other impermeable layer is acceptable.
- Bioretention is prohibited within 300 feet of an erosion hazard, or landslide hazard area (as defined by PCC Title 18E.80) unless the slope stability impacts of such systems have been analyzed and mitigation proposed by a geotechnical professional, and appropriate analysis indicates that the impacts are negligible.
- In no case shall bioretention areas be placed closer than 100 feet from drinking water wells and springs used for drinking water supplies.
  - Where water supply wells exist nearby, it is the responsibility of the applicant's engineer to locate such wells, meet any applicable protection standards, and assess possible impacts of the proposed infiltration facility on groundwater quality. If negative impacts on an individual or community water supply are possible, additional runoff treatment must be included in the facility design, or relocation of the facility should be considered.
  - Bioretention areas upgradient of drinking water supplies and within 1, 5, and 10-year time of travel zones must comply with Washington State Wellhead Protection Program Guidance Document, DOH, 6/2010. Infiltration systems that qualify as Underground Injection Control Wells must comply with Chapter 173-218 WAC and follow the Washington Department of Ecology's "Guidance for UIC Wells that Manage Stormwater," Publication No. 0510067. For additional requirements refer to Volume I, Appendix I-C – Underground Injection Control (UIC) Program Guidelines.
  - The soils report must be updated to demonstrate and document that the above criteria are met and to address potential impacts to water supply wells or springs.
- Bioretention constructed with imported composted materials should not be used within one-quarter mile of phosphorus-sensitive waterbodies if the underlying native soil does not meet the soil suitability criteria for treatment in Volume V, Chapter 6. Preliminary monitoring indicates that new bioretention areas can add phosphorus to stormwater. Therefore, they shall also not be used with an underdrain when the underdrain water would be routed to a phosphorus-sensitive receiving water.
- In the event that the downstream pathway of infiltration, interflow, and/or the infiltration capacity is insufficient to handle the contributing area flows (e.g., a facility enclosed in a loop roadway system or a landscape island within a parking lot), an underdrain system can

be incorporated into the bioretention area. The underdrain system can then be conveyed to a nearby vegetated channel, another stormwater facility, or dispersed into a natural protection area. See the underdrain section below for additional information.

Flow Entrance/Presettling

The design of flow entrance to a bioretention area will depend upon topography, flow velocities, flow volume, and site constraints. Flows entering a facility should have a velocity of less than 1 foot per second to minimize erosion potential. Vegetated buffer strips are the preferred entrance type because they slow incoming flows and provide initial settling of particulates.

Minimum requirements associated with the flow entrance/presettling design include the following:

- If concentrated flows are entering the facility, engineered flow dissipation (e.g., rock pad or flow dispersion weir) must be incorporated
- A minimum 2inch grade change between the edge of a contributing impervious surface and the vegetated flow entrance, or 5 percent slope from the outer curb face extending to a minimum of 12 inches beyond the back of curb, is required.

Four primary types of flow entrances can be used for bioretention:

1. Dispersed, low velocity flow across a grass or landscape area – this is the preferred method of delivering flows to the facility and can provide initial settling of particulates. Dispersed flow may not be possible given space limitations or if the facility is controlling roadway or parking lot flows where curbs are mandatory.
2. Dispersed flow across pavement or gravel and past wheel stops for parking areas.
3. Drainage curb cuts for, driveway, or parking lot areas – curb cuts shall include rock or other erosion protection material in the channel entrance to dissipate energy. See also Attachments Section A Detail 26.1. Drainage curb cuts along roadsides shall include a metal cap on top of the curb per Attachments Section A, Detail 26.3 to prevent vehicle launching.
    - Parking lots that incorporate bioretention into landscaped areas should use concrete curb blocks as wheel stops to protect the bioretention area from traffic intrusion while also allowing the parking lot runoff to flow somewhat unobstructed to the bioretention area.
    - The minimum 12-inch drainage curb cut results in a 12-inch opening measured at the curb flow line and will require a 3-foot cut in an existing curb. An 18-inch curb cut is recommended for most applications. Avoid the use of angular rock or quarry spalls and instead use round (river) rock if needed. Removing sediment from angular rock is difficult. Curb cut flow entrances must have either a minimum of 5 percent slope from the outer curb face extending to a minimum of 12 inches beyond the back of curb, or provide a minimum of a 2inch vertical drop from the back of curb to the vegetated surface of the facility. Provide an area for settling and periodic removal of sediment and coarse material before flow dissipates to the remainder of the cell.
    - Curb cuts used for bioretention areas in high-use parking lots or roadways require increased level of maintenance due to high coarse particulates and trash accumulation in the flow entrance and associated bypass of flows. The following are methods recommended for areas where heavy trash and coarse particulates are anticipated:

- Curb cut width: 18 inches.
- At a minimum the flow entrance should drop 2 to 3 inches from gutter line into the bioretention area and provide an area for settling and periodic removal of debris.
- Anticipate relatively more frequent inspection and maintenance for areas with large impervious areas, high traffic loads and larger debris loads.
- Catch basins or forebays may be necessary at the flow entrance to adequately capture debris and sediment load from large contributing areas and high-use areas. Piped flow entrance in this setting can easily clog and catch basins with regular maintenance are necessary to capture coarse and fine debris and sediment.

4. Pipe flow entrance – piped entrances shall include rock or other erosion protection material in the facility entrance to dissipate energy and/or provide flow dispersion.
    - Catch basin: In some locations where road sanding or higher than usual sediment inputs are anticipated, catch basins can be used to settle sediment and release water to the bioretention area through a grate for filtering coarse material.
    - Trench drains: can be used to cross sidewalks or driveways where a deeper pipe conveyance creates elevation problems. Trench drains tend to clog and may require additional maintenance.

Woody plants should not be placed directly in the entrance flow path as they can restrict or concentrate flows and can be damaged by erosion around the root ball.

Ponding Area

Bioretention ponding area may be an earthen depression (for bioretention cells and swales), or a planter box (for bioretention planters or planter boxes). The ponding area provides surface storage for storm flows, particulate settling, and the first stages of pollutant treatment within the facility. Ponding depth and draw-down rate requirements are to provide surface storage, adequate infiltration capability, and soil moisture conditions that allow for a range of appropriate plant species. Soils must be allowed to dry out periodically in order to 1) restore hydraulic capacity of system, 2) maintain infiltration rates, 3) maintain adequate soil oxygen levels for healthy soil biota and vegetation, 4) provide proper soil conditions for biodegradation and retention of pollutants, and 5) prevent conditions supportive of mosquito breeding.

Minimum requirements associated with the bioretention ponding area design include the following:

- The ponding depth shall be a maximum of 12 inches
- The surface pool drawdown time (surface ponding volume) shall be a maximum of 24 hours (drain time is calculated as a function of ponding depth and native soil design infiltration rate or bioretention soil mix infiltration rate, whichever is less).

For projects subject to Minimum Requirement #5 and choosing to use List #1 or List #2 of that requirement, the bioretention area shall have a horizontally projected surface area below the overflow which is at least 5 percent of the total impervious surface area draining to it. If lawn/landscape area will also be draining to the bioretention area, the horizontally projected surface area below the overflow shall be increased by 2 percent of the lawn/landscape area.

The minimum freeboard measured from the invert of the overflow pipe or earthen channel to facility overtopping elevation shall be 2 inches for drainage areas less than 1,000 square feet and

6 inches for drainage areas 1,000 square feet or greater.

If berming is used to achieve the minimum top elevation needed to meet ponding depth and freeboard needs, maximum slope on berm shall be 3H:1V, and minimum top width of design berm shall be 1 foot. Soil used for berming shall be imported bioretention soil or amended native soil and compacted to a minimum of 90 percent dry density.

Bottom Area and Side Slopes

Bioretention areas are highly adaptable and can fit various settings such as rural and urban roadsides, ultra urban streetscapes and parking lots by adjusting bottom area and side slope configuration. Recommended maximum and minimum dimensions include:

- The maximum planted side slope shall be 3H:1V. If steeper side slopes are necessary rockeries, concrete walls, or soil wraps may be effective design options.
- The bottom width shall be no less than 2 feet.

Bioretention areas shall have a minimum shoulder of 12 inches between the road edge and beginning of the bioretention side slope where flush curbs are used. Compaction effort for the shoulder should be 90 percent proctor.

Overflow

An overflow route must be identified for stormwater flows that overtop the bioretention area when infiltration capacity is exceeded or the facility becomes plugged and fails. The overflow route must be able to convey the 100year recurrence interval developed peak flow to the downstream conveyance system or other acceptable discharge point without posing a health or safety risk or causing property damage.

Overflow designs shall be tailored to site conditions. Options include, but are not limited to: an emergency overflow spillway per Attachments Section A, Detail 7.0 (minimum length of 3 feet), a vertical drain pipe installed at the designed maximum ponding elevation (12 inches) and connected to a downstream BMP or an approved discharge point, a curb cut at the down-gradient end of the bioretention area to direct overflows back to the street, drainage curb cuts along roadsides shall include a metal cap on top of the curb per Attachments Section A, Detail 26.3 to prevent vehicle launching. See also Attachments Section A Detail 26.2.

Bioretention Soil Mix

Unlike infiltration basins and trenches, native soil underlying bioretention areas is not subject to the soil infiltration treatment requirements discussed in Volume V (i.e., soil suitability criteria #1 and soil suitability criteria #2). Bioretention areas meet the requirements for basic and enhanced treatment, when the bioretention soil mix meets the requirements of the bioretention soil mix design criteria (see bioretention soil mix criteria below).

Do not use filter fabrics between the subgrade and the bioretention soil mix. The gradation between existing soils and bioretention soil mix is not great enough to allow significant migration of fines into the bioretention soil mix. Additionally, filter fabrics may clog with downward migration of fines from the bioretention soil mix.

The minimum requirements associated with the bioretention soil mix include the following:

- Minimum depth of treatment soil must be 18 inches
- Projects can either use a default bioretention soil mix or can create a custom bioretention

soil mix.

- Projects which use the default bioretention soil mix do not have to test bioretention soil mix infiltration rate. They may assume the rates specified in the next subsection.
- Projects which create a custom bioretention soil mix rather than using the default requirements must demonstrate compliance with the specific design criteria and must test the bioretention soil mix infiltration rate as described in the "Custom Bioretention Soil Mix" section below.

Default Bioretention Soil Mix

Bioretention soil shall be a well-blended mixture of mineral aggregate and composted material measured on a volume basis. Bioretention soil shall consist of two parts fine compost (approximately 35 to 40 percent) by volume and three parts mineral aggregate (approximately 60 to 65 percent), by volume. The mixture shall be well blended to produce a homogeneous mix.

- Mineral Aggregate:
  - Percent Fines: A range of 2 to 4 percent passing the US #200 sieve is ideal and fines should not be above 5 percent for a proper functioning specification according to ASTM D422.
- Mineral Aggregate Gradation:
  - Mineral Aggregate shall be free of wood, waste, coating, or any other deleterious material. The aggregate portion of the Bioretention Soil Mix (BSM) should be well-graded. According to ASTM D 2487-98 (Classification of Soils for Engineering Purposes (Unified Soil Classification System)), well-graded sand should have the following gradation coefficients:
    - Coefficient of Uniformity (Cu = D60/D10) equal to or greater than 4, and
    - Coefficient of Curve (Cc = (D30)2/D60 x D10) greater than or equal to 1 and less than or equal to 3.

Aggregate shall be analyzed by an accredited lab using the US sieve numbers and gradation noted in Table 3.4.

Table 3.4. - Aggregate for Bioretention Soil.

US Sieve Number	Percent Passing
0.375 inch	100
4	95-100
10	75-90
40	24-40
100	4-10
200	2-5

Where existing soils meet the above aggregate gradation, those soils may be amended rather than importing mineral aggregate.

Compost to Aggregate Ratio, Organic Matter Content, Cation Exchange Capacity

- **Compost to aggregate ratio:** 60-65 percent mineral aggregate, 35–40 percent compost.
- **Organic matter content:** 5–8 percent by weight.

- **Cation Exchange Capacity (CEC)** must be > 5 milliequivalents/100 g dry soil. Note: Soil mixes meeting the above specifications do not have to be tested for CEC. They will readily meet the minimum CEC.

Composted Material

To ensure that the BSM will support healthy plant growth and root development, contribute to biofiltration of pollutants, and not restrict infiltration when used in the proportions cited herein, the following compost standards are required.

- Material must meet the definition of "composted material" in WAC 173-350-100 and complies with testing parameters and other standards in WAC 173-350-220.
- Material must be produced at a composting facility that is permitted by a jurisdictional health authority. Permitted compost facilities in Washington are included on a list available on Ecology's website.
- The compost product must originate a minimum of 65 percent by volume from recycled plant waste comprised of "yard debris," "crop residues," and "bulking agents" as those terms are defined in WAC 173-350-100. A maximum of 35 percent by volume of "postconsumer food waste" as defined in WAC 173-350-100, but not including biosolids, may be substituted for recycled plant waste.
- Moisture content must be such that there is no visible free water or dust produced when handling the material.
- The material shall be tested in accordance with the U.S. Composting Council "Test Method for the Examination of Compost and Composting" (TMECC), as established in the Composting Council's "Seal of Testing Assurance" (STA) program. Most Washington compost facilities now use these tests.
- Composted material shall meet the size gradations established in the U.S. Composting Council's Seal of Testing Assurance (STA) program, as follows: Fine Compost shall meet the following gradation by dry weight:

	Min.	Max.
Percent passing 2"	100	
Percent passing 1"	99	100
Percent passing 0.625"	90	100
Percent passing 0.25"	75	100

- The pH shall be between 6.0 and 8.5 (TMECC 04.11-A). "Physical contaminants" (as defined in WAC 173-350-100) content shall be less than 1 percent by weight (TMECC 03.08-A) total, not to exceed 0.25 percent film plastic by dry weight.
- Minimum organic matter content shall be 40 percent by dry weight basis as determined by TMECC 05.07A, "Loss-On-Ignition Organic Matter Method."
- Soluble salt contents shall be less than 4.0 dS/mm (mmhos/cm) tested in accordance with TMECC 04.10-A, "1:5 Slurry Method, Mass Basis."
- Maturity indicators from a cucumber bioassay shall be greater than 80 percent for both emergence and vigor, in accordance with TMECC 05.05-A, "Germination and Vigor."
- The material must be stable (low oxygen use and CO2 generation) and mature (capable of supporting plant growth). This is critical to plant success in a bioretention soil mixes.

Stability shall be 7 mg CO2-C/g OM/day or below in accordance with TMECC 05.08-B, "Carbon Dioxide Evolution Rate."

- Fine Compost shall have a carbon to nitrogen ratio of less than 25:1 as determined using TMECC 05.02A "Carbon to Nitrogen Ratio" which uses TMECC 04.01 "Organic Carbon" and TMECC 04.02D "Total Nitrogen by Oxidation." The Engineer may specify a C:N ratio up to 35:1 for projects where the plants selected are entirely Puget Sound lowland native species and up to 40:1 for coarse compost to be used as a surface mulch (not in a soil mix).

Compost not conforming to the above requirements or taken from a source other than those tested and accepted shall be immediately removed from the project and replaced.

Acceptable compost product sources include:

- Cedar Grove Composting, Washington
- Other approved equal.

If using the bioretention soil mix recommended herein, a default infiltration rate of 12 inches per hour shall be used. Refer to Determining Design Bioretention Soil Mix Infiltration Rate below.

Custom Bioretention Soil Mixes

Projects which prefer to create a custom bioretention soil mix rather than using the default requirements above must demonstrate compliance with the following criteria using the specified test method:

- CEC ≥ 5 milliequivalents/100 grams of dry soil; USEPA 9081.
- pH between 5.5 and 7.0.
- 5-8 percent organic matter content before and after the saturated hydraulic conductivity test; ASTM D2974 (Standard Test Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils).
- 2-5 percent fines passing the US #200 sieve; TMECC 04.11-A.
- If compost is used in creating the custom mix, it must meet all of the specifications listed above for compost, except for the gradation specification. An alternative gradation specification must indicate the minimum percent passing for a range of similar particle sizes.
- Measured (Initial) saturated hydraulic conductivity of less than 12 inches per hour; ASTM D 2434 (Standard Test Method for Permeability of Granular Soils (Constant Head)) at 85 percent compaction per ASTM D 1557 (Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort). Also, use Appendix III-A, Recommended Modifications to ASTM D 2434 When Measuring Hydraulic Conductivity for Bioretention Soil Mixes.
- Design (long-term) saturated hydraulic conductivity greater than 1-inche per hour. Refer to Determining Design Bioretention Soil Mix Infiltration Rate below.

Determining Design Bioretention Soil Mix Infiltration Rate

- A long-term infiltration rate correction factor of 4 shall be used for the bioretention soil if the area tributary to the facility meets or exceeds any of the below thresholds (for bioretention areas with a contributing area less than the below thresholds, a long-term infiltration rate correction factor of 2 for the bioretention soil mix is acceptable):

- 10,000 square feet of impervious area
- 5,000 square feet of PGIS
- 0.75 acres of lawn and landscape.

Underdrain (Optional)

Where the underlying native soils have an estimated initial infiltration rate between 0.3 and 0.6 inches per hour, bioretention areas without an underdrain, or with an elevated underdrain directed to a surface outlet, may be used to satisfy List #2 of Minimum Requirement #5. Underdrained bioretention areas that drain to a retention/detention facility must meet the following criteria if they are used to satisfy List #2 of Minimum Requirement #5.

- The invert of the underdrain must be elevated 6 inches above the bottom of the aggregate bedding layer. A larger distance between the underdrain and bottom of the bedding layer is desirable.
- The distance between the bottom of the bioretention soil mix and the crown of the underdrain pipe must be not less than 6 or more than 12 inches.
- The aggregate bedding layer must run the full length and the full width of the bottom of the bioretention area.
- The facility must not be underlain by a low permeability liner that prevents infiltration into the native soil.

Underdrain systems should be installed only if the bioretention area is located where infiltration is not permitted and a liner is used, or where subgrade soils have infiltration rates that do not meet the maximum pool drawdown time. In these cases, underdrain systems can be installed and the facility can be used to filter pollutants and detain flows. However, designs utilizing underdrains provide less infiltration and flow control benefits.

The volume above an underdrain pipe in a bioretention area provides pollutant filtering and some flow attenuation; however, only the void volume of the aggregate below the underdrain invert and above the bottom of the bioretention area (subgrade) can be used in the latest version of WWHM for dead storage volume that provides flow control benefit. Assume a 40 percent void volume for the filter material aggregate specified below.

Elevating the underdrain to create a temporary saturated zone beneath the drain is advised to promote denitrification (conversion of nitrate to nitrogen gas) and prolong moist soil conditions for plant survival during dry periods.

The minimum requirements associated with the underdrain design include:

- Slotted, thick-walled plastic pipe must be used:
  - Minimum pipe diameter: 4 inches (pipe diameter will depend on hydraulic capacity required, 4 to 8 inches is common).
  - Slotted subsurface drain PVC per ASTM D1785 SCH 40.
  - Slots should be cut perpendicular to the long axis of the pipe and be 0.04 to 0.069 inches by 1 inch long and be spaced 0.25 inches apart (spaced longitudinally). Slots should be arranged in four rows spaced on 45-degree centers and cover one-half of the circumference of the pipe. See Filter Materials section for aggregate gradation appropriate for this slot size.

- Underdrain pipe slope must be no less than 0.5 percent
- Pipe must be placed in filter material and have a minimum cover depth of 4 inches
- Filter material shall meet the requirements of WSDOT Standard Specifications 9-03.12(4) (gravel backfill for drains)
- A 6inch non-perforated cleanout must be connected to the underdrain every 300 feet minimum.
    - The underdrain can be connected to a downstream BMP such as another bioretention/ rain garden area as part of a connected system, or to an approved discharge point. A geotextile fabric (specifications in Volume V, Appendix V-A) must be used between the soil layer and underdrain.

Check Dams and Weirs

- For sloped bioretention areas, check dams are necessary to provide ponding, reduce flow velocities and reduce the potential for erosion. Typical check dam materials include concrete, wood, rock, compacted dense soil covered with vegetation, and vegetated hedge rows. Design depends on flow control goals, local regulations for structures within road right-of-ways and aesthetics. Optimum spacing is determined by performance (modeling) and cost considerations. See the Low Impact Development Technical Guidance Manual for Puget Sound for typical designs.

Planting

The design intent for bioretention plantings is to replicate, to the extent possible, the hydrologic function of a mature forest including succession plants and groundcover. Plant roots aid in the physical and chemical bonding of soil particles that is necessary to form stable aggregates, improve soil structure, and increase infiltration capacity.

The minimum requirements associated with the vegetation design include the following:

- The design plans must specify that vegetation coverage of selected plants will achieve 90 percent coverage within 2 years or additional plantings will be provided until this coverage requirement is met
- For facilities receiving runoff from 5,000 square feet or more impervious surface, plant spacing and plant size must be designed to achieve specified coverage by a certified landscape architect
- The plants must be sited according to sun, soil, wind, and moisture requirements
- At a minimum, provisions must be made for supplemental irrigation during the first two growing seasons following installation.

Refer to the LID Technical Guidance Manual for Puget Sound for guidance on plant selection and recommendations for increasing survival rates.

Mulch Layer

Bioretention areas should be designed with a mulch layer or a dense groundcover. Properly selected mulch material also reduces weed establishment, regulates soil temperatures and moisture, and adds organic matter to soil. Mulch should be:

- Compost in the bottom of the facilities (compost is less likely to float than wood chip mulch

and is a better source for organic materials).

- Wood chip mulch composed of shredded or chipped hardwood or softwood on cell slopes above ponding elevation and rim area. Arborist mulch is mostly woody trimmings from trees and shrubs and is a good source of mulch material. Wood chip operations are a good source for mulch material that has more control of size distribution and consistency. Do not use shredded construction wood debris or any shredded wood to which preservatives have been added.
- Free of weed seeds, soil, roots and other material that is not trunk or branch wood and bark.
- A maximum of 3 inches thick (thicker applications can inhibit proper oxygen and carbon dioxide cycling between the soil and atmosphere).

Mulch shall not include weed seeds, soil, roots and other material that are not from the above ground components of a tree, grass clippings (decomposing grass clippings are a source of nitrogen and are not recommended for mulch in bioretention areas), pure bark (bark is essentially sterile and inhibits plant establishment).

In bioretention areas where higher flow velocities are anticipated, an aggregate mulch may be used to dissipate flow energy and protect underlying bioretention soil mix. Aggregate mulch varies in size and type, but 1 to 1.5 inch gravel (rounded) decorative rock is typical. The area covered with aggregate mulch must not exceed one third of the facility bottom area.

As an alternative to mulch, a dense groundcover may be used. Mulch is required in conjunction with the groundcover until groundcover is established.

Hydraulic Restriction Layer

For infiltrating bioretention areas adjacent to roads, foundations or other sensitive infrastructure, it may be necessary to restrict lateral infiltration pathways to prevent excessive hydrologic loading using a restricting layer (for the sides of the bioretention area only).

Two types of restricting layers can be incorporated into bioretention designs:

- Clay (bentonite) liners are low permeability liners
- Geomembrane liners completely block infiltration. The liner should have a minimum thickness of 30 mils and be ultraviolet (UV) resistant.

Note: only the infiltrating bottom area (i.e., unlined) may be used in sizing calculations or hydrologic modeling.

If it is necessary to prevent infiltration to underlying soils (e.g., contaminated soils or steep slope areas), the facility must include a hydraulic restriction layer across the facility. The facility may be composed of a low permeability (e.g., concrete) container with a closed bottom, or may be lined with a low permeability material (e.g., clay, geomembrane liner) to prevent infiltration. In these cases, underdrains are required.

Signage

Pierce County requires that bioretention installations used to meet Minimum #6 and/or #7 include informational signage upon completion of the installation to help identify the vegetated area as a stormwater BMP and to inform maintenance crews and the general public about protecting the facility's function. Signage is recommended for bioretention installations used to

meet Minimum Requirement #5 but is not required.

3.4.7 Bioretention Construction Criteria

See Volume II, Section 3.3 for infiltration facility construction requirements. Minimum requirements associated with bioretention area construction include the following:

- Bioretention areas that infiltrate into the underlying soil (i.e., do not include a liner) rely on water movement through the surface soils as infiltration and interflow to underlying soils. Therefore, it is important to always consider the pathway of interflow and assure that the pathway is maintained in an unobstructed and uncompacted state. This is true during the construction phase as well as postconstruction.
- During construction, it is critical to prevent clogging and over-compaction of the subgrade and bioretention soils. Specific construction criteria for bioretention areas are provided below.
- Place bioretention soil per the requirements of bioretention soil mix requirements specified in this section.

Verification of Performance

The project engineer or designee shall inspect bioretention areas before, during, and after construction as necessary to ensure facilities are built to design specifications, that proper procedures are employed in construction, that the infiltration surface is not compacted, and that protection from sedimentation is in place. Prior to placement of the Bioretention Soil Mix, the project engineer shall verify that the finished subgrade is scarified and meets the designed infiltration rate. Before release of the financial guarantee, the project engineer shall perform a minimum of two performance tests after construction to determine that the facility will operate as designed. The type of test will depend on specific facility and site constraints, and therefore shall be determined by the project engineer on a case-by-case basis and must be approved by the County prior to testing. The County must be notified of the scheduled infiltration testing at least two working days in advance of the test. See Appendix IIIA for testing requirements. If the tests indicate the facility will not function as designed, this information must be brought to the immediate attention of the county along with any reasons as to why not and how it can be remedied.

3.4.8 Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

3.5 Permeable Paving (Ecology BMP T5.15)

3.5.1 Description

Stormwater runoff from vehicular pavement can contain significant levels of solids, heavy metals, and hydrocarbon pollutants. Both pedestrian and vehicular pavements also contribute to increased peak flow durations and associated physical habitat degradation of streams and wetlands. Permeable pavement is designed to accommodate pedestrian, bicycle, and auto traffic while allowing infiltration and storage of stormwater.

Permeable pavement includes porous asphalt; pervious concrete; permeable pavers, aggregate

pavers, and grid systems permeable paver systems.

- Porous hot or warm-mix asphalt pavement is a flexible pavement similar to standard asphalt that uses a bituminous binder to adhere aggregate together. However, the fine material (sand and finer) is reduced or eliminated and, as a result, voids form between the aggregate in the pavement surface and allow water to infiltrate.
- Pervious Portland cement concrete is a rigid pavement similar to conventional concrete that uses a cementitious material to bind aggregate together. However, the fine aggregate (sand) component is reduced or eliminated in the gradation and, as a result, voids form between the aggregate in the pavement surface and allow water to infiltrate.
- Permeable concrete pavers and aggregate pavers. Permeable concrete pavers are solid, precast, manufactured modular units. The solid pavers are (impervious) high-strength Portland cement concrete manufactured with specialized production equipment. Pavements constructed with these units create joints that are filled with permeable aggregates and installed on an open-graded aggregate bedding course. Aggregate pavers (sometime called pervious pavers) are a different class of pavers from pervious concrete pavers. These include modular precast paving units made with similar sized aggregates bound together with Portland cement concrete with high-strength epoxy or other adhesives. Like permeable concrete pavers, the joints or openings in the units are filled with open-graded aggregate and placed on an open-graded aggregate bedding course. Aggregate pavers are intended for pedestrian use only.
- Grid systems include those made of concrete or plastic. Concrete units are precast in a manufacturing facility, packaged and shipped to the site for installation. Plastic grids typically are delivered to the site in rolls or sections. The openings in both grid types are filled with topsoil and grass or permeable aggregate. Plastic grid sections connect together and are pinned into a dense-graded base, or are eventually held in place by the grass root structure. Both systems can be installed on an open-graded aggregate base as well as a dense-graded aggregate base.

3.5.2 Applications and Limitations

- Permeable pavement is an onsite stormwater management BMP option for 1) projects that only have to comply with Minimum Requirements #1 through #5, and 2) projects that trigger Minimum Requirements #1 through #10.
- Permeable pavement can also achieve compliance with the Performance Standard option or can be applied from List #1 or List #2 option of Minimum Requirement #5.
- Permeable pavement can meet water quality treatment requirements of Minimum Requirement #6 when the underlying soil meets the treatment soil requirements outlined in Volume V, Section 6.3, or a water quality treatment course is included.
- Permeable pavement can meet the flow control duration standard of Minimum Requirement #7. The flow control performance is typically a function of the infiltration rate of the underlying subgrade soil and the depth of the aggregate storage reservoir that stores stormwater until it is infiltrated.
- Appropriate applications for permeable pavement include parking lots, low volume roads, alleys, access drives, pedestrian and bike trails, and patios. The application of permeable pavement on roads shall be limited to those roadways that receive very low-traffic volumes

(i.e., ADT less than or equal to 400).

- For public and private roadway projects, permeable pavement installations must consist of pervious concrete only. This requirement does not apply to shared accesses, driveways, sidewalks, and off-street parking. See Attachments Section A, Detail 27.0 for pervious concrete roadway sections.
- Permeable pavement works well in concert with other onsite stormwater management BMPs such as permeable pavement parking stalls adjacent to bioretention areas, and permeable roadway surfaces bordered by vegetated swales.
- Because permeable pavement can clog with sediment, permeable pavement is not recommended under the following conditions:
  - Excessive sediment contamination is likely on the pavement surface (e.g., construction areas, landscaping material yards)
  - It is infeasible to prevent stormwater runon to the permeable pavement from unstabilized erodible areas without pre-settling
  - Sites where the risk of concentrated pollutant spills are more likely (e.g., gas stations, truck stops, car washes, vehicle maintenance areas, industrial chemical storage sites).
- To reduce the potential of clogging, runoff generated from unstabilized pervious surfaces may not be directed onto a permeable pavement surface. Absolutely no point discharges may be directed onto permeable pavement. If runoff comes from minor or incidental pervious areas (including lawns), those areas must be fully stabilized.
- ADA compliance should be requested from the manufacturer and is a consideration in determining where to use permeable pavement.

3.5.3 Infeasibility Criteria

These are conditions that make permeable pavement not required for consideration in the List #1 or List #2 option of Minimum Requirement #5. If a project proponent wishes to use permeable pavement - though not required to because of these feasibility criteria - they may propose a functional design to the local government. These criteria also apply to impervious pavements that would employ stormwater collection from the surface of impervious pavement with redistribution below the pavement. In addition, other permeable pavement design criteria and site limitations that make permeable pavement infeasible (e.g., setback requirements) may also be used to demonstrate infeasibility, subject to approval by the county. See also Appendix III-D for a summary of infeasibility criteria for all BMPs.

Citation of any of the following infeasibility criteria must be based on an evaluation of sitespecific conditions and a written recommendation from an appropriate licensed professional (e.g., engineer, geologist, hydrogeologist):

- Where professional geotechnical evaluation recommends infiltration not be used due to reasonable concerns about erosion, slope failure, or downgradient flooding
- In accordance with PCC Title 18E limitations may exist and reports may be required when permeable pavement is within 300 feet of a landslide hazard area or within 200 feet of an erosion hazard area
- Where infiltrating and ponded water below new permeable pavement area would compromise adjacent impervious pavements

- Where infiltrating water below a new permeable pavement area would threaten existing below grade basements
- Where infiltrating water would threaten shoreline structures such as bulkheads
- Down slope of steep, erosion prone areas that are likely to deliver sediment
- Where fill soils are used that can become unstable when saturated
- Excessively steep slopes where water within the aggregate base layer or at the subgrade surface cannot be controlled by check dams and may cause erosion and structural failure, or where surface runoff velocities may preclude adequate infiltration at the pavement surface
- Where permeable pavements cannot provide sufficient strength to support heavy loads at industrial facilities such as ports
- Where installation of permeable pavement would threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, or pre-existing road subgrades.

The following criteria can be cited as reasons for infeasibility without further justification (though some require professional services to make the observation):

- Within setbacks provided in Section 3.5.6.
- For properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)):
    - Within 100 feet of an area known to have deep soil contamination
    - Where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in the groundwater
    - Wherever surface soils have been found to be contaminated unless those soils are removed within 10 horizontal feet from the infiltration area
    - Any area where these facilities are prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW.
- Within 100 feet of a closed or active landfill.
- Within 10 feet of any underground storage tank and connecting underground pipes, regardless of tank size. As used in these criteria, an underground storage tank means any tank used to store petroleum products, chemicals, or liquid hazardous wastes of which 10 percent or more of the storage volume (including volume in the connecting piping system) is beneath the ground surface.
- At multi-level parking garages, and over culverts and bridges.
- Where the site design cannot avoid putting pavement in areas likely to have long-term excessive sediment deposition after construction (e.g., construction and landscaping material yards).
- Where the site cannot reasonably be designed to have a porous asphalt surface at less than 5 percent slope, or a pervious concrete surface at less than 10 percent slope, or a permeable interlocking concrete pavement surface (where appropriate) at less than 12

percent slope. Grid systems upper slope limit can range from 6 to 12 percent; check with manufacturer and local supplier.

- Where the subgrade soils below a pollution-generating permeable pavement (e.g., road or parking lot) do not meet the soil suitability criteria for providing treatment. See soil suitability criteria for treatment in Volume V, Chapter 6. Note: In these instances, the county may approve installation of a 6-inch sand filter layer meeting county specifications for treatment as a condition of construction.
- Where underlying soils are unsuitable for supporting traffic loads when saturated. Soils meeting a California Bearing Ratio of 5 percent are considered suitable for residential access roads.
- Where appropriate field testing indicates soils have a measured (a.k.a., initial) subgrade soil saturated hydraulic conductivity less than 0.3 inches per hour. A small-scale PIT or large-scale PIT accordance with Appendix III-A shall be used to demonstrate infeasibility of permeable pavement areas. (Note: In these instances, unless other infeasibility restrictions apply, roads and parking lots may be built with an underdrain, preferably elevated within the base course, if flow control benefits are desired.)
- Roads that receive more than very low traffic volumes, and areas having more than very low truck traffic. Roads with a projected average daily traffic volume of 400 vehicles or less are very low volume roads (AASHTO, 2001)(U.S. Dept. of Transportation, 2013). Areas with very low truck traffic volumes are roads and other areas not subject to through truck traffic but may receive up to weekly use by utility trucks (e.g., garbage, recycling), daily school bus use, and multiple daily use by pick-up trucks, mail/parcel delivery trucks, and maintenance vehicles. Note: This infeasibility criterion does not extend to sidewalks and other non-traffic bearing surfaces associated with the collector or arterial.
- Where replacing existing impervious surfaces unless the existing surface is a non-pollution generating surface over an outwash soil with a saturated hydraulic conductivity of 4 inches per hour or greater.
- At sites defined as “high-use sites.” For more information on high-use sites, refer to the Glossary in Volume I; and Volume V, Section 2.1, Step 3.
- In areas with “industrial activity” as defined in the Glossary (located in Volume I).
- Where the risk of concentrated pollutant spills is more likely, e.g., gas stations, truck stops, and industrial chemical storage sites.
- Where routine, heavy applications of sand occur in frequent snow zones to maintain traction during weeks of snow and ice accumulation.

3.5.4 Modeling and Sizing

Note that if the project is using permeable pavement to only meet The List Approach within Minimum Requirement #5, there is no need to model the permeable pavement in a continuous runoff model.

For permeable pavements designed to meet Minimum Requirements #5, #6, #7 or #8, the permeable pavement must be sized using an approved continuous simulation model.

Continuous runoff modeling software include specific modeling elements to use to model the stormwater for permeable pavement.

Within these elements, the model user specifies pavement thickness and porosity, aggregate base material thickness and porosity, maximum allowed ponding depth, and the infiltration rate into the native soil.

- For grades less than 2 percent, no adjustment to the below ground volumes are necessary.
- For grades greater than 2 percent without internal dams within the base materials, the below ground storage volume must be adjusted as follows:
    - Permeable pavement surfaces that are below the surrounding grade and that are on a slope can be modeled as permeable pavement with an infiltration rate and a nominal depth.
    - The dimensions of the permeable pavement are: the length (parallel to and beneath the road) of the base materials that are below grade; the width of the below grade base materials; and an Effective Total Depth of 1 inch. If the continuous runoff model requires the permeable pavement to have an overflow riser to model overflows that occur should the available storage get exceeded, enter 0.04 ft (1/2 inch) for the "Riser Height" and a large Riser Diameter (say 1000 inches) to ensure that there is no head build up.
    - If a drainage pipe is embedded and elevated in the below grade base materials, the pipe should only have perforations on the lower half (below the spring line) or near the invert. Pipe volume and trench volume above the pipe invert cannot be assumed as available storage space. If a drainage pipe is placed at the bottom of the base material, the pavement is modeled as an impervious surface without any gravel trench.
- For roads on a slope with internal dams within the base materials that are below grade, the below ground storage volume must be adjusted as follows:
    - Each stretch of permeable pavement (cell) that is separated by barriers can be modeled separately. For each cell, determine the average depth of water within the cell at which the barrier at the lower end will be overtopped.
    - Specify the dimensions of each cell of the below-grade base materials using the permeable pavement dimension fields for: the "Pavement Length" (length of the cell parallel to the road); the "Pavement Bottom Width"(width of the bottom of the base material); and the Effective Total Depth. In WWHM2012, the field entitled "Effective Volume Factor" is used by the program to calculate the effective storage volume within the below-grade base materials for roads on a slope. The Effective Volume Factor is the ratio of the average maximum water depth behind a check dam (typically at the middle of the pavement length) to the below-grade base materials depth.
    - Each cell should have its own tributary drainage area within the permeable pavement element that includes the road above it, any project site areas whose runoff drains onto and through the road (lateral flow soil or impervious basin), and any offsite areas. Represent each drainage area with a permeable pavement icon and a lateral flow basin icon (if runon occurs).

In the runoff modeling, similar designs throughout a development can be summed and represented as one large facility. For instance, walkways can be summed into one facility. Driveways with similar designs (and enforced through deed restrictions) can be summed into one facility. In these instances, a weighted average of the design infiltration rates (where within a factor of two) for each location may be used. The averages are weighted by the size of their

drainage area. The design infiltration rate for each site is the measured Ksat multiplied by the appropriate correction factors.

On the Permeable Pavement screen under "Infiltration", there is a field that asks the following "Use Wetted Surface Area?" By default, it is set to "NO". It should stay "NO" if the below-grade base material trench has sidewalls steeper than 2 H: 1V.

3.5.5 Field and Design Procedures

Geotechnical analysis is an important first step to develop an initial assessment of the variability of site soils, infiltration characteristics and the necessary frequency and depth of infiltration tests. This section includes infiltration testing requirements and application of appropriate safety factors specific to permeable pavement surfaces.

Refer to Appendix III-A for detailed descriptions of methods for infiltration rate testing procedures; however, note that the subgrade safety factors in Appendix III-A may not apply to permeable pavement. Perform infiltration testing in the soil profile at the estimated bottom elevation of base materials for the permeable pavement. If no base materials (e.g., a pervious concrete sidewalk), perform the testing at the estimated bottom elevation of the pavement. All test hole or test pit explorations outlined below shall be conducted during mid to late in the wet season (December 1 through April 30) to provide accurate groundwater saturation and groundwater information.

Determining Initial Subgrade Infiltration Rates

- **Projects subject to Minimum Requirements #1–#5:**
    - A small-scale Pilot Infiltration Test (PIT), or other methods outlined in Appendix III-A, shall be performed for every 5,000 square feet of permeable pavement, but not less than one test per site.
    - Note that to demonstrate infeasibility for Minimum Requirement #5, only the small-scale or large-scale PIT methods may be used (i.e., measured infiltration rate of less than 0.3 inches per hour).
    - Confirm that the site has the required 1 foot minimum clearance to the seasonal high groundwater or other impermeable layer (refer to Setbacks and Site Constraints below).
- **Projects subject to Minimum Requirements #1–#10:**
    - On commercial property: a small-scale Pilot Infiltration Test (PIT), or other methods outlined in Appendix III-A, should be performed for every 5,000 square feet of permeable pavement, but not less than one test per site.
    - On residential developments: a small-scale Pilot Infiltration Test (PIT), or other methods outlined in Appendix III-A, shall be performed at every proposed lot, at least every 200 feet of roadway and within each length of road with significant differences in subsurface characteristics. However, if the site subsurface characterization - including soil borings across the development site - indicate consistent soil characteristics and depths to seasonal high groundwater conditions, the number of test locations may be reduced to a frequency recommended by a geotechnical professional.

      Note that to demonstrate infeasibility for Minimum Requirement #5, only the small-scale or large-scale PIT methods may be used (i.e., measured infiltration rate of less

than 0.3 inches per hour).

- Confirm that the site has the required 1 foot minimum clearance to the seasonal high groundwater or other impermeable layer (refer to Setbacks and Site Constraints below).

Assignment of Appropriate Safety/Correction Factors

- If deemed necessary by a qualified professional engineer, a safety factor may be applied to the measured Ksat of the subgrade soils to estimate its design (long-term) infiltration rate. Depending on the size of the facility, the variability of the underlying soils, and the number of infiltration tests performed, a safety factor may be advisable.
- A safety factor for the subgrade (i.e., $F_{plugging}$ used in Appendix III-A) does not have to take into consideration the extent of influent control and clogging over time, unless deemed necessary by a professional engineer.
- The quality of pavement aggregate base material may be compromised if the aggregate base is not clean washed material, and has more than 1 percent fines passing the US #200 sieve. In these cases, a correction factor ($F_{aggregate}$) may be necessary. $F_{aggregate}$ ranges from 0.9 (not clean or washed aggregate, greater than 1 percent fines passing the US #200 sieve) to 1 (aggregate base meets specifications).

Soil Suitability Criteria Confirmation

- Where permeable pavements are used for pollution-generating hard surfaces (primarily roads, shared accesses, driveways, and parking lots), there must be a determination whether the soil suitability criteria of Volume V, Section 6.3 are met. This requirement does not apply to projects that trigger only Minimum Requirement #1 through #5.
- Sites not meeting these criteria are considered infeasible for permeable pavements for pollution-generating hard surfaces, unless a treatment layer is provided.
- The information to make this determination may be obtained from various sources: historic site information, estimated qualities of a general soil type, laboratory analysis of field samples.

Prepare Soils Report

For projects subject to Minimum Requirements #1 through #5, a soils report must be prepared by a professional soil scientist certified by the Soil Science Society of America (or an equivalent national program), a locally licensed onsite sewage designer, or by other suitably trained persons working under the supervision of a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington. Refer to Volume I, Section 3.2.8 for Abbreviated Plan Soils Report requirements.

For projects subject to Minimum Requirements #1 through #10, a soils report must be prepared that is stamped by a professional engineer with geotechnical expertise, a licensed geologist, a hydrogeologist, or an engineering geologist registered in the State of Washington that summarizes site characteristics and demonstrates that sufficient permeable soil for infiltration exists at the proposed facility location. At a minimum, the report must contain the following:

- Figure showing the following:
  - Topography within 500 feet of the proposed facility.

- Locations of any water supply wells within 500 feet of the proposed facility.
- Location of groundwater protection areas, aquifer recharge areas, or 1-, 5-, and 10year times of travel zones for wellhead protection areas.
- Locations of test pits or test holes. A minimum of one soil log or test pit is required at each site.

- Results of soils tests including but not limited to: detailed soil logs, visual grain size analysis, grain-size distribution (required if using the grain size analysis method to estimate infiltration rates), percent clay content (include type of clay, if known), color/ mottling, variations and nature of stratification, description of local site geology, including soil or rock units likely to be encountered at soil sampling depths and the seasonal high groundwater elevation
- Detailed documentation of the design infiltration rate determination, as specified above
- State whether location is suitable for infiltration and recommend a design infiltration rate.

Estimate Volume of Stormwater

Use the latest version of the Western Washington Hydrology Model (WWHM), or other approved continuous runoff model to generate an influent file that will be used to size the permeable pavement facility. The facility must infiltrate either all of the flow volume as specified by the influent file, or a sufficient amount of the flow volume such that any overflow/bypass meets the flow duration standard in Minimum Requirement #7. In addition, the overflow/bypass must meet the LID performance standard if it is the option chosen to meet Minimum Requirement #5, or if it is required of the project.

3.5.6 Paving Surface Design Criteria

The following provides a description, recommendations, and requirements for the components of permeable pavement. Some or all of the components may be used for a given application depending on the site characteristics and restrictions, pollutant loading, and design objectives. Submittal for facility review must include documentation of the following elements, discussed in detail below:

- Setbacks and site constraints
- Permeable wearing course
- Drainage conveyance
- Leveling course
- Aggregate storage reservoir
- Lateral subsurface impermeable barriers
- Nonwoven geotextile (optional)
- Subgrade
- Water quality treatment layer
- Signage.

Typical cross-sections of permeable pavement consist of a top layer (pervious wearing course) underlain by a leveling course (if required), aggregate storage reservoir, geotextile fabric

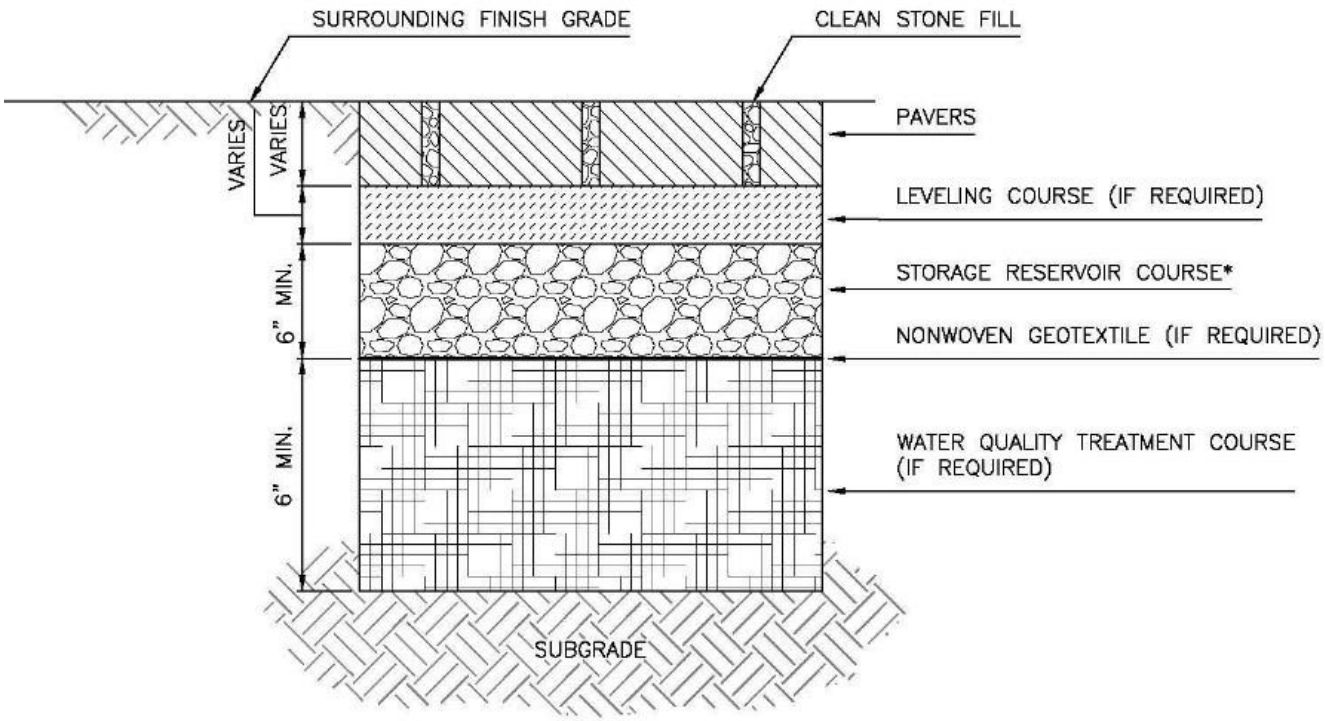
(optional), treatment layer (if required) and subgrade. See Figures 3.7 and 3.8 for example permeable surface cross-sections.

Setbacks and Site Constraints

See Infeasibility Criteria in Section 3.5.3 for setbacks and site constraints used to evaluate the permeable pavement option of List #1 and List #2 (Minimum Requirement #5). (See also Appendix III-D for a summary of infeasibility criteria for all BMPs.) The following minimum setbacks and site constraints apply to all permeable pavement areas.

- The base of the lowest gravel course or treatment layer shall be a minimum of 1 foot positive vertical clearance structures within 25 feet.
- All permeable pavement surfaces shall be set back at least 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on the slope. The geotechnical assessment may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.
- For sites with onsite or adjacent septic systems, the discharge point must be at least 30 feet upgradient, or 10 feet downgradient, of the drainfield primary and reserve areas. This requirement may be modified by the Tacoma-Pierce County Health Department if site topography clearly prohibits flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary.
- Permeable pavement shall not be located where seasonal high groundwater or an underlying impermeable/low permeable layer would create saturated conditions within 1 foot of the bottom of the lowest gravel base course.
- In no case shall permeable pavement surfaces be placed closer than 100 feet from a public water source.
    - Where water supply wells exist nearby, it is the responsibility of the applicant's engineer to locate such wells, meet any applicable protection standards, and assess possible impacts of the proposed infiltration facility on groundwater quality. If negative impacts on an individual or community water supply are possible, additional runoff treatment must be included in the facility design, or relocation of the facility should be considered.

Figure 3.8. - Permeable Paver Section



* STORAGE RESERVOIR MUST BE LAID PARTIALLY OR COMPLETELY BELOW SURROUNDING FINISH GRADE.

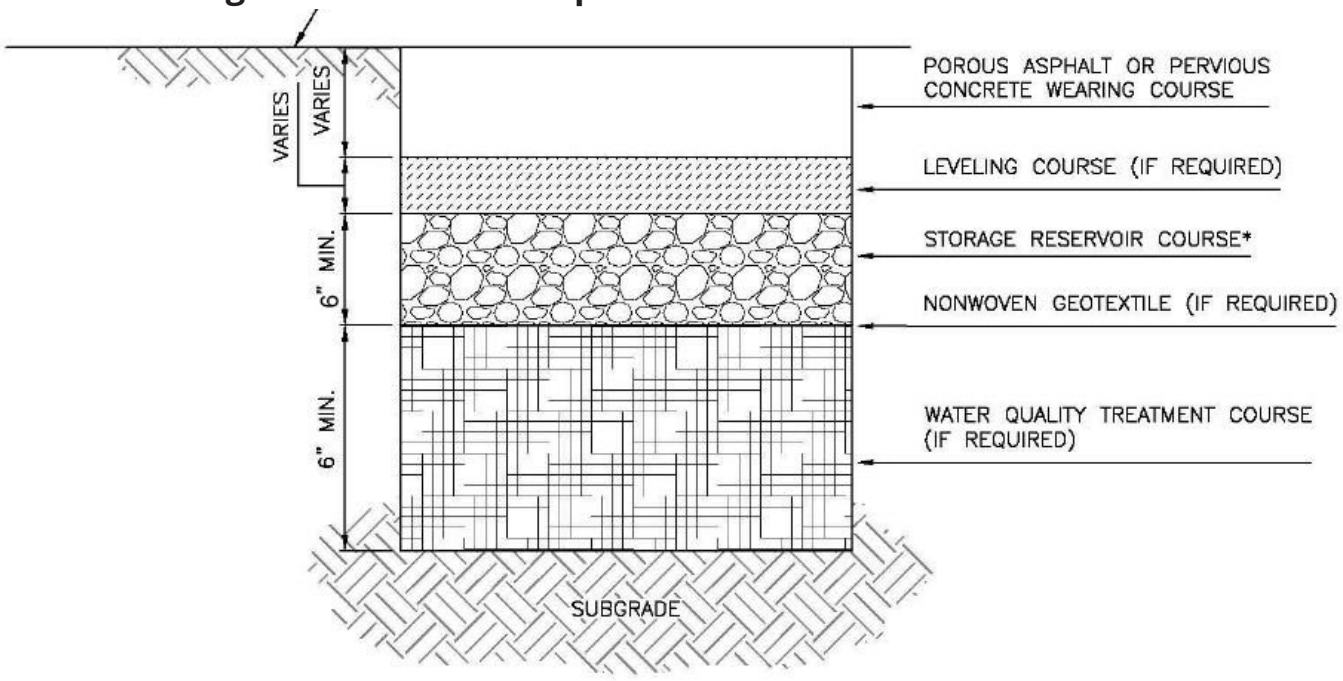
NOTE

1. OVERFLOW AND LATERAL SUBSURFACE IMPERMEABLE BERMS NOT SHOWN.

PERMEABLE PAVER SECTION

NTS

Figure 3.8. - Porous Asphalt or Pervious Concrete Section.



POROUS ASPHALT OR PERVIOUS CONCRETE SECTION

NTS

- Permeable pavement surfaces upgradient of drinking water supplies and within 1, 5, and 10-year time of travel zones must comply with Washington State Wellhead Protection Program Guidance Document, DOH, 6/2010. Infiltration systems that qualify as Underground Injection Control Wells must comply with Chapter 173-218 WAC and follow the Washington Department of Ecology's "Guidance for UIC Wells that Manage Stormwater," Publication No. 05-10-067.
- The soils report must be updated to demonstrate and document that the above criteria are met and to address potential impacts to water supply wells or springs.

- Permeable pavement surfaces are prohibited within 300 feet of an erosion hazard, or landslide hazard area (as defined by PCC Title 18E.80) unless the slope stability impacts of such systems have been analyzed and mitigation proposed by a geotechnical professional, and appropriate analysis indicates that the impacts are negligible.

Permeable Wearing Course

The wearing course or surface layer of the permeable pavement surface may consist of porous asphalt, pervious concrete, interlocking concrete pavers, or open-celled paving grid with vegetation or gravel.

- Recommended maximum wearing course slopes for permeable paving surfaces are 5 percent (porous asphalt), 10 percent (pervious concrete), 12 percent (interlocking pavers), and 12 percent (grid and lattice systems) (check with manufacturer or local supplier).
- Manufacturer's recommendations on design, installation, and maintenance shall be followed for each application.
- For all surface types, a minimum initial infiltration rate of 20 inches per hour is required. To improve the probability of long-term performance, significantly higher initial infiltration rates are desirable. For measuring initial surface infiltration rates for porous asphalt, pervious concrete, or permeable interlocking concrete pavers, ASTM C1701 shall be used. For grid systems, refer to manufacturers testing recommendations.
  - Porous Asphalt: Products must have adequate void spaces through which water can infiltrate and must meet performance grade (PG) 70-22. See the LID Technical Guidance Manual for the Puget Sound Basin for additional specifications.
  - Pervious Concrete: Products must have adequate void spaces through which water can infiltrate and must meet the most current version of American Concrete Institute (ACI) 522. See the LID Technical Guidance Manual for the Puget Sound Basin for additional specifications.
  - Grid/lattice systems filled with gravel, sand, or a soil of finer particles with or without grass: The fill material must be at least a minimum of 2 inches of sand, gravel, or soil. Fill media for grid systems with grass vary per manufacturer from coarse sand to topsoil. Consult manufacturer to confirm that the fill media will provide adequate infiltration capacity and, at that rate, support healthy plant growth.
  - Permeable Interlocking Concrete Pavement and Aggregate Pavers: See the LID Technical Guidance Manual for the Puget Sound Basin for specifications and installation procedures published by the Interlocking Concrete Pavement Institute.
- Permeable pavement systems that utilize pavers need to be confined with a rigid edge system to prevent gradual movement of the paving stones.

- Both gravel and soil with vegetation can be used to fill the openings in paver and rigid grid systems and manufacturer recommendations should be followed to apply the appropriate material for each application.
- Structural designs for permeable pavement should be per the manufacturer's specifications. If any deviations are made from the manufacturer's recommendations or if the manufacturer's recommendations require engineering judgments to be made, the design shall be stamped by a geotechnical engineer.

Drainage Conveyance

Flow Entrance/Presettling Requirements

- Runon to permeable pavement must be dispersed as sheet flow or delivered subsurface to the storage reservoir. If subsurface delivery is used, primary settling is required (e.g., via catch basin, hooded outlet, sump) followed by distribution to storage reservoir (e.g., via perforated drain pipe).
- Runon from up-gradient adjacent impervious paved surfaces is not recommended, but permissible if the permeable pavement area is twice the area of the impervious area and the length of sheet flow from the impervious paved surface is no greater than half the length across the permeable pavement section.

Overflow Requirements

- In small area applications, the subgrade can be built up with permeable base material and graded to direct runoff through this material to an eventual discharge location, such as bioretention areas. In larger areas, an elevated underdrain system should be installed to collect and convey runoff to bioretention areas or open space. In this manner, stormwater is stored and metered out slowly, similar to the way the existing topsoil on a site captures and slowly releases runoff. (See also the Aggregate Storage Reservoir section below for additional details on underdrains.)
- An overflow route must be identified for stormwater flows that overtop the permeable pavement surface when infiltration capacity is exceeded or the facility becomes plugged and fails. The overflow route must be able to convey the 100year recurrence interval developed peak flow to the downstream conveyance system or other acceptable discharge point without posing a health or safety risk or causing property damage.
- Overflow must be designed to convey excess flow to an approved point of discharge. Options include:
    - Subsurface slotted drain pipe(s) set at the design ponding elevation to route flow to a conveyance system
    - Lateral flow through the storage reservoir to a daylighted conveyance system.

Leveling Course

Depending upon the type of permeable pavement installation, a leveling course (also called a bedding or choker course) may be required (per manufacturer recommendations). A leveling course is often required for porous asphalt, open-celled paving grids, and interlocking concrete pavers. This course is a layer of aggregate that provides a more uniform surface for laying pavement or pavers and consists of crushed aggregate smaller in size than the underlying aggregate storage reservoir. Course thickness will vary with permeable pavement type.

Leveling course material and thickness shall be included as required per manufacturer recommendations. Leveling course material must be compatible with underlying aggregate storage reservoir material.

Aggregate Storage Reservoir

Stormwater passes through the wearing and leveling courses to an underlying aggregate storage reservoir, also referred to as "base material," where it is filtered and stored prior to infiltration into the underlying soil. The aggregate storage reservoir also serves as the pavement's support base and must be sufficiently thick to support the expected loads and be free draining. The aggregate should meet the following criteria:

- A 6inch minimum depth of aggregate storage reservoir is recommended under the permeable wearing course and leveling course (if any) for water storage. The County may allow a reduced depth on a case-by-case basis.
- Aggregate storage reservoir should consist of larger rock at the bottom and smaller rock directly under the top surface (e.g., a gradient from 2 to five-eighths inch).
- Designs utilizing an underdrain that is elevated within the aggregate base course to protect the pavement wearing course from saturation are still considered a LID BMP and can be used to satisfy Minimum Requirement #5, so long as the underdrain invert is set at or above the maximum design ponding depth.

Lateral Subsurface Impermeable Barriers

Sloped permeable pavement surfaces have an increased potential for lateral flows through the aggregate storage reservoir along the top of relatively impermeable subgrade soil. This poses a risk of subsurface erosion and reduces the storage and infiltration capacity of the pavement facility. To address this, the subgrade must be designed to create subsurface ponding to detain subsurface flow, increase infiltration, and reduce structural problems associated with subgrade erosion on slopes.

Ponding must be provided using periodic lateral impermeable barriers (e.g. check dams, impermeable liners, or low conductivity geotextiles) oriented perpendicular to the subgrade slope when the slope of the permeable pavement is 3 percent or greater. While the frequency of the barriers is calculated based on the required subsurface ponding depth and the subgrade slope, typical designs include barriers every 6 to 12 inches of grade loss. See Attachments Section A, Details 27.1 for an example of subsurface permeable pavement check dams.

Minimum requirements associated with lateral impermeable barriers include the following:

- Lateral impermeable barriers must be installed at regular intervals perpendicular to the subgrade slope to provide the average subsurface ponding depth in the aggregate storage reservoir required to meet the desired performance standard
- The barriers must not extend to the elevation of the surrounding ground
- Each barrier must have an overflow, as described below, or allow overtopping to the next downslope aggregate storage reservoir section without causing flows to express from the pavement surface or out the sides of the base materials that are above grade.

Nonwoven Geotextile (Optional)

Generally, geotextiles and geogrids are applied:

- To prevent fines from migrating to more open-graded material and the associated structural instability.
- For soil types with poor structural stability to prevent downward movement of the aggregate base into the subgrade.
- If a sand layer is utilized, geotextile is required between the aggregate storage reservoir and the sand layer. Geotextile is also required between the native soil and the sand layer.

Geotextiles between the permeable pavement subgrade and aggregate base are not required or necessary for many soil types and, if incorrectly applied, can clog and reduce infiltration capability at the subgrade or other material interface. Therefore, the use of geotextiles is discouraged unless it is deemed necessary. As part of the pavement section design, the designer should review the existing subgrade or subbase characteristics and determine if a nonwoven geotextile is needed for separation of subbase from underlying soils.

Subgrade

- Compact the subgrade to the minimum necessary for structural stability. Two guidelines currently used to specify subgrade compaction are "firm and unyielding" (qualitative), and 90 to 92 percent Standard Proctor (quantitative).
- If the permeable pavement is being designed to provide water quality treatment, underlying soils must meet the requirements for treatment soil provided in Volume V, Chapter 6.

Water Quality Treatment Layer

If the permeable pavement is being designed to provide water quality treatment, underlying soils must meet the requirements for treatment soil provided in Volume V, Chapter 6. If the existing subgrade does not meet these requirements, a 6inch water quality treatment course may be included between the subbase and the aggregate storage reservoir. The course must be comprised of the sand material specification for sand filters in the Ecology Manual.

Signage

Pierce County requires that permeable pavement installations used to meet Minimum Requirement #6 and/or #7 include informational signage upon completion of the installation to help identify the area as a stormwater BMP and to inform maintenance crews and the general public about protecting the facility's function. Signage is recommended for permeable pavement installations used to meet Minimum Requirement #5 but is not required.

3.5.7 Construction Criteria

Minimum requirements associated with permeable pavement construction include the following:

- Proper installation is one of the key components to ensure the success of permeable pavement. As with any pavement system, permeable pavement requires careful preparation of the subgrade and aggregate storage reservoir to ensure success in terms of strength and permeability. The compressive strength of a permeable paver system relies in large part on the strength of the underlying soils, particularly in the case of modular or plastic units where the pavement itself lacks rigidity. Design and installation of permeable pavement shall be according to manufacturer recommendations.

- Field infiltration and compaction testing of the optional water quality treatment course shall be conducted prior to placement of overlying courses.
- To prevent compaction when installing the aggregate storage reservoir, the following steps (back-dumping) should be followed:
  - The aggregate storage reservoir is dumped onto the subgrade from the edge of the installation and the aggregate is then pushed out onto the subgrade
  - Trucks then dump subsequent loads from on top of the aggregate storage reservoir as the installation progresses.
- The various aggregate storage reservoir materials shall be prevented from intermixing with fines and sediment. All contaminated material must be removed and replaced.
- Field infiltration test of the permeable surface shall be conducted after complete pavement section is installed (see Verification of Performance below).
- If possible, temporary roads should be used during construction and final construction of the aggregate storage reservoir material and permeable surfacing completed after building construction is complete. This construction method is similar to the installation of leveling courses of asphalt in a subdivision prior to building individual lots and installation of the final wearing course upon completion of building construction.

Refer to Volume II, Section 3.3 LID BMP Protection During Construction for construction considerations specific to LID BMPs.

Verification of Performance

The project engineer or designee shall inspect permeable pavement areas before, during, and after construction as necessary to ensure facilities are built to design specifications, that proper procedures are employed in construction, that the infiltration surface is not compacted, and that protection from sedimentation is in place. Prior to placing the aggregate storage reservoir, the project engineer shall verify that the finished subgrade is scarified and meets the designed infiltration rate. The project engineer shall verify that the aggregate storage reservoir has been adequately installed and protected (e.g., from compaction and sedimentation) per the design specifications, prior to paving. Prior to accepting the installation of the permeable pavement and also before release of the financial guarantee, the project engineer shall perform a sufficient number of ASTM C1701 tests (a minimum of two) after construction to determine that the facility will operate as designed and to verify that it meets the minimum initial uncorrected infiltration rate of 20 inches per hour (see Wearing Course section). The County must be notified of the scheduled infiltration testing at least two working days in advance of the test. See Appendix IIIA for testing requirements. If the tests indicate the facility will not function as designed, this information must be brought to the immediate attention of the county along with any reasons as to why not and how it can be remedied.

3.5.8 Operations and Maintenance Criteria

- See Minimum Requirement #9 in Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.
- Where runon flows onto permeable pavement, these areas shall be identified in the Maintenance and Source Control Manual as requiring more frequent cleaning and inspection to ensure that the overall facility is performing.

- Clogging is the primary mechanism that degrades infiltration rates. However, as discussed above, the surface design can have a significant influence on clogging of void space.
- Studies have indicated that infiltration rates on moderately degraded porous asphalts and pervious concrete can be partially restored by suctioning and sweeping of the surface. Highly degraded porous asphalts and concrete require high pressure washing with suction.
- Maintenance frequencies of suctioning and sweeping shall be specified in the Maintenance and Source Control Manual, or as specified in Volume I, Appendix IA, whichever is more stringent.
- Permeable pavement systems designed with pavers have advantages of ease of disassembly when repairs or utility work is necessary. However, it is important to note that the paver removal area should be no greater than the area that can be replaced at the end of the day. If an area of pavers is removed, leaving remaining edges unconfined, it is likely that loading in nearby areas will create movement of the remaining pavers thereby unraveling significantly more area than intended.

3.6 Infiltration Trenches (Ecology BMP T7.20)

3.6.1 Description

Infiltration trenches are generally at least 24 inches wide, and are backfilled with a coarse stone aggregate, allowing for temporary storage of stormwater runoff in the voids of the aggregate material. Stored runoff then gradually infiltrates into the surrounding soil. The surface of the trench can be covered with grating and/or consist of stone, gabion, sand, or a grassed covered area with a surface inlet. Perforated rigid pipe of at least 8inch diameter can also be used to distribute the stormwater in a stone trench. Note that an infiltration trench with a perforated pipe is considered an Underground Injection Control (UIC) well and is required to be registered with Ecology, unless the infiltration trench is located at a single-family home (or duplex) and only receives residential roof runoff or is used to control basement flooding (per WAC 173-218-070 (1)(e). See also Section 2.6 and Volume I, Appendix I-C – Underground Injection Control (UIC) Program Guidelines for more information on UIC well registration.

See Attachments Section A, Details 2.0, 3.0, 4.0, and 23.0 for examples of infiltration trench facilities in various configurations and site settings. Included in the details are infiltration trenches with a grass buffer, as well as an example of a parking lot perimeter infiltration trench design. For trenches associated specifically with roof downspout infiltration, see Section 3.9.3.

3.6.2 Applications and Limitations

- Infiltration trenches can be used to meet the flow control standards of Minimum Requirement #7.
- When used in combination with other onsite stormwater management BMPs, they can also help achieve compliance with the Performance Standard option of Minimum Requirement #5.
- Infiltration trenches can be used to meet some of the water quality treatment requirements of Minimum Requirement #6 if the underlying soil meets the requirements provided in Volume V, Section 6.3.

3.6.3 Modeling and Sizing

See Section 2.5.3 for guidance on modeling and sizing of infiltration facilities.

3.6.4 Infiltration Trench Design Criteria

Refer to Section 2.5 for general procedures and design criteria applicable to infiltration trenches. This section provides additional design criteria specific to infiltration trenches:

- Due to accessibility and maintenance limitations, infiltration trenches must be carefully designed and constructed.
- Provide a structure or cleanout at each end of the infiltration trench for accessibility to conduct inspections and maintenance.
- Minimum spacing between distribution pipe centerlines must be 6 feet.
- Maximum spacing between distribution pipe centerlines must be 10 feet.
- Backfill material – The aggregate material for the infiltration trench must consist of a clean aggregate and meet WSDOT Specification 9-03.12(5) that nominally ranges from 0.75-inch to 1.5-inch diameter. A maximum diameter of 3 inches and a minimum diameter of 1.5 inches may be approved if void space is maintained. Void space for these aggregates must be in the range of 30 to 40 percent.
- Geotextile fabric liner – Completely encase the aggregate fill material in an engineering geotextile material. Geotextile must surround all of the aggregate fill material except for the top 1 foot, which is placed over the geotextile. Carefully select geotextile fabric with acceptable properties to avoid plugging (see Volume V, Appendix VA).
- A 6inch minimum layer of sand may be used as a filter media at the bottom of the trench instead of geotextile.
- The bottom sand or geotextile fabric as shown in Attachments Section A, Details 2.0, 3.0, 4.0, and 23.0 is optional.

Refer to the Federal Highway Administration Manual "Geosynthetic Design and Construction Guidelines," Publication No. FHWA HI95038, May 1995 for design guidance on geotextiles in drainage applications. Refer to the NCHRP Report 367, "Long-Term Performance of Geosynthetics in Drainage Applications," 1994, for long-term performance data and background on the potential for geotextiles to clog, blind, or to allow piping to occur and how to design for these issues.

- **Overflow channel** – Because an infiltration trench is generally used for small drainage areas, an emergency spillway is not necessary. However, provide a non-erosive overflow channel leading to a stabilized watercourse.
- **Surface cover** – A stone filled trench can be placed under a porous or impervious surface cover to conserve space.
- **Observation well** – Install an observation well at the lower end of the infiltration trench to check water levels, drawdown time, sediment accumulation, and conduct water quality monitoring. See Attachments Section A, Detail 15.0 for an example observation well detail. It should consist of a perforated PVC pipe which is 4 to 6 inches in diameter and it should be constructed flush with the ground elevation. For larger trenches a 12- to 36inch diameter well can be installed to facilitate maintenance operations such as pumping out the sediment. The top of the well should be equipped with a secure well cap to discourage

vandalism and tampering.

3.6.5 Construction Criteria for Trenches

Most of the construction requirements for small scale infiltration facilities included in Volume II, Section 3.3 apply to all infiltration facilities. Additional specific construction criteria for infiltration trenches are provided below. Criteria for residential roof downspout trenches are located in Section 3.9.

- **Trench preparation** – Excavated materials must be placed away from the trench sides to enhance trench wall stability. Take care to keep this material away from slopes, neighboring property, sidewalks and streets. It is recommended that this material be covered with plastic (see Erosion and Sediment Control Criteria in Volume II, BMP C123- Plastic Covering).
- **Stone aggregate placement and compaction** – Place the stone aggregate in lifts and compact using plate compactors. In general, a maximum loose lift thickness of 12 inches is recommended. The compaction process ensures geotextile conformity to the excavation sides, thereby reducing potential piping and geotextile clogging, and settlement problems.
- **Potential contamination** – Prevent natural or fill soils from intermixing with the stone aggregate. Remove all contaminated stone aggregate and replace with uncontaminated stone aggregate.
- **Overlapping and covering** – Following the stone aggregate placement, the geotextile must be folded over the stone aggregate to form a 12 inch minimum longitudinal overlap. When overlaps are required between rolls, the upstream roll must overlap a minimum of 2 feet over the downstream roll in order to provide a shingled effect.
- **Voids behind geotextile** – Voids between the geotextile and excavation sides must be avoided. Removing boulders or other obstacles from the trench walls is one source of such voids. Place natural soils in these voids at the most convenient time during construction to ensure geotextile conformity to the excavation sides. This remedial process will avoid soil piping, geotextile clogging, and possible surface subsidence.
- **Unstable excavation sites** – Vertically excavated walls may be difficult to maintain in areas where the soil moisture is high or where soft or cohesionless soils predominate. Trench boxes or trapezoidal, rather than rectangular, cross-sections may be needed.

3.6.6 Operations and Maintenance Criteria for Trenches

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.

3.7 Infiltration Basins (Ecology BMP T7.10)

3.7.1 Description

Infiltration basins are earthen impoundments used for the collection, temporary storage and infiltration of stormwater runoff. (See schematic in Attachments Section A, Detail 5.0.)

3.7.2 Applications and Limitations

Infiltration basins can be used to meet the flow control standards of Minimum Requirement #7. They can also meet some of the water quality treatment requirements of Minimum Requirement

#6 if the underlying soil meets the requirements provided in Volume V, Section 6.3.

3.7.3 Infiltration Basin Design Criteria

Refer to Section 2.5 for general procedures and design criteria applicable to infiltration basins. This section provides additional design criteria specific to infiltration basins:

- Access must be provided for vehicles to easily maintain the forebay (presettling basin) area and not disturb vegetation, or resuspend sediment any more than is absolutely necessary.
- The slope of the basin bottom shall not exceed 3 percent in any direction.
- A minimum of 1 foot of freeboard is required when establishing the design ponded water depth. Freeboard is measured from the rim of the infiltration facility to the maximum ponding level or from the rim down to the overflow point if overflow or a spillway is included.
- Vegetation – The embankment, emergency spillways, spoil and borrow areas, and other disturbed areas shall be stabilized and planted, preferably with grass, in accordance with stormwater site plan (see Volume I, Minimum Requirement #1). Without healthy vegetation the surface soil pores would quickly plug. Treatment infiltration basins must have sufficient vegetation established on the basin floor and side slopes to prevent erosion and sloughing and to provide additional pollutant removal. Select suitable vegetative materials for the basin floor and side slopes. Refer to detention pond guidance in Section 3.12.1 for recommended vegetation. Use the seed mixtures recommended in Table 3.8.

3.7.4 Construction Criteria

Most of the construction requirements for small scale infiltration facilities included in Volume II, Section 3.3 apply to all infiltration facilities. Specific construction criteria for infiltration basins are provided below.

- Initial basin excavation must be conducted to within 2 feet of the final elevation of the basin floor. Excavate infiltration trenches and basins to final grade only after all disturbed areas in the upgradient project drainage area have been permanently stabilized. The final phase of excavation must remove all accumulation of silt in the infiltration facility before putting it in service.
- Generally, it is preferable to avoid using infiltration facilities as temporary sediment traps during construction. If an infiltration basin is to be used as a sediment trap, do not excavate to final grade until after stabilizing the upgradient drainage area. Remove any accumulation of silt in the basin before putting it in service.

3.7.5 Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements. Additional maintenance considerations for infiltration basins are provided below.

- Maintain basin floor and side slopes to promote dense turf with extensive root growth. This enhances infiltration, prevents erosion and consequent sedimentation of the basin floor, and prevents invasive weed growth.
- Apply fertilizers only as necessary and in limited amounts to avoid contributing to groundwater pollution. Consult the local agricultural or gardening resources such as

Washington State University Extension for appropriate fertilizer type, including slow release fertilizers, and application rates.

3.8 Rain Gardens (Ecology BMP T5.14A)

3.8.1 Description

Rain gardens are shallow stormwater systems with compost amended soil or imported bioretention soil and plants adapted to the local climate and soil moisture conditions. Like bioretention, rain gardens are designed to mimic a forested condition by controlling stormwater through detention, infiltration, and evapotranspiration. Rain gardens also provide water quality treatment through sedimentation, filtration, adsorption, and phytoremediation.

Rain gardens function by storing stormwater as surface ponding before it filters through the underlying amended soil. Stormwater that exceeds the surface storage capacity overflows to an adjacent drainage system. Treated water is infiltrated into the underlying soil.

The terms bioretention and rain garden are sometimes used interchangeably. However, in Pierce County (in accordance with the Washington State Department of Ecology's distinction), the term bioretention is used to describe an engineered facility that includes designed soil mixes and perhaps underdrains and control structures. The term, rain garden, is used to describe a landscape feature that serves to capture stormwater on small project sites that only trigger Minimum Requirements #1-#5.

Rain gardens are similar to bioretention areas (refer to Section 3.4) with the following exceptions:

- Rain gardens may only be used to meet onsite stormwater management requirements (List #1) and must not be used on projects that trigger water quality treatment or flow control requirements (i.e., they are only applicable for projects that only trigger MR #1 through MR #5)
- Rain gardens may not have a liner or underdrain
- The maximum ponding depth is 6 inches
- A certified landscape architect is not required for vegetation design
- Rain gardens must not receive runoff from a public roadway

3.8.2 Applications and Limitations

Bioretention areas and rain gardens are applications of the same LID concept and can be highly effective for reducing surface runoff and removing pollutants.

- Rain gardens are an onsite stormwater management BMP option for projects that have to comply with Minimum Requirements #1 through #5, but not Minimum Requirements #1 through #10.
- Rain gardens may be utilized as an on-lot stormwater system, even in areas where underlying soils may not be conducive to rapid infiltration (such as underlying glacial till), but where the area does have a surface soil cover that allows the migration of stormwater through the upper soil horizon as interflow.
- Underdrains may not be used for rain gardens. For sites with poorly draining soils (e.g., 0.3 to 0.6 inches per hour), applicants are encouraged to contact an engineer for other recommended options (e.g., designing a bioretention area for the site).

- Rain gardens should be used to receive rooftop runoff in areas where infiltration facilities are not feasible and in preference to dispersing runoff, and may be integrated into the landscaped areas of the lot.
- Rain gardens shall not accept runoff from a public roadway.

3.8.3 Infeasibility Criteria

Infeasibility criteria describe conditions that make rain gardens not required for consideration in the List #1 option of Minimum Requirement #5. Infeasibility criteria for rain gardens are the same as for bioretention. See bioretention area infeasibility criteria in Section 3.4.3. In addition, other rain garden design criteria and site limitations that make rain gardens infeasible (e.g., setback requirements) may also be used to demonstrate infeasibility, subject to approval by the county. See also Appendix III-D for a summary of infeasibility criteria for all BMPs.

3.8.4 Modeling and Sizing

Sizing of a rain garden (lot-scale facility, contributing area less than twice the area for which it is sized to a maximum of 5,000 square feet of impervious surface) can be done by relating the square footage of the surface area of the rain garden to the size of the area contributing runoff. For design on projects subject to Minimum Requirement #5, and choosing to use List #1 of that requirement, rain gardens shall have a horizontally projected surface area below the overflow which is at least 5 percent of the total impervious surface area draining to it. If lawn/landscape area will also be draining to the rain garden, the rain garden's horizontally projected surface area below the overflow shall be increased by 2 percent of the lawn/landscape area.

It is recommended that the rain garden bottom not be oversized because the vegetation in oversized rain gardens may not receive sufficient stormwater runoff for irrigation, increasing O&M requirements. Stormwater flows from other areas (beyond the area for which the rain garden is sized) should be bypassed around the rain garden in order to reduce sediment loading and the potential for clogging. While it is preferred that rain gardens be sized to manage only the area draining to it, excess flows may be routed through a rain garden designed for the onsite stormwater management standard with the following limitations:

- The maximum impervious drainage area that may be routed to a rain garden must not exceed twice the area for which it is sized to a maximum of 5,000 square feet. Additional runoff contributions from pervious areas are acceptable. No onsite stormwater management credit is given for runoff from areas beyond the design area.
- Additional runoff routed to a rain garden must be clearly noted on submitted plans.

3.8.5 Field and Design Procedures

Geotechnical analysis is an important first step to develop an initial assessment of the variability of site soils, infiltration characteristics and the necessary frequency and depth of infiltration tests. This section includes infiltration testing requirements and application of appropriate safety factors specific to rain garden areas.

Refer to Appendix III-A for detailed descriptions of methods for infiltration rate testing procedures; however, note that the subgrade safety factors in Appendix III-A may not apply to rain gardens (additional details provided below).

Determining Design Infiltration Rate

Infiltration rates are determined through soil infiltration tests. Infiltration tests should be run at the anticipated elevation of the top of the native soil beneath the rain garden area. A small-scale PIT, or other methods outlined in Appendix III-A, shall be performed at each potential rain garden site. Test hole or test pit explorations shall be conducted during mid to late in the wet season (December 1 through April 30) to provide accurate groundwater saturation and groundwater information. Note that to demonstrate infeasibility for Minimum Requirement #5, only the small scale PIT may be used (i.e., measured infiltration rate of less than 0.3 inches per hour). Also determine whether the site has at least 1 foot minimum clearance to the seasonal high groundwater or other impermeable layer. Note that when using the field testing procedures outlined in Appendix III-A, a safety factor is not required for rain gardens.

Prepare Soils Report

A soils report must be prepared by a professional soil scientist certified by the Soil Science Society of America (or an equivalent national program), a locally licensed onsite sewage designer, or by other suitably trained persons working under the supervision of a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington. Refer to Volume I, Section 3.2.8 for Abbreviated Plan Soils Report Requirements.

3.8.6 Rain Garden Design Criteria

The following provides a description, recommendations, and requirements for the components of a rain garden. Some or all of the components may be used for a given application depending on the site characteristics and restrictions, pollutant loading, and design objectives. Submittal for rain garden review must include documentation of the elements discussed below.

Setbacks and Site Constraints

Setbacks and site constraints for rain gardens are the same as those for infiltrating bioretention areas (see Section 3.4.6).

Flow Entrance

Flow entrances should be sized to capture flow from the catchment area and designed to both reduce the potential for clogging at the inlet and prevent inflow from causing erosion in the rain garden. See the Rain Garden Handbook for Western Washington, page 29 for additional details and information.

Cell Ponding Area

Cell ponding area design criteria for rain gardens are the same as those specified in the Rain Garden Handbook for Western Washington, except for the following:

- The ponding depth for rain gardens shall be a maximum of 6 inches.
- The minimum freeboard measured from the invert of the overflow pipe or earthen channel to facility overtopping elevation shall be 6 inches.
- If berming is used to achieve the minimum top elevation needed to meet ponding depth and freeboard needs, the maximum slope on berm shall be 3H:1V, and the minimum top width of design berm shall be 1 foot. Soil used for berming shall be imported bioretention soil, rain garden soil, or amended native soil.

Bottom Area and Side Slopes

Rain gardens are highly adaptable and can fit various rural and urban settings by adjusting bottom area and side slope configuration. Recommended maximum and minimum dimensions include:

- The planted side slope shall be no steeper than 3H:1V. If steeper side slopes are necessary rockeries, concrete walls or soil wraps may be effective design options
- The bottom width shall be no less than 2 feet.

Overflow

An overflow route must be identified for stormwater flows that overtop the rain garden area when infiltration capacity is exceeded or the facility becomes plugged and fails. The overflow route must flow to the downstream conveyance system or other acceptable discharge point without posing a health or safety risk or causing property damage.

Rain garden overflow can be provided by a drain pipe installed at the designed maximum ponding elevation and connected to a downstream BMP or an approved discharge point.

See the Rain Garden Handbook for Western Washington for additional details and information.

Rain Garden Soil Mix

See the Rain Garden Handbook for Western Washington for soil mix information. For amending the native soil within the rain garden, the county recommends use of compost that meets the compost specification for bioretention (see Section 3.4.6). Compost that includes biosolids or manure shall not be used.

Planting

Refer to the Rain Garden Handbook for Western Washington for guidance on plant selection and recommendations for increasing survival rates. The minimum requirements associated with the vegetation design include the following:

- The design plans must specify that vegetation coverage of selected plants will achieve 90 percent coverage within 2 years or additional plantings will be provided until this coverage requirement is met.
- Plant spacing and plant size must be designed to achieve specified coverage.
- The plants must be sited according to sun, soil, wind, and moisture requirements.
- At a minimum, provisions must be made for supplemental irrigation during the first two growing seasons following installation.

Signage

Pierce County recommends that rain garden installations include informational signage upon completion of the installation to help identify the area as a stormwater BMP and to inform the general public about protecting the facility's function.

Mulch Layer

Refer to the Rain Garden Handbook for Western Washington for mulch layer requirements. Properly selected mulch material also reduces weed establishment, regulates soil temperatures and moisture, and adds organic matter to soil. Mulch should consist of compost in the bottom of

the facilities (compost is less likely to float than wood chip mulch and is a better source for organic materials).

3.8.7 Rain Garden Construction Criteria

During construction, it is critical to prevent clogging and over-compaction of the native soil, bioretention soils, rain garden soils, or amended soils. Additionally, excavation, soil placement, or soil amendment must not be allowed during wet or saturated conditions.

See Volume II, Section 3.3, and Section 3.4.7 of this volume for additional infiltration facility and bioretention area construction requirements that also apply to rain gardens.

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

3.9 Roof Downspout Controls

Description

Roof downspout controls include smaller, dispersed stormwater systems designed to infiltrate and/or disperse runoff from roof areas. Large lots in rural areas typically have enough area to infiltrate or disperse roof runoff. Lots created in urban areas will typically be smaller and have a limited amount of area in which to incorporate infiltration or dispersion trenches.

This section presents an overview of the types and applications of roof downspout controls. Additional details on specific BMPs are provided in subsequent sections.

3.9.1 Selection of Roof Downspout Controls

The feasibility or applicability of downspout infiltration and dispersion must be evaluated for all subdivision single-family lots. Single family subdivision projects subject to Minimum Requirement #5 or #7 (Volume I, Chapter 2) must provide for individual downspout infiltration, bioretention, rain garden, dispersion systems, or perforated stub-out connection systems where practicable.

3.9.2 Applications to Minimum Requirements

The feasibility and applicability of roof downspout controls must be evaluated for all projects subject to Minimum Requirement #5 (see Volume I, Chapter 2). Projects must provide for individual downspout infiltration, bioretention, rain garden, dispersion systems, or perforated stub-out connection systems where practicable. Where roof downspout controls are required or planned, the following three types must be considered in order of preference, per Minimum Requirement #5 (Note some of the following BMPs are discussed in other sections):

- Full Dispersion (see Volume VI, Section 2.3)
- Downspout infiltration systems (Section 3.9.3)
- Bioretention cells, swales and planter boxes (Section 3.4) or rain gardens (Section 3.8)
- Downspout dispersion systems (Section 3.9.4).
- Perforated stub-out connections (Section 3.9.5).

Other innovative downspout control BMPs such as rain barrels, ornamental ponds, downspout

cisterns, or other downspout water storage devices may also be used with prior approval by the county. Any alternative methods proposed will be required to meet the performance criteria of all applicable minimum requirements, particularly Minimum Requirements #5 or #7.

Downspout disconnection, dispersion, or perforated stub-outs will not be allowed in situations where the action could cause erosion or flooding problems, either on site or on adjacent lots. The design engineer must demonstrate that the proposed release rate will not have an adverse downstream impact. The county will review each proposal on a case-by-case basis due to the uniqueness of each site condition.

The following sections outline design information specific to roof downspout infiltration (Section 3.9.3), roof downspout dispersion (Section 3.9.4), and perforated stub-out connections (Section 3.9.5).

3.9.3 Downspout Infiltration Systems (Ecology BMP T5.10A)

Description

Downspout infiltration systems are trench or drywell designs intended only for use in infiltrating runoff from roof downspout drains. They are not designed to directly infiltrate runoff from pollutant-generating impervious surfaces. See Volume V, Chapter 6 for infiltration treatment requirements.

Applications and Limitations

- Downspout infiltration can be used to help meet the flow control standards of Minimum Requirement #7.
- When used in combination with other onsite stormwater management BMPs, downspout infiltration can also help achieve compliance with Minimum Requirement #5.

Modeling and Sizing

- If roof runoff is infiltrated according to the requirements of this section, the roof area may be discounted from the project area used for sizing stormwater facilities.
- Pierce County has developed standardized tables that can be used to facilitate sizing of infiltration trenches and drywells for smaller site applications. See Table 3.5 at the end of this section.
- All sites have the option to do their own engineered design in lieu of using Table 3.5 at the end of this section (in accordance with the design requirements presented below), subject to approval by the county.

Procedure for Evaluating Feasibility

Downspout infiltration is considered feasible on lots or sites that meet all the following:

- Site-specific tests must indicate that soils are not silty clay loam, clay loam, clay, or any other soil having a percolation rate slower than 1 inch per hour.
- Site-specific tests must indicate 12 inches or more of permeable soil from the proposed bottom (final grade) of the infiltration system to the seasonal high groundwater table or other impermeable layer. (Refer to the soil investigation requirements below.)
- The downspout infiltration system can be designed to meet the minimum design criteria

specified below.

A soils report must be prepared by one of the following professionals to determine if soils suitable for infiltration are present on the site:

- A professional soil scientist certified by the Soil Science Society of America (or an equivalent national program)
- A licensed onsite sewage designer
- A suitably trained person working under the supervision of a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington.

Refer to Volume I, Section 3.2.8 for general Soils Report content requirements. In addition, for downspout infiltration the soils investigation and report must evaluate the following:

1. Individual lot or site tests must consist of at least one soils log at the location of the infiltration system, a minimum of 4 feet in depth (from proposed grade), identifying the Natural Resources Conservations Service (NRCS – formerly the SCS) series of the soil and the USDA textural class of the soil horizon through the depth of the log, and noting any evidence of high groundwater level, such as mottling
2. Document that soils in the location of the proposed infiltration system are not silty clay loam, clay loam, clay, or any other soil having a percolation rate slower than 1 inch per hour.
3. For sites that use the sizing tables presented in Table 3.5 at the end of this section, no further soils infiltration testing is required

For sites that do not use the sizing tables presented in Table 3.5, the site infiltration rates must be determined using the procedures outlined in Appendix IIIA.

Downspout Infiltration System Design Criteria

The following standardized design criteria are intended to guide the applicant in providing an acceptable design for an individual downspout infiltration system. The standardized design criteria can only be used under the following conditions:

- The proposed site development does not result in a net increase in impervious surfaces of 5,000 square feet or more.
- The project has prepared a soils report as outlined above.
- The system is sized according to the sizing chart shown in Table 3.5 at the end of this section and the general guidelines below for trench or drywell designs.
- For sites with onsite or adjacent septic systems, the discharge point must be at least 30 feet upgradient, or 10 feet downgradient, of the drainfield primary and reserve areas. This requirement may be modified by the Tacoma-Pierce County Health Department if site topography clearly prohibits flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary.
- Systems shall be set back at least 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on the slope. The geotechnical assessment may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.
- All systems shall be a minimum of 10 feet away from any structure or property line.

Downspout Infiltration Trench System Design Criteria

The trench system is to be constructed according to the standard design shown in Attachments Section A, Detail 11.1.

Any deviation in design or construction from the items above or the standardized design criteria detailed below will result in it being required that the individual downspout infiltration be designed by a professional engineer in accordance with the guidelines presented in this volume.

Table 3.5 outlines an approved prescriptive design for downspout infiltration trenches that meet Pierce County flow control requirements. The tables present trench footprint areas based on various depths, contributing areas, and infiltration rates. All trenches must be constructed according to the standard design shown in Attachments Section A, Detail 11.1. Note that for roof areas that fall between the areas represented by each column in the table, the required trench footprint area may be interpolated based on the information in the tables. However, for infiltration rates that fall between the rates represented in each table, the designer must use the more conservative (i.e., lower) infiltration rate in their design. As noted previously, all sites have the option to do their own engineered design for infiltration trenches in lieu of using Table 3.5 at the end of this section, subject to approval by the county. In addition to the sizing requirements outlined in Table 3.5, the following design requirements apply to downspout infiltration trenches:

- Maximum length of trench must not exceed 100 feet from the inlet sump.
- Minimum spacing between distribution pipe centerlines must be 6 feet.
- Maximum spacing between distribution pipe centerlines must be 10 feet.
- The aggregate material for the infiltration trench shall consist of 0.75-inch to 1.5 inch diameter washed round rock that meets WSDOT Specification 903.12(5).
- Geotextile filter fabric shall be wrapped entirely around trench drain rock prior to backfilling EXCEPT that a 6inch layer of sand below the trench bottom may be used in-lieu of a geotextile filter fabric liner on the bottom.
- Infiltration trenches may be placed in fill material if the fill is placed and compacted under the direct supervision of a geotechnical engineer or professional civil engineer with geotechnical expertise, and if the measured infiltration rate is at least 8 inches per hour. Infiltration rates can be tested using the methods described in Appendix III-A.
- Provide a structure or cleanout at each end of the infiltration trench for accessibility to conduct inspections and maintenance.
- A structure with a sump (see Attachments Section A, Details 11.0 and 11.1) shall be located upstream of the trench, which provides a minimum of 12 inches of depth below the outlet riser. The outlet riser pipe bottom shall be designed so as to be submerged at all times, and a screening material shall be installed on the pipe outlet.

Trenches may be located under pavement if designed by a professional engineer. Trenches must include an overflow at least 1 foot below the pavement, and in a location which can accommodate the overflow without creating a significant adverse impact to downhill properties or drainage systems. This is intended to prevent saturation of the pavement in the event of system failure. The trench depth must be measured from the overflow elevation, not the ground surface elevation.

Downspout Infiltration Drywell System Design Criteria

- The drywell system is to be constructed according to the standard design shown in Attachments Section A, Detail 14.0.
- The drywell shall include a settling chamber (as shown in Detail 11.1), or its equivalent for particulate removal. If non-roof runoff is also draining to the drywell system, the contributing flows must also pass through a catch basin structure with a sump (see examples in Attachments Section A, Details 11.1 and 11.0).
- Typically drywells are 48 inches in diameter (minimum) and have a depth of 5 feet (4 feet of gravel and 1 foot of suitable cover material).
- Filter fabric (geotextile) must be placed on top of the drain rock and on trench or drywell sides prior to backfilling.
- Spacing between drywells must be a minimum of 4 feet measured from edge of gravel backfill.

Construction Criteria

See Volume II, Section 3.3 for infiltration facility construction requirements.

Verification of Performance

The project engineer or designee shall inspect infiltration systems before, during, and after construction as necessary to ensure facilities are built to design specifications, that proper procedures are employed in construction, that the infiltration surface is not compacted, and that protection from sedimentation is in place. If the project designee or County inspection indicate the facility will not function as designed, the County may require verification of performance testing as required for infiltration trenches in Section 2.5.2, as well as design modifications if needed.

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

Table 3.5. - Sizing Table for Downspout Infiltration Trenches.

Square Feet of Trench Bottom for Gravel/Type A Soils (30 in/ hour)

Total Depth Below Ground Surface [1] (ft)	Roof Area (square feet)									
	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	4,999
2.5	15	29	44	59	74	88	103	118	132	147
3.0	13	26	39	52	65	78	91	104	117	130
3.5	12	24	37	49	61	73	85	97	110	122
4.0	11	23	34	45	57	68	79	91	102	113
4.5	11	22	33	44	55	66	76	87	98	109
5.0	11	21	32	42	53	63	74	84	95	105
5.5	10	20	30	40	50	60	71	81	91	101

Square Feet of Trench Bottom for Medium Sand/Type A Soils (12 in/hour)

Total Depth Below Ground Surface [1] (ft)	Roof Area (square feet)									
	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	4,999
2.5	23	45	68	91	113	136	159	181	204	227
3.0	21	42	63	84	105	126	147	168	189	210
3.5	20	39	59	79	99	118	138	158	178	197
4.0	18	37	55	74	92	111	129	148	166	185
4.5	17	34	50	67	84	101	118	134	151	168
5.0	16	33	49	66	82	98	115	131	147	164
5.5	16	31	47	62	78	93	109	124	140	155

Square Feet of Trench Bottom for Loamy Sand/Type A Soils (4 in/hour)

Total Depth Below Ground Surface [1] (ft)	Roof Area (square feet)									
	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	4,999
2.5	43	87	130	173	216	260	303	346	389	433
3.0	40	80	120	160	200	239	279	319	359	399
3.5	37	74	111	148	185	222	259	296	333	370
4.0	34	69	103	138	172	207	241	276	310	344
4.5	33	66	98	131	164	197	229	262	295	328
5.0	31	62	93	124	155	187	218	249	280	311
5.5	29	59	88	118	147	176	206	235	265	294

Table 3.5. (cont.) - Sizing Table for Downspout Infiltration Trenches.

Square Feet of Trench Bottom for Loam/Type B Soils (2 in/hour)

Total Depth Below Ground Surface [1] (ft)	Roof Area (square feet)									
	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	4,999
2.5	65	130	195	260	326	391	456	521	586	651
3.0	60	121	181	242	302	363	423	484	544	605
3.5	56	113	169	225	281	338	394	450	507	563
4.0	53	106	159	212	265	318	371	423	476	529
4.5	50	101	151	202	252	302	353	403	454	504
5.0	48	96	144	192	239	287	335	383	431	479
5.5	45	91	136	181	227	272	318	363	408	454

Square Feet of Trench Bottom for Porous Silt Loam/Type C Soils (1 in/hour)

Total Depth Below Ground Surface [1] (ft)	Roof Area (square feet)									
	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	4,999
2.5	100	199	299	398	498	597	697	796	896	995
3.0	92	183	275	366	458	549	641	733	824	916
3.5	86	172	258	344	431	517	603	689	775	861
4.0	81	161	242	323	403	484	565	645	726	806
4.5	77	154	231	308	384	461	538	615	692	769
5.0	73	146	219	292	365	439	512	585	658	731
5.5	67	134	202	269	336	403	470	538	605	672

1 The “total depth below ground surface” is the depth of the trench bottom. The trench consists of gravel covered by 6 inches of compacted backfill. Hence, the gravel thickness is 6 inches less than the depth listed

3.9.4 Downspout Dispersion Systems (Ecology BMP T5.10B)

Description

Downspout dispersion systems are gravelfilled trenches or splashblocks, which serve to spread roof runoff over vegetated areas. Dispersion attenuates peak flows by slowing runoff entering into the conveyance system, allowing some infiltration, and providing some water quality benefits.

Applications and Limitations

- Downspout dispersion can be used to help meet the flow control standards of Minimum Requirement #7.
- When used in combination with other onsite stormwater management BMPs, downspout dispersion can also help achieve compliance with Minimum Requirement #5.
    - Note that for projects that are underlain by Spanaway soils[1], downspout dispersion systems designed per the requirements of this section may be considered as part of Option #2 in List #1 and List #2 for managing runoff from roof areas.
- The layout of the natural resource protection areas adjacent to and downgradient of individual lots can provide opportunities to disperse runoff into the natural resource protection area. However, when installed over Spanaway soils, the downspout dispersion BMP must have a slope of 10 percent or less.

Modeling and Sizing

If roof runoff is dispersed according to the requirements of this section on lots greater than 22,000 square feet, and over a vegetative flow path that is 50 feet or longer (for splashblocks) through undisturbed native landscape or lawn/landscape area that meets the soils criteria outlined in Section 3.1, the roof area may be modeled as grass/lawn surface. If the available vegetated flow path is 25 to 50 feet, use of a dispersion trench allows modeling the roof as 50 percent impervious/50 percent landscape.

Downspout Dispersion Design Criteria

General Downspout Dispersion Design Criteria

Refer to Section 3.2.1 for general dispersion design criteria. This section provides design criteria for both dispersion trenches and splashblocks:

- Each downspout dispersion trench shall have a separate flow path
- For the purpose of maintaining adequate separation of flows discharged from adjacent dispersion trenches, vegetated flow paths shall be at least 20 feet apart at the upslope end and must not overlap with other flow paths at any point along the flow path lengths
- See additional applicable dispersion area setbacks in Section 3.2.1.

Dispersion Trench Design Criteria

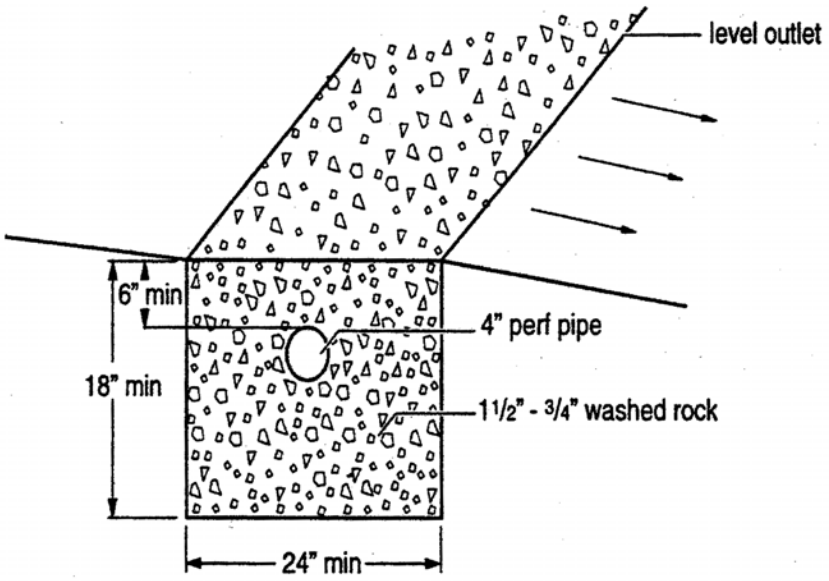
This section provides additional design criteria specific to dispersion trenches.

- Dispersion trenches shall be designed as shown in Figures 3.9a and 3.9b, and Attachments Section A, Detail 1.0.
- A vegetated flow path of at least 25 feet in length must be maintained between the outlet of a trench and any property line; structure; critical area (i.e., stream, wetland), or impervious surface.
- Trenches serving up to 700 square feet of roof area may be simple 10foot long by 2foot

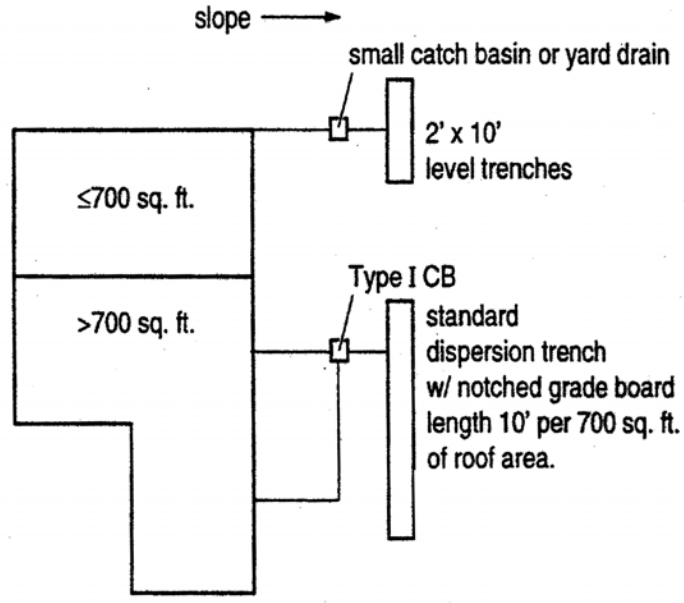
1 As defined by the Soils Survey of Pierce County Area (1979), and field verified and tested that percolation rates are greater than 30 in/hr by a professional soil scientist certified by the Soil Science Society of America (or an equivalent national program); a locally licensed onsite sewage designer; or by other suitably trained persons working under the supervision of a professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington

wide gravel filled trenches as shown in Figures 3.9a and 3.9b. For roof areas larger than 700 square feet, a dispersion trench with notched grade board as shown in Attachments Section A, Detail 1.0 shall be used. It is acceptable to have multiple downspouts routed to a dispersion trench. The total length of this design must not exceed 50 feet and must provide at least 10 feet of trench per 700 square feet of roof area. In both systems it is important to include a cleanout structure prior to discharge into the dispersal area. Although Figure 3.9a and Attachments Section A, Detail 1.0 refer at times to a Type 1 catch basin being used, it is also acceptable to utilize an equivalent type structure which includes a lid, 1foot minimum sump, and Ttype outlet with screen as shown in Attachments Section A, Detail 11. 1.

Figure 3.9a. - Typical Downspout Dispersion Trench.



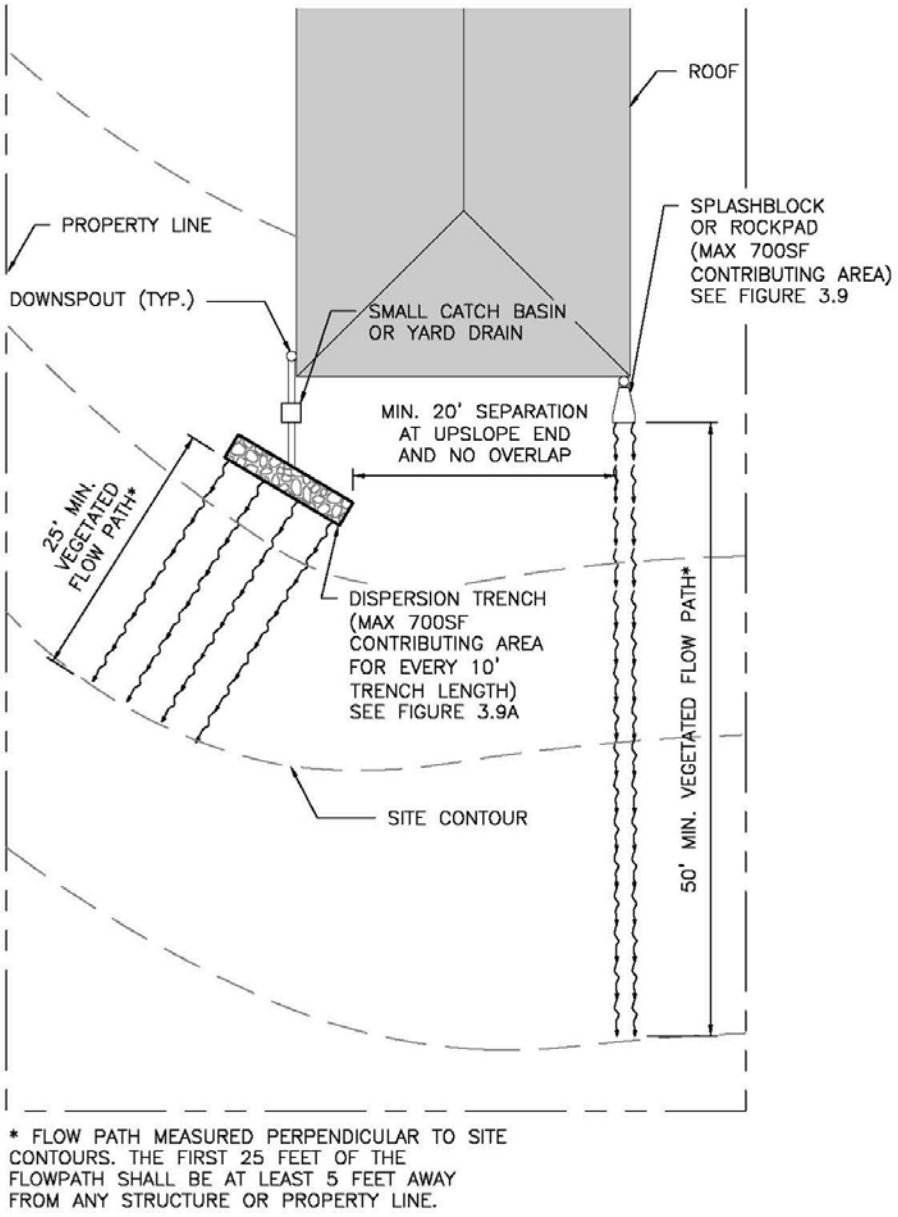
TRENCH X-SECTION
NTS



PLAN VIEW OF ROOF
NTS

See Attachment Section A, Detail 1.0

Figure 3.9b. - Typical Downspout Dispersion Trench.



Source: City of Seattle (reproduced with permission)

Splashblocks

This section provides additional design criteria specific to splashblocks.

- Splashblocks shown in Figure 3.10 may be used for downspouts discharging to a vegetated flow path at least 10 feet in width and 50 feet in length as measured from the downspout to the downstream property line; structure; critical areas (i.e., stream, wetland), or other impervious surface
- A maximum of 700 square feet of roof area may drain to each splashblock
- A splashblock or a pad of crushed rock (2 feet wide by 3 feet long by 6 inches deep) should be placed at each downspout discharge point.

Construction Criteria

See Volume II, Section 3.3 for dispersion facility construction requirements.

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

Figure 3.10. - Typical Downspout Splashblock Dispersion.

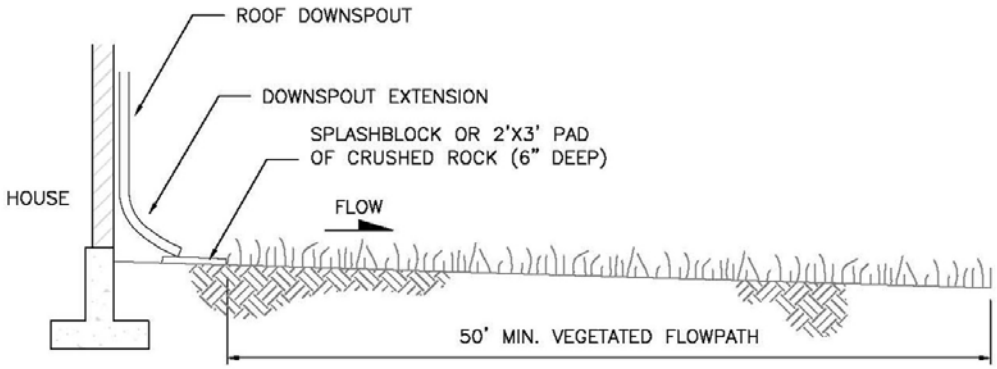


FIG 3.10 – TYPICAL DOWNSPOUT SPLASHBLOCK DISPERSION

Source: City of Seattle (reproduced with permission)

3.9.5 Perforated Stub-Out Connections (Ecology BMP T5.10C)

Description

A perforated stub-out connection is a length of perforated pipe within a gravel-filled trench that is placed between roof downspouts and a stub-out to the downstream drainage system. Figure 3.11 illustrates a perforated stub-out connection. These systems are intended to provide some infiltration during drier months. During the wet winter months, they may provide little or no flow control.

Applications and Limitations

- Perforated stub-outs are not appropriate where the highest estimated groundwater level or other impermeable layer is less than one foot below the trench bottom. In projects subject to Minimum Requirement #5 (see Volume I), perforated stub-out connections may be used only when all other higher priority onsite stormwater management BMPs are not feasible, per the criteria for each of those BMPs.
- Select the location of the connection to allow a maximum amount of runoff to infiltrate into the ground (ideally a dry, relatively well-drained location).
- To facilitate maintenance, do not locate the perforated pipe portion of the system under impervious or heavily compacted surfaces (e.g., driveways and parking areas). Use the same setbacks as for downspout infiltration systems (see Section 3.9.3), with the following modification to the setback from onsite or adjacent septic systems:
    - Apply the prescribed setbacks from onsite or adjacent septic systems to the perforated portion of the pipe (not the discharge point).
    - The perforated portion of the pipe may not be upgradient of the drainfield primary and reserve areas. This requirement can be waived if site topography will clearly prohibit flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary.
- Do not place the perforated portion of the pipe within 300 feet of an erosion hazard area, or a landslide hazard area (as defined by PCC Title 18E.80), or above slopes greater than 20 percent, unless the slope stability impacts of such systems have been analyzed and mitigated by a geotechnical professional, and appropriate analysis indicates that the impacts are negligible
- Perforated stub-outs are not appropriate where connecting pipe discharges to a stormwater facility designed to meet Minimum Requirement #7 Flow Control requirements.

Modeling and Sizing

Any flow reduction is variable and unpredictable. No computer modeling techniques are allowed that would predict any reduction in flow rates and volumes from the connected area.

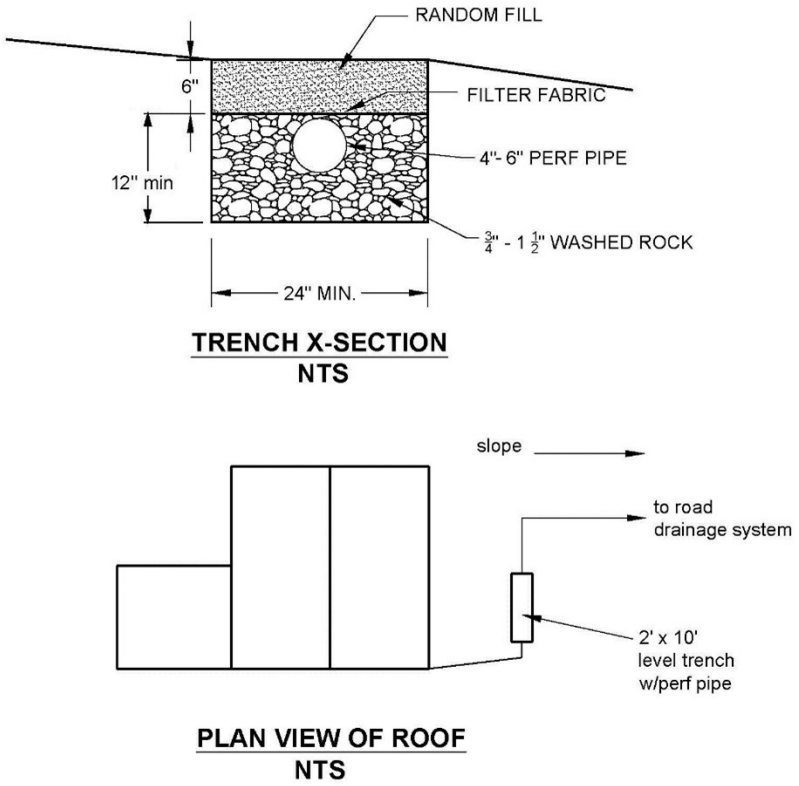
Perforated Stub-Out Design Criteria

Perforated stub-out connections consist of at least 10 feet of perforated pipe per 5,000 square feet of roof area laid in a level, 2-foot wide trench backfilled with 12-inch minimum depth of washed drain rock. Lay the 4 or 6 inch diameter perforated pipe level with 6 to 8 inches of drain rock below the bottom of the pipe. Cover the rock trench with filter fabric and minimum of 6 inches of fill (see Figure 3.11).

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements (refer to maintenance requirements for Infiltration Basins and Trenches).

Figure 3.11. - Perforated Stub- Out Connection.



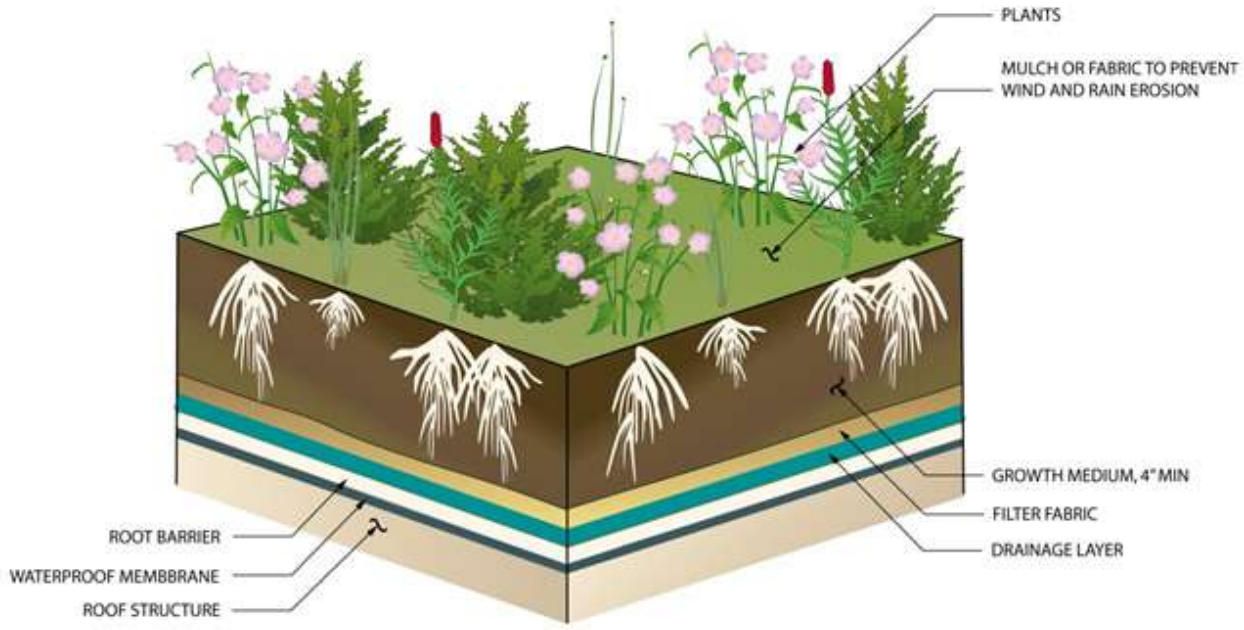
3.10 Vegetated Roofs (Ecology BMP T5.17)

3.10.1 Description

Vegetated roofs are areas of living vegetation installed on top of buildings, or other above-grade impervious surfaces. Vegetated roofs are also known as ecoroofs, green roofs, and roof gardens. Because vegetated roofs are an integral component of the building structure, and the design and construction approaches continue to get refined as this technology evolves, this section primarily focuses on the stormwater elements of vegetated roof design. Other technical resources are referenced in this section for additional guidance and information (such as the LID Technical Guidance Manual for Puget Sound).

A vegetated roof consists of a system in which several materials are layered to achieve the desired vegetative cover and stormwater management function (see Figure 3.12). Design components vary depending on the vegetated roof type and site constraints, but may include a waterproofing material, a root barrier, a drainage layer, a separation fabric, a growth medium (soil), and vegetation. Vegetated roofs are categorized by the depth and the types of courses used in their construction.

Figure 3.12. - Vegetated Roof.



Source: City of Seattle (reproduced with permission

- **Intensive roofs:** Intensive roofs are deeper installations, comprised of at least 6 inches of growth media and planted with ground covers, grasses, shrubs and sometimes trees.
- **Extensive roofs:** Extensive roofs are shallower installations, comprised of less than 6 inches of growth media and planted with a palette of drought-tolerant, low maintenance ground covers. Extensive vegetated roofs have lower weight than intensive roofs, and are typically the most suitable for placement on existing structures. Extensive systems are further divided into two types:
  - "Single-course" systems consist of a single media designed to be freely draining and support plant growth
  - "Multi-course" systems include both a growth media layer and a separate, underlying drainage layer.

The following types of vegetated roofs are acceptable for flow control applications in Pierce County:

- Extensive multi-course systems (and commercially available modular systems) with at least 4 inches of growth medium
- Extensive single-course systems with at least 4 inches of growth medium for areas less than 1,000 square feet.

3.10.2 Applications and Limitations

- Vegetated roofs can be used to help meet the flow control standards of Minimum Requirement #7.
- When used in combination with other onsite stormwater management BMPs, vegetated roofs can also help achieve compliance with Minimum Requirement #5.

- Vegetated roofs are generally applicable to roof slopes between 1 and 22 degrees (0.2:12 and 5:12).
- A primary consideration for the feasibility of vegetated roofs is the structural capability of the roof and building structure. Related factors, including design load, slipping and shear issues, and wind load, are outside the scope of this manual. Refer to PCC Title 17C Construction and Infrastructure Regulations – Building and Fire Codes and the IBC/IRC for structural requirements.

3.10.3 Modeling and Sizing

When using an approved continuous runoff model to quantify the onsite stormwater management and/or flow control performance of vegetated roofs, the assumptions listed in Table 3.6 must be applied. It is recommended that vegetated roofs be modeled as layers of aggregate with surface flows, interflow, and exfiltrating flow routed to an outlet.

The medium depth can be modified to achieve various degrees of flow control. Because the onsite stormwater management and flow control standards cannot typically be achieved using a vegetative roof, additional downstream flow control measures may be required.

Table 3.6. - Continuous Modeling Assumptions for Vegetated Roofs.

Variable	Assumption
Precipitation Series	Pierce County
Computational Time Step	15 minutes
Inflows to Facility	None
Precipitation and Evaporation Applied to Facility	Yes
Depth of Material (inches)	Growth medium/soil depth (minimum of 4 inches).
Vegetative Cover	Ground cover or shrubs. Shrubs are appropriate only when growth medium is at least 6 inches.
Length of Rooftop (ft)	The length of the surface flow path to the roof drain
Slope of Rooftop (ft/ft)	The slope of the vegetated roof
Discharge from Facility	Surface flow, interflow and exfiltrated flow from vegetated roof module routed to downstream BMP or point of compliance. Note that the exfiltrated flow (flow infiltrated through the media and collected by the drainage layer) is tracked as “groundwater” in WWHM.

3.10.4 Vegetated Roof Design Criteria

The following sections provide a description and general specifications for the common components of vegetated roofs. Typical components of a vegetated roof are shown in Figure 3.12. Design criteria are provided in this section for the following elements:

- Roof slope
- Vegetation
- Growth medium
- Drainage layer
- Drain system and overflow

While vegetated roofs will include additional system components (e.g., waterproof membrane, root barrier, separation fabric for multi-course systems), the design and construction

requirements for these components are outside of the scope of this manual. Refer to the LID Technical Guidance Manual for Puget Sound for a more detailed description of the components of and design criteria for vegetated roofs, as well as additional references and design guidance.

Roof Slope

Vegetated roofs can be applied to a range of rooftop slopes; however, steeper slopes may result in reduced flow control performance and may warrant a more complicated design (e.g., lateral support measures). Roofs with slopes between 5 and 22 degrees (1:12 and 5:12) are the easiest to install, are the least complex, and generally provide the greatest stormwater storage capacity per inch of growth medium.

For flow control compliance, the roof slope must be between 1 and 22 degrees (0.2:12 and 5:12). Roofs with slopes greater than 10 degrees (2H:12V) require an analysis of engineered slope stability.

Vegetation

Vegetation used on extensive vegetated roofs should be drought tolerant, self-sustaining, low maintenance, and perennial or self-sowing. Appropriate plants should also be able to withstand heat, cold, periodic inundation and high winds. Vegetation with these attributes typically includes succulents, grasses, herbs, and wildflowers that are adapted to harsh conditions. Refer to the LID Technical Guidance Manual for Puget Sound for additional vegetation guidance for vegetated roofs.

Minimum requirements associated with vegetation design include the following:

- Plans must specify that vegetation coverage of selected plants must achieve 90 percent coverage within 2 years or additional plantings must be provided until this coverage requirement is met
- Plant spacing and plant size must be designed to achieve specified coverage by a licensed landscape architect
- Vegetation must be suitable for rooftop conditions (e.g., hot, cold, dry, and windy)
- Plants must not require fertilizer, pesticides or herbicides after 2year establishment period.

Growth Medium

Vegetated roofs use a light-weight growth medium with adequate fertility and drainage capacity to support plants and allow filtration and storage of water. Growth medium composition (fines content and water holding capacity) is key to flow control performance. Refer to the LID Technical Guidance Manual for Puget Sound for additional guidance on growth medium design.

Minimum requirements associated with the growth medium design include the following:

- The growth medium must be a minimum of 4 inches deep
- Growth medium depth and characteristics must support growth for selected plant species and must be approved by a licensed landscape architect
- Vegetated roofs must not be subject to any use that will significantly compact the growth medium
- Unless designed for foot traffic, vegetated roof areas that are accessible to the public must be protected (e.g., signs, railing, and fencing) from foot traffic and other loads

- Mulch, mat, or other measures to control erosion of growth media must be maintained until 90 percent vegetation coverage is achieved.

Drainage Layer

Intensive and extensive multi-course vegetated roof systems must include a drainage layer below the growth medium. The drainage layer is a multipurpose layer designed to provide void spaces to hold a portion of the water that passes through the growth medium and to channel the water to the roof drain system. The drainage layer can consist of a layer of aggregate or a manufactured mat or board that provides an open free-draining area. Many manufactured products include "egg carton" shaped depressions that retain a portion of the water for eventual evapotranspiration. Refer to the LID Technical Guidance Manual for Puget Sound for additional guidance on drainage layer design.

Drain System and Overflow

Vegetated roofs must be equipped with a roof drainage system capable of collecting subsurface and surface drainage and conveying it safely to a downstream BMP or an approved point of discharge. To facilitate subsurface drainage, interceptor drains are often installed at a regular spacing to prevent excessive moisture build up in the media and convey water to the roof drain. Roof outlets must be protected from encroaching plant growth and loose gravel, and must be constructed and located so that they are permanently accessible.

3.10.5 Construction Criteria

The growth medium must be protected from over compaction during construction.

3.10.6 Operations and Maintenance Criteria

Vegetated roofs are designed to need very little maintenance and if designed correctly should have a longer lifespan than traditional roofs because of the protective nature of the soil structure. Inspections still should be performed regularly to identify any leakage of the membrane system or blockages of the overflow system. See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

3.11 Roof Rainwater Collection Systems (Ecology BMP T5.20)

3.11.1 Description

Roof rainwater collection systems are designed to collect stormwater runoff from non-polluting surfaces (typically roofs), and to make use of the collected water. Reuse of the runoff can be for irrigation, potable, and non-potable uses, but requires different levels of storage and water quality treatment depending on the intended use. Rainwater collection systems have been designed and installed in many locations throughout the northwest, including Pacific Plaza in Tacoma, and the Bullitt Center in Seattle. The most abundant use of water collection and reuse systems in the northwest has been on some of the island communities where potable water is scarce. In these cases, the systems have been sized and designed to capture all rooftop runoff with adequate treatment for reuse as a potable water source. Rainwater collection and reuse systems are also commonly referred to as "rainfall catchment" and "rainwater harvesting" systems.

Because of the wide variety of uses and scenarios that can apply to rooftop rainwater collection

and use, this section primarily focuses on the stormwater elements of rainwater collection design. Additional guidance and information on issues such as modeling indoor water use can be found in the LID Technical Guidance Manual for Puget Sound (and other resources).

3.11.2 Applications and Limitations

- Rainwater collection systems can be used to help meet the flow control standards of Minimum Requirement #7.
- When used in combination with other onsite stormwater management BMPs, Rainwater collection systems can also help achieve compliance with Minimum Requirement #5.
- Rainwater collection systems can also be an effective volume reduction practice for projects where infiltration is not permitted or desired.
- Rainwater collection has higher stormwater management benefits when designed for uses that occur regularly through the wet season (e.g., toilet flushing and cold water laundry).
- Highly developed areas or commercial centers where larger buildings, especially multistory buildings, encompass nearly all of the area are highly suitable for rainwater collection systems where it might not be feasible to preserve natural protection areas. In these areas, any type of stormwater management is expensive due to the high cost of land and therefore the cost of a rainwater collection and reuse system can be more competitive.
- Roof rainwater collection systems have the additional benefit of decreasing demands on the treated potable water supply.
- Use of a roof rainwater collection system as a potable source will require approval by the Washington State Department of Health and/or the Tacoma-Pierce County Health Department.

Although use of rain barrels for capturing rainfall can be beneficial for providing a small amount of irrigation and also provide an educational aspect to the benefits of water reuse, they generally do not provide enough storage of seasonal runoff to be considered to meet the performance goals of Minimum Requirement #5 or #7, or the general performance requirements of LID projects, unless prior approval is obtained from the county.

3.11.3 Modeling and Sizing

- Roof rainwater collection systems must be sized according to roof area, monthly rainfall patterns, and anticipated water usage of connected plumbing facilities. To estimate the storage volume required, the volume of rainfall off the roof surface should be plotted over time against curves showing the amount of water use anticipated. Use monthly average rainfall for Pierce County, shown in Table 3.7.

Table 3.7. - Pierce County Monthly Average Rainfall.

January	5.74 inches	July	0.96 inches
February	4.21 inches	August	1.2 inches
March	4.12 inches	September	1.91 inches
April	3.27 inches	October	3.27 inches
May	2.49 inches	November	6.21 inches
June	2.20 inches	December	5.76 inches

Note: The rainfall depths above represent the average monthly rainfall from 1941 – 2013.

- Rainwater collection systems also experience water losses due to roofing material texture, evaporation, and inefficiencies in the collection process, which can account for up to a 25 percent loss of annual rainfall. As noted previously, additional guidance and information on modeling and sizing for indoor water use can be found in the LID Technical Guidance Manual for Puget Sound (and other resources).

3.11.4 General Roof Rainwater Collection System Design Criteria

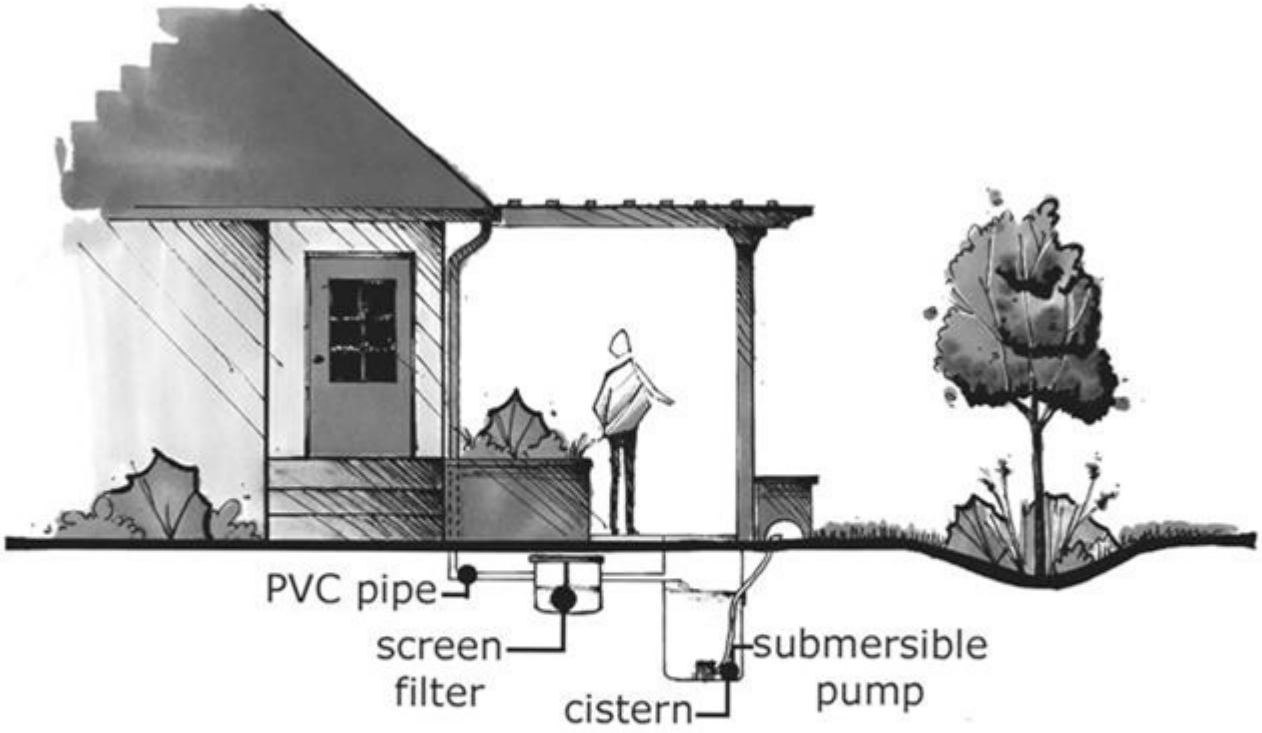
Rainwater collection systems can be designed as part of the foundation to fit under the house (adding about 1 foot in height), or can be placed next to the house, either above or below ground. When the storage of runoff is incorporated into the building design it shall be approved as part of the building permit. Figure 3.13 provides an illustration of an example cistern installation.

- Rainwater reuse systems that supply non-potable water should be designed to augment the supply of treated water and therefore should be designed to use the stored rainfall runoff first and use the treated water supply when the rainfall runoff is depleted
- Refer to the LID Technical Guidance Manual for Puget Sound for additional guidance for design of rainwater harvesting systems and cistern design requirements specific to indoor use of harvested rainwater.

3.11.5 Construction Criteria

Rainwater harvesting systems must be constructed according to the manufacturer's recommendations, the I-Codes, and all applicable laws.

Figure 3.13. - Cistern.



CISTERN
N.T.S.
10 - 17

3.11.6 Operations and Maintenance Criteria

Maintenance covenants shall provide for annual inspections of systems to assure pumps and filters are working properly and the design level of water quality is being maintained.

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.

3.12 Detention Facilities

This section presents the methods, criteria, and details for design and analysis of detention facilities. These facilities provide for the temporary storage of increased surface water runoff resulting from development pursuant to the performance standards set forth in Minimum Requirement #7 for flow control (Volume I).

There are three primary types of detention facilities described in this section: detention ponds, tanks, and vaults.

3.12.1 Detention Ponds

The design criteria in this section apply to detention ponds. However, many of the criteria also apply to infiltration basins (Section 3.7), and water quality wet ponds and combined detention/ wet ponds (see Volume V). Standard details for detention ponds and key detention pond structures are provided in Attachments Section A, Details 5.1 (pond detail), 7.0 (overflow spillway detail), and 16.0 (overflow structure detail). Control structure design requirements are provided in Section 3.12.4.

Methods of Analysis

Detention Volume and Outflow. The volume and outflow design for detention ponds must be in accordance with Minimum Requirements #7 in Volume I and the hydrologic analysis and design methods in Chapter 2 of this volume. Design guidelines for restrictor orifice structures are given in Section 3.12.4.

Note: The design water surface elevation is the highest elevation which occurs in order to meet the required outflow performance for the pond.

Detention Ponds in Infiltrative Soils. Detention ponds may occasionally be sited on till soils that are sufficiently permeable for a properly functioning infiltration system (see Section 2.5). These detention ponds have a surface discharge and may also utilize infiltration as a second pond outflow. Detention ponds sized with infiltration as a second outflow must meet all the requirements of Section 2.5 for infiltration basins, including a soils/geotechnical report, testing, groundwater protection, presettling, and construction techniques.

Emergency Overflow Spillway Capacity. For impoundments under 10acre-feet, the emergency overflow spillway weir section must be designed to pass the 100year recurrence interval runoff event for developed conditions assuming a broad-crested weir. The broad-crested weir equation for the spillway section (see also Attachments Section A, Detail 7.0), for example, would be:

$$Q_{100} = C\,(2g)^{1/2}\left[\frac{2}{3}LH^{3/2} + \frac{8}{15}(\mathrm{Tan}\theta)\,H^{5/2}\right] \qquad \text{(equation 1)}$$

Where:

- Q_{100} = peak flow for the 100-year recurrence interval runoff event (cubic feet per second) indicated by an approved continuous runoff model using a 15-minute time step.
- C = discharge coefficient (0.6)
- g = gravity (32.2 ft/sec^2)
- L = length of weir (ft)
- H = height of water over weir (ft)
- θ = angle of side slopes

Assuming $C = 0.6$ and $\mathrm{Tan}\,\theta = 3$ (for 3:1 slopes), the equation becomes:

$$Q_{100} = 3.21[LH^{3/2} + 2.4\,H^{5/2}] \qquad \text{(equation 2)}$$

To find width L for the weir section, the equation is rearranged to use the computed Q_{100} and trial values of H (0.2 feet minimum):

$$L = [Q_{100}/(3.21H^{3/2})] - 2.4\,H \quad \text{or} \quad 6 \text{ feet minimum} \qquad \text{(equation 3)}$$

Dam Safety for Detention BMPs

Stormwater facilities that can impound 10 acre-feet (435,600 cubic feet; 3.26 million gallons) or more with the water level at the embankment crest are subject to the state's dam safety requirements, even if water storage is intermittent and infrequent (Washington Administrative Code [WAC] 173175020(1)). The principal safety concern is for the downstream population at risk if the dam should breach and allow an uncontrolled release of the pond contents. Peak flows from dam failures are typically much larger than the 100year flows which these ponds are typically designed to accommodate.

In addition to the hydrologic and hydraulic issues related to precipitation and runoff, other dam safety requirements include geotechnical issues, construction inspection and documentation, dam breach analysis, inundation mapping, emergency action planning, and periodic inspections by project owners and by dam safety engineers. It is recommended and requested that dam safety be contacted early in the facilities planning process. Electronic versions of the guidance documents in PDF format are available on Ecology's Website.

General Detention Design

- Ponds must be designed as flow-through systems (however, parking lot storage may be utilized through a back-up system; see Section 3.12.5). Developed flows must enter through a conveyance system separate from the control structure and outflow conveyance system. Maximizing distance between the inlet and outlet is encouraged to promote sedimentation.
- Pond bottoms must be level and be located a minimum of 0.5 foot (preferably 1 foot) below the inlet and outlet to provide sediment storage.
- Design guidelines for outflow control structures are specified in Section 3.12.4.
- All detention ponds, vaults, and tanks are required to include a crest gauge that will record maximum pond water surface elevation after a storm event. See Attachments Section A, Detail 25.0 for crest gauge details. In addition, project submittals must include a table that identifies the design facility stage expected for the 2-, 5-, 10-, 25-, 50-, and 100year recurrence interval flows.
- A geotechnical assessment and soils report must be prepared for work located within 300 feet of the top of a steep slope, erosion hazard, or landslide hazard area (as defined in PCC Title 18E.80). The scope of the soils report shall include the assessment of impoundment seepage on the stability of the natural slope where the facility will be located within the setback limits set forth in this section.
- Drainage facilities should be made attractive features of the urban environment. To this end, engineers are encouraged to be creative in shaping and landscaping facilities and to consider aesthetics when choosing alternatives for parking lot paving, conveyance systems, detention facilities, weirs, structures, etc.

Side Slopes

- Interior side slopes up to the emergency overflow water surface shall not be steeper than 3H:1V unless a fence is provided (see "fencing").
- Exterior side slopes must not be steeper than 2H:1V unless analyzed for stability by a geotechnical engineer.
- Pond walls may be vertical retaining walls, provided: (a) they are constructed of reinforced

concrete per Section 3.12.3, Material; (b) a fence is provided along the top of the wall; (c) the entire pond perimeter may be retaining walls, however, it is recommended that at least 25 percent of the pond perimeter be a vegetated soil slope not steeper than 3H:1V; (d) the design is stamped by a licensed civil engineer with structural expertise; (e) an access ramp to the bottom of the pond is provided. Other retaining walls such as rockeries, concrete, masonry unit walls, and keystone type wall may be used if designed by a geotechnical engineer or a civil engineer with structural expertise.

Embankments

Pond berm embankments shall satisfy the following criteria:

- Construct pond berm embankments on native consolidated soil (or adequately compacted and stable fill soils analyzed by a geotechnical assessment), which is free of loose surface soil materials, roots and other organic debris.
- Construct pond berm embankments by excavating a "key" equal to 50 percent of the berm embankment cross-sectional height and width (except on till soils where the "key" minimum depth can be reduced to 1 foot of excavation into the till).
- Pond berm embankment cores shall be constructed of compacted soil (a minimum of 95 percent of the maximum dry density, standard proctor method per American Society for Testing and Materials [ASTM] D1557) placed in 6inch lifts, with the following soil characteristics per the USDA's textural triangle: a minimum of 30 percent clay, a maximum of 60 percent sand, a maximum of 60 percent silt, with nominal gravel and cobble content or as recommended by a geotechnical engineer. (Note: in general, excavated glacial till will be well-suited for berm embankment material.) The core shall be adequate to make the embankment impervious.
- Place anti-seepage collars on outflow pipes in berm embankments impounding water greater than 8 feet in depth at the design water surface.
- Exposed earth on the pond side slopes shall be sodded or seeded with appropriate seed mixture (see Volume II, Erosion and Sedimentation Control BMPs). Establishment of protective vegetative cover shall be ensured with appropriate surface protection BMPs and reseeded as necessary.
- Where maintenance access is provided along the top of the berm, the minimum width of the top of the berm shall be 15 feet.
- Pond berm embankments greater than 6 feet in height shall be designed by a professional engineer with geotechnical expertise.
- Embankments less than 6 feet in height shall have a minimum 6foot top width and slopes not to exceed 2H:1V. However, maintenance access for mowing and pond access must still be provided.
- Embankments adjacent to a stream or other body of water shall be sufficiently protected with riprap or bioengineering methods to prevent erosion of the pond embankment. Other control measures may be necessary to protect the embankment.
- Exterior and interior side slopes of retention and detention ponds that are steeper than 2H:1V, must be analyzed for stability by a qualified civil or geotechnical engineer.

Anti-seepage filter-drain diaphragms must be placed on outflow pipes in berm embankments

impounding water with depths greater than 8 feet at the design water surface. See Dam Safety Guidelines, Part IV, Section 3.3.B. An electronic version of the Dam Safety Guidelines is available on Ecology's website.

Overflow

- Provide a primary overflow (usually a riser pipe within the control structure; see Section 3.12.4) in all ponds, tanks, and vaults to bypass the 100year recurrence interval developed peak flow over or around the restrictor system. This assumes the facility will be full due to plugged orifices or high inflows; the primary overflow is intended to protect against breaching of a pond embankment (or overflows of the upstream conveyance system in the case of a detention tank or vault). The design must provide controlled discharge directly into the downstream conveyance system or another acceptable discharge point.
- Provide a secondary inlet to the control structure in ponds as additional protection against overtopping should the inlet pipe to the control structure become plugged. A grated opening ("jailhouse window") in the control structure manhole functions as a weir when used as a secondary inlet. Note: The maximum circumferential length of this opening must not exceed one-half the control structure circumference. The "birdcage" overflow structure may also be used as a secondary inlet (see also Attachments Section A, Detail 16.0).

Emergency Overflow Spillway

- In addition to the above overflow provisions, ponds must have an emergency overflow spillway. For impoundments of 10 acre-feet or greater, the emergency overflow spillway must meet the state's dam safety requirements. For impoundments less than 10 acre-feet, ponds must have an emergency overflow spillway that is sized to pass the 100year recurrence interval developed peak flow in the event of total control structure failure (e.g., blockage of the control structure outlet pipe) or extreme inflows. Emergency overflow spillways are intended to control the location of pond overtopping and direct overflows back into the downstream conveyance system or other acceptable discharge point.
- Provide emergency overflow spillways for ponds with constructed berms over 2 feet in height, or for ponds located on grades in excess of 5 percent. As an option for ponds with berms less than 2 feet in height and located at grades less than 5 percent, emergency overflow may be provided by an emergency overflow structure, such as a Type II manhole fitted with a birdcage as shown in Attachments Section A, Detail 16.0. The emergency overflow structure must be designed to pass the 100year recurrence interval developed peak flow, with a minimum 6 inches of freeboard, directly to the downstream conveyance system or another acceptable discharge point. Where an emergency overflow spillway would discharge to a steep slope, consideration shall be given to providing an emergency overflow structure in addition to the spillway.
- Armor the emergency overflow spillway with riprap in conformance with "BMP C209: Outlet Protection" in Volume II. The spillway must be armored full width, beginning at a point midway across the berm embankment and extending downstream to where emergency overflows reenter the conveyance system (see Attachments Section A, Detail 7.0).
- Emergency overflow spillway designs must be analyzed as broad-crested trapezoidal weirs as described in Methods of Analysis at the beginning of this section.
- Design the emergency overflow spillway to allow a minimum of 1 foot of freeboard above the design water surface elevation.

Access

Pond Access Roads

Pond access roads shall provide access to all drainage structure(s) and alongside the pond for vehicular maintenance access to each pond cell. In addition, pond access roads are required around the entire pond perimeter in order to provide complete vehicular access to all points of the pond requiring regular maintenance, inspection, and repairs. Regular maintenance is considered activities that will be done on a regular basis such as vegetation control where removed vegetation will need to be loaded into a truck for removal. Because each site condition and design is unique there may be cases where the perimeter road is not necessary because no regular maintenance will be anticipated. In these cases the designer may request to waive the perimeter road requirement by submitting a conceptual pond layout and a narrative which demonstrates that where the perimeter road is being eliminated, no regular maintenance activities are anticipated. Approval will be at the discretion of the County Engineer.

Pond access roads shall be located in the same tracts when the ponds themselves are in tracts. When ponds are located in open space, the pond access roads may be located in open space also, provided that they are constructed so as to be aesthetically compatible with the open space use.

Pond Access Road Design Guidelines

Access roads shall be a minimum of 15 feet in width. Perimeter roads may be 12 feet in width where not accessing a structure or being used for a circular loop road in lieu of turn around. Access roads may be constructed with an asphalt, gravel surface, or modular pavers. However, access to all control structures, catch basins, and other drainage structures associated with the pond (e.g., inlet or bypass structures) must be via an asphalt surface designed to support heavy loads including vactor trucks. Access to an emergency spillway is not required to be asphalt surface. A paved apron must be provided where access roads connect to paved public roadways. The inside road radius for access roads to ramps and all drainage structures shall not be less than 40 feet. Inside road radius for perimeter access roads shall not be less than 25 feet.

Manhole and catch basin lids must be in or at the edge of the access road and at least 3 feet from a property line.

When the length of a pond access road to a drainage structure or pond exceeds 75 feet, a vehicle turn-around must be provided, designed to accommodate vehicles having a maximum length of 31 feet and having an inside wheel path radius of 40 feet. The vehicle turn around requirement may be waived if the access road around the perimeter of the pond is entirely paved, and can be used in a continuous drive back to the entrance with no turnarounds.

Access roads to all drainage structures shall have a maximum slope of 12 percent. See Attachments Section A, Detail 21.0 for turn-around details.

Pond Access Gates or Bollards

Vehicle access shall be limited by a double gate if a pond is fenced or by bollards if the pond is not fenced. A minimum of one locking access road gate shall be provided that meets WSDOT State Standard Plan L30.10. Gates may be 14, 16, 18, or 20 feet in width. Bollards shall consist of two fixed bollards, on the outside of the access road and two removable bollards equally spaced between the fixed bollards (or all four removable if placed in the traveled way).

Access gates and bollards must be set 20 feet back from property line where the road it is connecting from is posted 35 mph or greater (Arterials).

Access Ramps

Pond access ramps shall be provided to all cells unless all of following conditions apply: cell bottoms are accessible or reachable by trackhoes from the perimeter access road, a truck can be loaded without the truck accessing the bottom of the cell, and no point in the bottom of the cell is more than 40 feet from the center of the access road. Trackhoe maximum reach from an access road is 20 feet. Cell bottoms will be considered accessible where at least one of the side slopes of the cell is no steeper than 3H:1V. Truck loading will be considered achievable where the cell depth (measured as bottom of cell to access road surface) is 4 feet or less at a point along the pond perimeter where a truck can be parked and loaded.

Access Ramp Design Guidelines

The access ramp shall have a minimum width of 15 feet and a maximum grade of 15 percent if paved. If the access ramp happens to be the only access to a control structure, catch basin, or other drainage structure it must be asphalt. An alternate ramp surface can be constructed with a maximum slope of 12 percent by laying a geotextile fabric over the native soil, placing quarry spalls (2 to 4inch) six inches thick, then providing a 2inch thick crushed rock surface.

When a ramp is required (see above), the ramp must extend to the pond bottom if the cell bottom is greater than 1,500 square feet (measured without the ramp). If the pond bottom is less than 1,500 square feet (measured without the ramp), the ramp may end at an elevation 4 feet above the cell bottom.

The internal berm of a wet pond or combined detention and wet pond may be considered the maintenance access to the next cell if the following conditions are met:

- The berm is no more than 4 feet above either cell bottom
- The berm is designed to support the weight of a trackhoe (considering the berm is normally submerged and saturated)
- The berm side slopes are no steeper than 3H:1V.

Fencing

- A fence is required around all public stormwater facility tracks. On private facilities fences need only be constructed for those slopes steeper than 3H:1V, at the emergency overflow water surface elevation, or higher.
- A fence is also required where a pond impoundment wall is greater than 24 inches in height.
- Other regulations such as the International Building Code (IBC) may require fencing of vertical walls. If more than 10 percent of slopes are steeper than 3H:1V, it is recommended that the entire pond be fenced.
- Detention ponds on school sites will need to comply with safety standards developed by the Washington State Department of Health (DOH) and the superintendent for public instruction. These standards include what is called a “non-climbable fence.” One example of a non-climbable fence is a chain-link fence with a tighter mesh, so children cannot get a foot-hold for climbing. For school sites, and possibly for parks and playgrounds, the designer should consult the DOH’s Office of Environmental Programs.
- Fences discourage access to portions of a pond where steep side slopes (steeper than 3:1) increase the potential for slipping into the pond. Fences also serve to guide those who have

fallen into a pond to side slopes that are flat enough (flatter than 3:1 and unfenced) to allow for easy escape.

- Fencing of public drainage ponds shall consist of a minimum 6foot-high chain link fence Type 1, per Attachments Section A, Detail 24.0. Fencing of tracts within the clear zone of roads with design speeds of 35 mph or higher shall use chain link fence Type 3 (modified, per Attachments Section A, Detail 24.1). Access shall be provided as specified in the previous section. Any fencing shall be placed at the tract or easement boundary, and where applicable a minimum of 5 feet from the top slope catch point.
- Any pipe stem access to a basin shall be fenced with a WSDOT Type 4 chain link fence with a 14foot gate. Access shall be provided as specified in the previous section.
- Pedestrian access gates (if needed) shall be a minimum of 4 feet in width and meet WSDOT State Standard Plan L3.
- Fence material shall be No. 9 gauge galvanized steel fabric with bonded vinyl coating. Vinyl coating shall be green or black. All posts, cross bars, fasteners, and gates shall be painted or coated the same color as the vinyl clad fence.
- For metal baluster fences, IBC standards apply.
- Wood fences may be used in subdivisions where the fence will be maintained by homeowners' associations or adjacent lot owners.
- Wood fences shall have pressure treated posts (ground contact rated) either set in 24inch deep concrete footings or attached to footings by galvanized brackets. Rails and fence boards may be cedar, pressure-treated fir, or hemlock.

Signage

Detention ponds, infiltration basins, wet ponds, and combined ponds shall have a sign placed for maximum visibility from adjacent streets, sidewalks, and paths. An example of sign specifications for a permanent surface water control pond is illustrated in Attachments Section F. For private facilities show the owner's name and contact information. For homeowners' associations, the contact can be a residence address, P.O. Box, or email address. Contact the county for open space and landscaping criteria.

Right-of-Way

Right-of-way may be needed for detention pond maintenance. It is recommended that any tract not abutting public right-of-way have 15 to 20foot wide extension of the tract to an acceptable access location.

Setbacks

All setbacks shall be horizontal unless otherwise specified.

All detention ponds shall maintain minimum setback distances as follows unless modified with written approval by the TPCHD for wells and septic:

- 1 foot positive vertical clearance from maximum water surface to structures within 25 feet.
- 5 feet from maximum water surface to septic tank or distribution box.
- 10 feet from maximum water surface to property lines and onsite structures.

- 10 feet from maximum water surface to building sewer.
- 10 feet from maximum water level location to nearest tract property boundary lines.
- 30 feet from maximum water surface to septic drainfields and drainfield reserve areas for single family onsite sewage disposal systems.
- 100 feet from maximum water surface to septic drainfields and drainfield reserve areas for community onsite sewage disposal systems.
- 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on the slope. The geotechnical assessment may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.
- 100 feet from well to stormwater control and water quality facility, maximum water surface.

In addition, all stormwater vaults and tanks shall be a setback from any structure or property line a distance equal to the depth of the ground disturbed in setting the structure. Vaults and tanks shall also be within tracts or easements with widths equivalent to those listed for conveyance systems in Section 4.6.

Seeps and Springs

Intermittent seeps along cut slopes are typically fed by a shallow groundwater source (interflow) flowing along a relatively impermeable soil stratum. These flows are storm driven and should discontinue after a few weeks of dry weather. However, more continuous seeps and springs, which extend through longer dry periods, are likely from a deeper groundwater source. When continuous flows are intercepted and directed through flow control facilities, adjustments to the facility design may have to be made to account for the additional baseflow (unless already considered in design).

Planting Requirements

Sod or seed exposed earth on the pond bottom and interior sides with an appropriate seed mixture. Plant all remaining areas of the tract with grass or landscape and mulch with a 3inch cover of hog fuel or shredded wood mulch (note: if implementing soil preservation and amendment in replanted areas per Section 3.1, 2-4 inches of hog fuel/woodchip mulch is required). Shredded wood mulch is made from shredded tree trimmings, usually from trees cleared on site. The mulch must be free of garbage and weeds and shall not contain excessive resin, tannin, or other material detrimental to plant growth. Do not use construction materials wood debris or wood treated with preservatives for producing shredded wood mulch.

Landscaping

Landscaping is encouraged for most stormwater tract areas (see below for areas not to be landscaped). However, if provided, landscaping should adhere to the criteria that follow so as not to hinder maintenance operations. Landscaped stormwater tracts may, in some instances, provide a recreational space. In other instances, “naturalistic” stormwater facilities may be placed in open space tracts. In addition, the community plans identified in PCC Title 18J must be reviewed for possible additional area-specific requirements.

Follow these guidelines if landscaping is proposed for facilities:

- Do not plant trees or shrubs on berms meeting the criteria of dams regulated for safety.
- Do not plant trees and shrubs within a Public stormwater tract.
- Do not plant trees or shrubs within 10 feet of inlet or outlet pipes or manmade drainage structures such as spillways or flow spreaders. Species with roots that seek water, such as willow or poplar, shall be avoided within 50 feet of pipes or manmade structures.
- Restrict planting on berms that impound water permanently or temporarily during storms. This restriction does not apply to cut slopes that form pond banks, only to berms.
    - Do not plant trees or shrubs on portions of waterimpounding berms taller than 4 feet high. Plant only grasses on berms taller than 4 feet.
    - Grasses allow unobstructed visibility of berm slopes for detecting potential dam safety problems such as animal burrows, slumping, or fractures in the berm.
    - Trees planted on portions of water-impounding berms less than 4 feet high must be small, not higher than 20 feet mature height, and have a fibrous root system. These trees reduce the likelihood of blow-down trees, or the possibility of channeling or piping of water through the root system, which may contribute to dam failure on berms that retain water.

  Note: The internal berm in a wet pond is not subject to this planting restriction since the failure of an internal berm would be unlikely to create a safety problem.
- Plant all landscape material, including grass, in good topsoil. Native underlying soils may be made suitable for planting if amended with 4 inches of compost tilled into the subgrade. Refer to the Soil Amendment heading in Section 3.1.4 for additional information on soil quality standards.
- Soil in which trees or shrubs are planted may need additional enrichment or additional compost top-dressing. Consult a landscape professional, or arborist for site-specific recommendations.
- For a naturalistic effect as well as ease of maintenance, trees or shrubs should be planted in clumps to form “landscape islands” rather than evenly spaced.
- The landscaped islands should be a minimum of 6 feet apart, and if set back from fences or other barriers, the setback distance should also be a minimum of 6 feet. Where tree foliage extends low to the ground, the 6foot setback should be counted from the outer drip line of the trees (estimated at maturity).

  This setback allows a 6-foot wide mower to pass around and between clumps.
- Evergreen or columnar deciduous trees along the west and south sides of ponds are recommended to reduce thermal heating. Evergreen trees or shrubs are preferred to avoid problems associated with leaf drop. Columnar deciduous trees (e.g., hornbeam, Lombardy poplar) typically have fewer leaves than other deciduous trees. In addition to shade, trees and shrubs also discourage waterfowl use and the attendant phosphorus enrichment problems they cause. Setback trees so the branches will not extend over the pond.
- Drought tolerant species are recommended.

Guidelines for Naturalistic Planting. Stormwater facilities may sometimes be located within open space tracts if "natural appearing." Two generic kinds of naturalistic planting are outlined below, but other options are also possible. Native vegetation is preferred in naturalistic plantings.

Open Woodland. In addition to the general landscaping guidelines above, the following are recommended:

- Landscaped islands (when mature) should cover a minimum of 30 percent or more of the tract, exclusive of the pond area.
- Underplant tree clumps with shade-tolerant shrubs and groundcover plants. The goal is to provide a dense understory that need not be weeded or mowed.
- Place landscaped islands at several elevations rather than "ring" the pond, and vary the size of clumps from small to large to create variety.
- Not all islands need to have trees. Shrub or groundcover clumps are acceptable, but lack of shade should be considered in selecting vegetation.

  Note: Landscaped islands are best combined with the use of wood-based mulch (hog fuel) or chipped onsite vegetation for erosion control (only for slopes above the flow control water surface). It is often difficult to sustain a low-maintenance understory if the site was previously hydroseeded. Compost or mulch (typically used for constructed wetland soil) can be used below the flow control water surface (materials that are resistant to and preclude flotation). The method of construction of soil landscape systems can also cause natural selection of specific plant species. Consult a soil restoration or wetland soil scientist for site-specific recommendations.

Northwest Savannah or Meadow. In addition to the general landscape guidelines above, the following are recommended:

- Landscape islands (when mature) should cover 10 percent or more of the site, exclusive of the pond area.
- Planting groundcovers and understory shrubs is encouraged to eliminate the need for mowing under the trees when they are young.
- Landscape islands should be placed at several elevations rather than "ring" the pond.

  The remaining site area should be planted with an appropriate grass seed mix, which may include meadow or wildflower species. Native or dwarf grass mixes are preferred. Table 3.1 below gives an example of dwarf grass mix developed for central Puget Sound. Grass seed should be applied at 2.5 to 3 pounds per 1,000 square feet.

  Note: Amended soil or good topsoil is required for all plantings.

  Creation of areas of emergent vegetation in shallow areas of the pond is recommended. Native wetland plants, such as sedges (Carex sp.), bulrush (Scirpus sp.), water plantain (Alisma sp.), and burreed (Sparganium sp.) are recommended. If the pond does not hold standing water, a clump of wettolerant, noninvasive shrubs, such as salmonberry or snowberry, is recommended below the detention design water surface.

  Note: This landscape style is best combined with the use of grass or sod for site stabilization and erosion control.

Seed Mixes. The seed mixes listed in Table 3.8 were developed for central Puget Sound. Note that the use of slow-growing, stoloniferous grasses will permit long intervals between mowing.

Table 3.8. - Stormwater Tract "Low Grow" Seed Mix.

Seed Name	Percentage of Mix
Dwarf tall fescue	40%
Dwarf perennial rye "Barclay"[1]	30%
Red fescue	25%
Colonial bentgrass	5%

[1] If wildflowers are used and sowing is done before Labor Day, the amount of dwarf perennial rye can be reduced proportionately to the amount of wildflower seed used.

Stormwater Sign Sample Specifications

- Size: 48 inches by 24 inches
- Material: 0.125gauge aluminum
- Face: Non-reflective vinyl or three coats outdoor enamel (sprayed).
- Lettering: Silk screen enamel where possible, or vinyl letters.
- Colors: Beige background, teal letters.
- Type face: Helvetica condensed. Title: 3inch. Subtitle: 1.5inch. Text: 1 inch. Outer border: one-eighth-inch border distance from edge: one-fourth-inch; all text 1.75inch from border.
- Posts: Pressure treated, beveled tops, 1.5-inch higher than sign.
- Installation: Secure to chain link fence if available. Otherwise install on two 4 x 4inch posts, pressure treated, mounted atop gravel bed, installed in 30inch concrete filled post holes (8inch minimum diameter). Top of sign no higher than 42 inches from ground surface.
- Placement: Face sign in direction of primary visual or physical access. Do not block any access road. Do not place within 6 feet of structural facilities (e.g., manholes, spillways, pipe inlets).
- Special Notes: This facility is lined to protect groundwater (if a liner that restricts infiltration of stormwater exists).

Maintenance

Maintenance is of primary importance if detention ponds are to continue to function as originally designed. Hence, provisions to facilitate maintenance operations must be built into the project when it is installed. Pierce County, a designated group such as a homeowners' association, or some individual must accept the responsibility for maintaining the structures and the impoundment area. A specific Maintenance and Source Control Manual must be formulated outlining the schedule and scope of maintenance operations. See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.

Handle any standing water and sediments removed during the maintenance operation in a manner consistent with Volume IV, Appendix IV-C, and the approved Maintenance and Source Control Manual for the facility.

3.12.2 Detention Tanks

Detention tanks are underground storage facilities typically constructed with large diameter corrugated metal pipe. Detention tanks are not to be perforated so as to provide infiltration of stormwater. Standard detention tank details are provided in Attachments Section A, Details 19.0 and 19.2. Control structure details are covered in Section 3.12.4.

Methods of Analysis

Detention Volume and Outflow

The volume and outflow design for detention tanks must be in accordance with Volume I, Minimum Requirement #7 and the hydrologic analysis and design methods in Chapter 2 of this volume. Restrictor and orifice design are given in Section 3.12.4.

Detention Tank Design Criteria

General. Typical design guidelines are as follows:

- Tanks may be designed as flow-through systems with manholes in line to promote sediment removal and facilitate maintenance. Tanks may be designed as back-up systems if preceded by water quality facilities, since little sediment should reach the inlet/control structure and low head losses can be expected because of the proximity of the inlet/control structure to the tank.
- The detention tank bottom must be located 0.5 feet below the inlet and outlet to provide dead storage for sediment.
- The minimum pipe diameter for a detention tank is 36 inches.
- Tanks larger than 36 inches may be connected to each adjoining structure with a short section (2foot maximum length) of 36inch minimum diameter pipe.
- Tanks shall not be located under the travel way in public rights-of-way. For single-family plats and planned urban developments (PUDs), planned residential developments, or planning and development district detention tanks shall be located in separate tracts.
- Details of outflow control structures are given in Section 3.12.4.

  Note: Control and access manholes must have additional ladder rungs to allow ready access to all tank access pipes when the catch basin sump is filled with water.

Materials. Galvanized metals leach zinc into the environment, especially in standing water situations. This can result in zinc concentrations that can be toxic to aquatic life. Therefore, use of galvanized materials in stormwater facilities and conveyance systems is discouraged. Where other metals, such as aluminum or stainless steel, or plastics are available, they should be used.

Pipe material, joints, and protective treatment for tanks shall be in accordance with Section 9.05 of the WSDOT/ American Public Works Association (APWA) Standard Specification.

Structural Stability. Tanks must meet structural requirements for overburden support and traffic loading if appropriate. Loads must be accommodated for tanks lying under parking areas and access roads per PCC Title 17B. Design metal tank end plates for structural stability at maximum hydrostatic loading conditions. Flat end plates generally require thicker gauge material than the pipe and/or require reinforcing ribs. Place tanks on stable, well consolidated native material with suitable bedding. Do not place tanks in fill slopes, unless analyzed through a geotechnical assessment for stability and constructability.

Buoyancy. In moderately pervious soils where seasonal groundwater may induce flotation, balance buoyancy tendencies either by ballasting with backfill or concrete backfill, providing concrete anchors, increasing the total weight, or providing subsurface drains to permanently lower the groundwater table. Calculations that demonstrate stability must be documented.

Access. The following guidelines for access may be used. See also Attachments Section A, Detail 19.2.

- The maximum depth from finished grade to tank invert shall be 20 feet.
- Position access openings a maximum of 50 feet from any location within the tank.
- All tank access openings shall have round, solid locking lids (usually one-half to five-eighths-inch diameter Allen-head cap screws).
- A 36inch minimum diameter CMP riser-type manholes of the same gauge as the tank material may be used for access along the length of the tank and at the upstream terminus of the tank in a backup system. The top slab is separated (1inch minimum gap) from the top of the riser to allow for deflections from vehicle loadings without damaging the riser tank.
- Make all tank access openings readily accessible by maintenance vehicles.
- Tanks must comply with the Occupational Safety and Health Administration (OSHA) confined space requirements, which includes clearly marking entrances to confined space areas. This may be accomplished by hanging a removable sign in the access riser(s), just under the access lid.

Access Roads. Access roads are needed to all detention tank control structures and risers. Design and construct access roads as specified for detention ponds in Section 3.12.1.

Setbacks. All stormwater vaults and tanks shall be a setback from any structure or property line a distance equal to the depth of the ground disturbed in setting the structure. Additional setbacks are listed in Section 3.12.1. Vaults and tanks shall also be within tracts or easements with widths equivalent to those listed for conveyance systems in Section 4.6.

All facilities must be a minimum of 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on a slope steeper than 20 percent. The geotechnical assessment may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.

Maintenance. Build provisions to facilitate maintenance operations into the project when it is installed. Maintenance must be a basic consideration in design and in determination of first cost. See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.

3.12.3 Detention Vaults

Detention vaults are box-shaped underground storage facilities typically constructed with reinforced concrete. Detention vaults are not intended to infiltrate stormwater and should not be perforated. A standard detention vault detail is provided in Attachments Section A, Detail 19.1. Control structure details are covered in Section 3.12.4.

Methods of Analysis

Detention Volume and Outflow

The volume and outflow design for detention vaults must be in accordance with Volume I, Minimum Requirement #7 and the hydrologic analysis and design methods in Chapter 2 of this volume. Restrictor and orifice design are given in Section 3.12.4.

Detention Vault Design Criteria

General. Typical design guidelines are as follows:

- Detention vaults may be designed as flow-through systems with bottoms level (longitudinally) or sloped toward the inlet to facilitate sediment removal. Distance between the inlet and outlet shall be maximized (as feasible).
- The detention vault bottom may slope at least 5 percent from each side towards the center, forming a broad "V" to facilitate sediment removal. More than one "V" may be used to minimize vault depth. However, the vault bottom may be flat with 0.5 to 1 foot of sediment storage if removable panels are provided over the entire vault. It is recommended that the removable panels be at grade, have stainless steel lifting eyes, and weigh no more than 5 tons per panel.
- The invert elevation of the outlet must be elevated above the bottom of the vault to provide an average 6 inches of sediment storage over the entire bottom. The outlet must also be elevated a minimum of 2 feet above the orifice to retain oil within the vault.
- Details of outflow control structures are given in Section 3.12.4.
- Vaults shall not be located under the travel way in public rights-of-way. For single-family plats and planned urban developments (PUDs), planned residential developments, or planned development district detention vaults shall be located in separate tracts.

Materials. Minimum 3,000 psi structural reinforced concrete may be used for detention vaults. Provide all construction joints with water stops.

Structural Stability. All vaults must meet structural requirements for overburden support and traffic loading (see Title 17B for current standards). Cast-in-place wall sections must be designed as retaining walls. Structural designs for cast-in-place vaults must be stamped by a licensed civil engineer with structural expertise. Place vaults on stable, well-consolidated native material with suitable bedding. Do not place vaults in fill slopes, unless analyzed through a geotechnical assessment for stability and constructability.

Access. Provide access over the inlet pipe and outlet structure. The following guidelines for access shall be used.

- Position access openings a maximum of 50 feet from any location within the tank. Additional access points may be needed on large vaults. Provide access to each "V" if more than one "V" is provided in the vault floor.
- For vaults with greater than 1,250 square feet of floor area, provide a 5 x 10foot removable panel over the inlet pipe (instead of a standard frame, grate and solid cover). Or, provide a separate access vault.
- Ladders and handholds need only be provided at the outlet pipe and inlet pipe, and as needed to meet OSHA confined space requirements. Vaults providing manhole access at 12foot spacing need not provide corner ventilation pipes as specified below.
- All access openings, except those covered by removable panels, shall have round, solid locking lids, or 3foot square, locking diamond plate covers.

- Vaults with widths 10 feet or less must have removable lids.
- The maximum depth from finished grade to the vault invert must be 20 feet.
- Internal structural walls of large vaults shall be provided with openings sufficient for maintenance access between cells. Size and situate the openings to allow access to the maintenance "V" in the vault floor.
- The minimum internal height must be 7 feet from the highest point of the vault floor (not sump), and the minimum width must be 4 feet. However, concrete vaults may be a minimum 3 feet in height and width if used as tanks with access manholes at each end, and if the width is no larger than the height. Also the minimum internal height requirement may not be needed for any areas covered by removable panels.
- Vaults must comply with the OSHA confined space requirements, including clearly marking entrances to confined space areas. This may be accomplished by hanging a removable sign in the access riser(s), just under the access lid.
- Provide ventilation pipes (minimum 12inch diameter or equivalent) in all four corners of vaults to allow for artificial ventilation prior to entry of maintenance personnel into the vault. Or, provide removable panels over the entire vault.

Setbacks. All stormwater vaults and tanks shall be a setback from any structure or property line a distance equal to the depth of the ground disturbed in setting the structure. Additional setbacks are listed in Section 3.12.1. Vaults and tanks shall also be within tracts or easements with widths equivalent to those listed for conveyance systems in Section 4.6.

All facilities must be a minimum of 50 feet from top of slopes steeper than 20 percent and greater than 10 feet high. A geotechnical assessment and soils report must be prepared addressing the potential impact of the facility on a slope steeper than 20 percent. The geotechnical assessment may recommend a reduced setback, but in no case shall the setback be less than the vertical height of the slope.

Maintenance. Build provisions to facilitate maintenance operations into the project when it is installed. Maintenance must be a basic consideration in design and in determination of first cost. See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.

3.12.4 Control Structures

Control structures are catch basins or manholes with a restrictor device for controlling outflow from a facility to meet the desired performance. Riser type restrictor devices ("Ts" or "FROPTs") also provide some incidental oil/water separation to temporarily detain oil or other floatable pollutants in runoff due to accidental spill or illegal dumping.

The restrictor device usually consists of two or more orifices and/or a weir section sized to meet performance requirements. Several publicly available and proprietary stormwater modeling programs are capable of sizing control structures. As such, the Methods of Analysis section (methods and equations for design of control structure restrictor devices) is included at the end of this section, rather than the beginning, as with the flow control BMPs above. Note that all detention and infiltration ponds, basins, vaults, tanks, and trenches **are required to include a crest gauge** that will record maximum pond water surface elevation after a storm event. The designer may submit alternative crest recording device for county approval. See Attachments Section A, Detail 25.0 for crest gauge details. In addition, project submittals **must** include a

table that identifies the design facility stage expected for the 2-, 5-, 10-, 25-, 50-, and 100year recurrence interval flows.

Standard control structure details are provided in Attachments Section A, Details 12.0 and 13.0.

Multiple Orifice Restrictor

In most cases, control structures need only two orifices: one at the bottom and one near the top of the riser, although additional orifices may best utilize detention storage volume. Several orifices may be located at the same elevation if necessary to meet performance requirements.

- Minimum orifice diameter is 0.5 inches. Note: In some instances, a 0.5inch bottom orifice will be too large to meet target release rates, even with minimal head. In these cases, the live storage depth need not be reduced to less than 3 feet in an attempt to meet the performance standards. A smaller orifice diameter may be permitted if a screen, per Attachments Section A, Details 12.0, is utilized to protect the orifice from fouling.
- Orifices may be constructed on a Tsection or on a baffle, as shown in Attachments Section A, Details 12.0 and 13.0 respectively.
- In some cases, performance requirements may require the top orifice/elbow to be located too high on the riser to be physically constructed (e.g., a 13inch diameter orifice positioned 0.5 feet from the top of the riser). In these cases, a notch weir in the riser pipe may be used to meet performance requirements (see Figure 3.15, presented later in this section).
- Consideration must be given to the backwater effect of water surface elevations in the downstream conveyance system. High tailwater elevations may affect performance of the restrictor system and reduce live storage volumes.

Riser and Weir Restrictor

- Properly designed weirs may be used as flow restrictors (see Figure 3.15 through Figure 3.17, presented later in this section). However, they must be designed to provide for primary overflow of the developed 100year recurrence interval peak flow discharging to the detention facility.
- The combined orifice and riser (or weir) overflow may be used to meet performance requirements; however, the design must still provide for primary overflow of the developed 100year recurrence interval peak flow assuming all orifices are plugged. Figure 3.18 can be used to calculate the head in feet above a riser of given diameter and flow.

Access. The following guidelines for access may be used.

- Provide an access road to the control structure for inspection and maintenance. Design and construct the access road as specified for detention ponds in Section 3.12.1.
- Manhole and catch basin lids for control structures must be locking, and rim elevations must match proposed finish grade.
- Manholes and catch basins must meet the OSHA confined space requirements, which include clearly marking entrances to confined space areas. This may be accomplished by hanging a removable sign in the access riser, just under the access lid.

Information Plate. It is recommended that a brass or stainless steel plate be permanently attached inside each control structure with the following information engraved on the plate:

- Name and file number of project

- Name and company of (1) developer, (2) engineer, and (3) contractor
- Date constructed
- Date of manual used for design
- Outflow performance criteria
- Release mechanism size, type, and invert elevation
- List of stage, discharge, and volume at 1foot increments
- Elevation of overflow
- Recommended frequency of maintenance.

Maintenance. Control structures and catch basins have a history of maintenance-related problems and it is imperative that a good maintenance program be established for their proper functioning. Typically sediment builds up inside the structure, which blocks or restricts flow to the inlet. To prevent this problem, routinely clean out these structures at least twice per year. Conduct regular inspections of control structures to detect the need for non-routine cleanout, especially if construction or land-disturbing activities occur in the contributing drainage area.

Install a 15foot wide access road to the control structure for inspection and maintenance.

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for additional information on maintenance requirements.

Methods of Analysis

This section presents the methods and equations for design of control structure restrictor devices. Included are details for the design of orifices, rectangular sharp-crested weirs, Vnotch weirs, sutro weirs, and overflow risers.

Orifices. Flow-through orifice plates in the standard Tsection or turndown elbow may be approximated by the general equation:

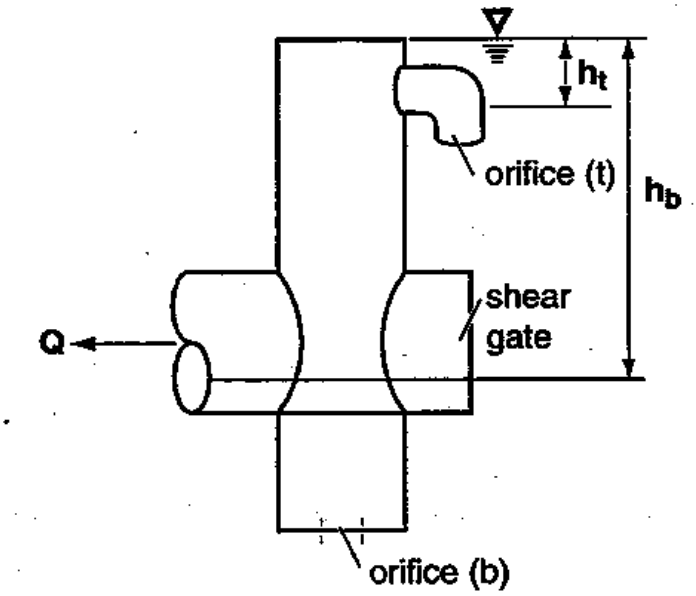
$$Q = CA\sqrt{2gh} \qquad \text{(equation 4)}$$

Where:

Q = flow (cubic feet per second)
C = coefficient of discharge (0.62 for plate orifice)
A = area of orifice (ft^2)
h = hydraulic head (ft)
g = gravity (32.2 ft/sec^2)

Figure 3.14 illustrates this simplified application of the orifice equation.

Figure 3.14. - Simple Orifice.



$$Q = CA_b\sqrt{2gh_b} + CA_t\sqrt{2gh_t}$$
$$= C\sqrt{2_g}\left(A_b\sqrt{h_b} + A_t\sqrt{h_t}\right)$$

hb = distance from hydraulic grade line at the 2-year flow of the outflow pipe to the overflow elevation

The diameter of the orifice is calculated from the flow. The orifice equation is often useful when expressed as the orifice diameter in inches:

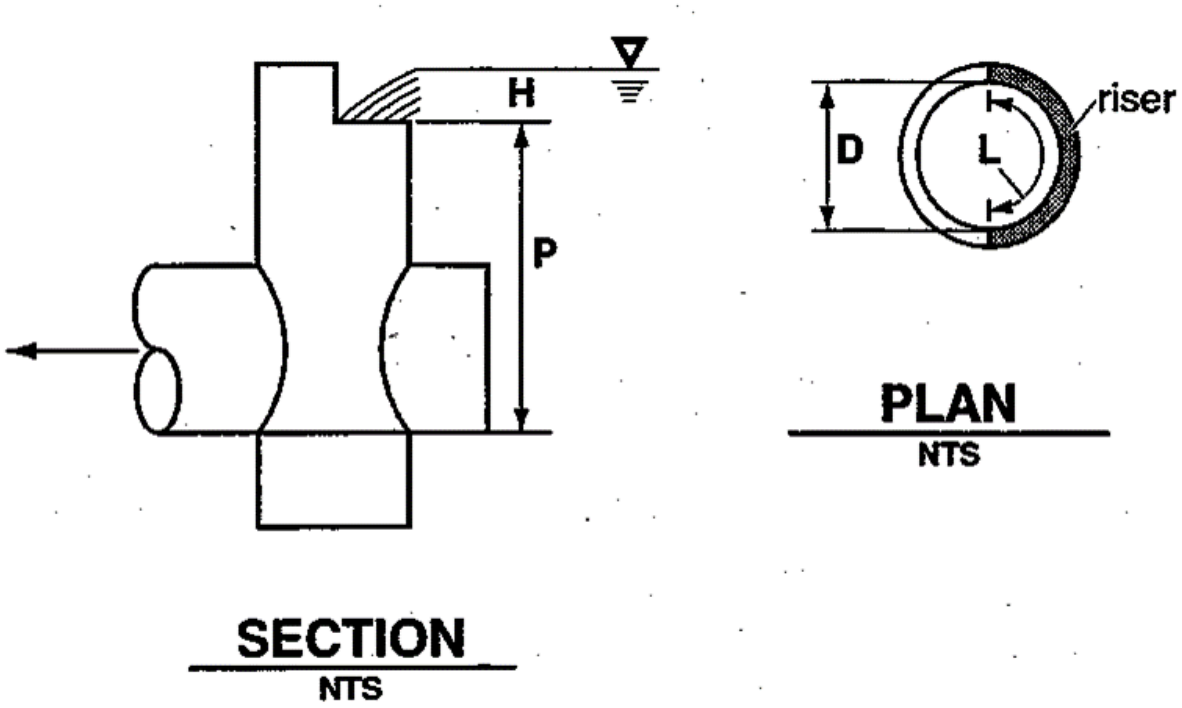
$$d = \sqrt{\frac{36.88Q}{\sqrt{h}}} \qquad \text{(equation 5)}$$

Where:

d = orifice diameter (inches)
Q = flow (cubic feet per second)
h = hydraulic head (ft)

Rectangular Sharp-Crested Weir. The rectangular sharp-crested weir design shown in Figure 3.15 may be analyzed using standard weir equations for the fully contracted condition.

Figure 3.15. - Rectangular, Sharp-Crested Weir.



$$Q = C\,(L - 0.2H)H^{3/2} \qquad \text{(equation 6)}$$

Where:

Q = flow (cubic feet per second)

C = 3.27 + 0.40 H/P (ft)

H, P are as shown above

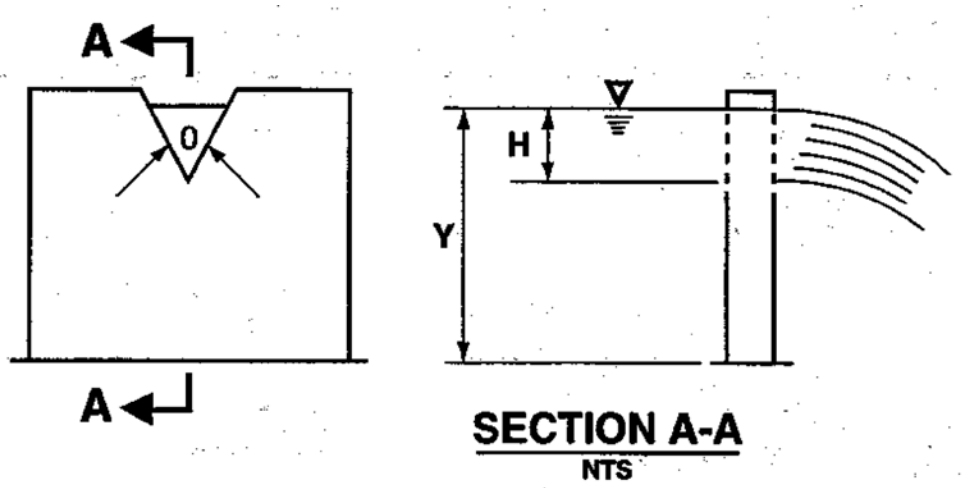
L = length (ft) of the portion of the riser circumference as necessary not to exceed 50 percent of the circumference

D = inside riser diameter (ft)

Note that this equation accounts for side contractions by subtracting 0.1H from L for each side of the notch weir.

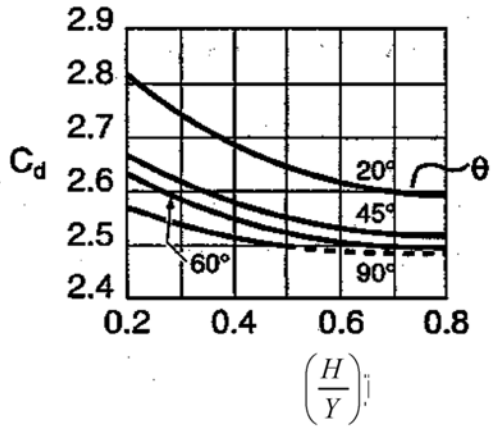
V-Notch Sharp – Crested Weir. V-notch weirs as shown in Figure 3.16 may be analyzed using standard equations for the fully contracted condition.

Figure 3.16. - V-Notch, Sharp-Crested Weir.



$$Q = C_d(\text{Tan } \Theta/2)H^{5/2}, \text{ in cfs}$$

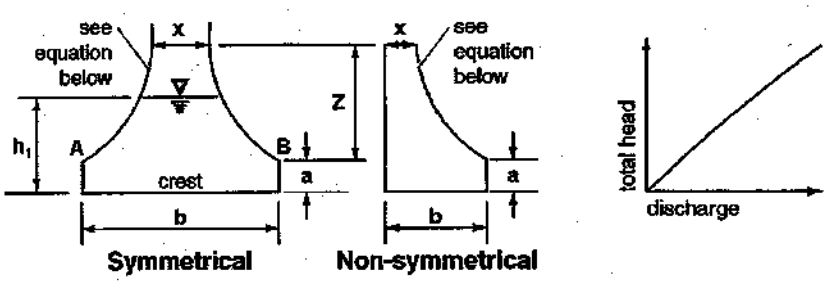
Where values of C_d may be taken from the following chart:



Proportional or Sutro Weir. Sutro weirs are designed so that the discharge is proportional to the total head. This design may be useful in some cases to meet performance requirements.

The sutro weir consists of a rectangular section joined to a curved portion that provides proportionality for all heads above the line AB (see Figure 3.17). The weir may be symmetrical or non-symmetrical.

Figure 3.17. - Sutro Weir.



For this type of weir, the curved portion is defined by the following equation (calculated in radians):

$$\frac{x}{b} = 1 - \frac{2}{\pi} Tan^{-1} \sqrt{\frac{Z}{a}} \qquad \text{(equation 7)}$$

where a, b, x and Z are as shown in Figure 3.17. The head-discharge relationship is:

$$Q = C_d b \sqrt{2ga} \left(h_1 - \frac{a}{3}\right) \qquad \text{(equation 8)}$$

Values of Cd for both symmetrical and non-symmetrical sutro weirs are summarized in Table 3.9.

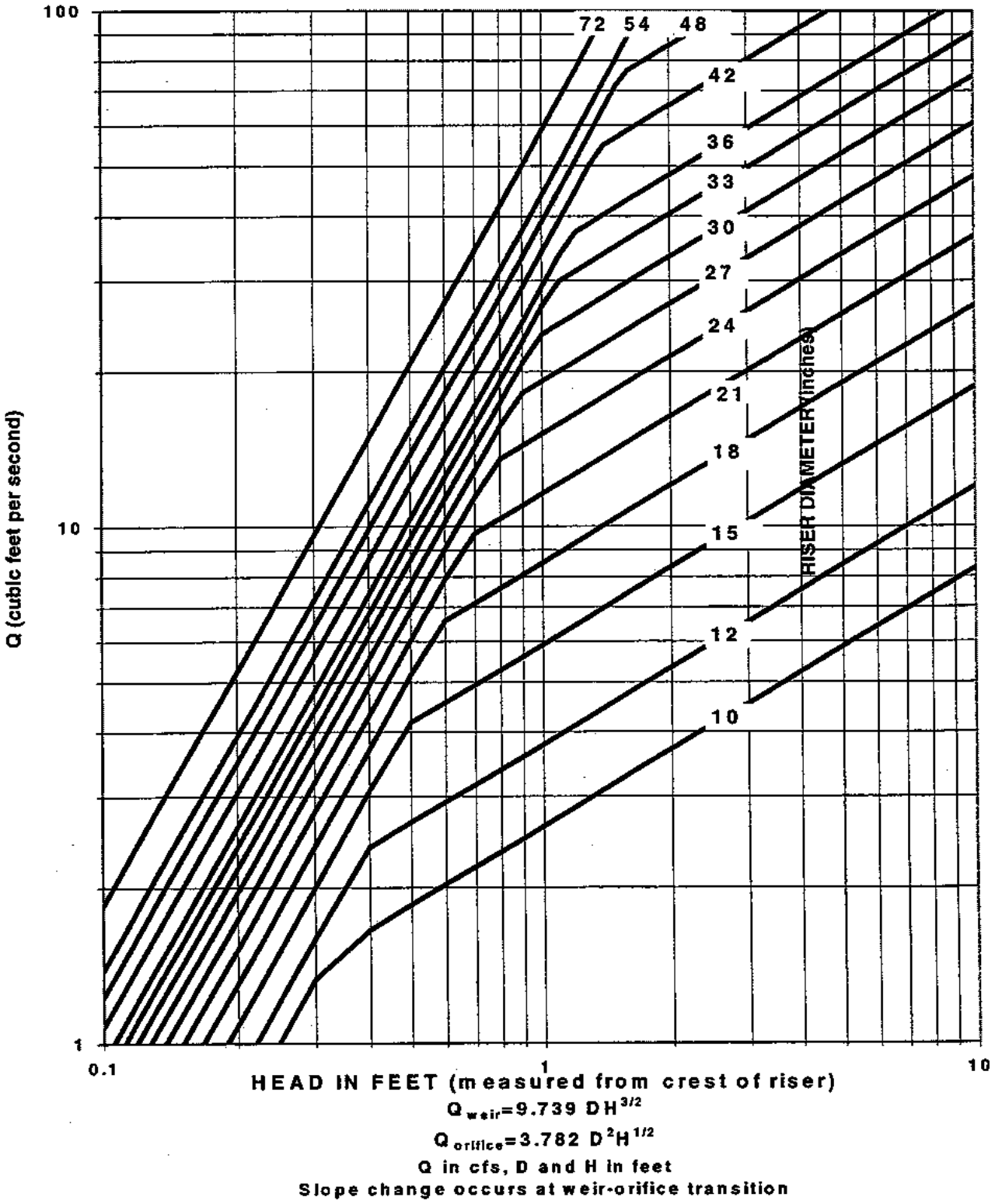
Table 3.9. - Values of C_d for Sutro Weirs.

C_d Values, Symmetrical					
	b (ft)				
a (ft)	0.50	0.75	1.0	1.25	1.50
0.02	0.608	0.613	0.617	0.6185	0.619
0.05	0.606	0.611	0.615	0.617	0.6175
0.10	0.603	0.608	0.612	0.6135	0.614
0.15	0.601	0.6055	0.610	0.6115	0.612
0.20	0.599	0.604	0.608	0.6095	0.610
0.25	0.598	0.6025	0.6065	0.608	0.6085
0.30	0.597	0.602	0.606	0.6075	0.608
C_d Values, Non-Symmetrical					
	b (ft)				
a (ft)	0.50	0.75	1.0	1.25	1.50
0.02	0.614	0.619	0.623	0.6245	0.625
0.05	0.612	0.617	0.621	0.623	0.6235
0.10	0.609	0.614	0.618	0.6195	0.620
0.15	0.607	0.6115	0.616	0.6175	0.618
0.20	0.605	0.610	0.614	0.6155	0.616
0.25	0.604	0.6085	0.6125	0.614	0.6145
0.30	0.603	0.608	0.612	0.6135	0.614

Note: When b > 1.50 or a > 0.30, use Cd=0.6.

Riser Overflow. The nomograph in Figure 3.18 can be used to determine the head (in feet) above a riser of given diameter and for a given flow (usually the 100year recurrence interval peak flow for developed conditions).

Figure 3.18. - Riser Inflow Curves.



3.12.5 Other Detention Options

This section presents other design options for detaining flows to meet flow control facility requirements.

Use of Parking Lots for Additional Detention. Private parking lots may be used to provide additional detention volume for runoff events greater than the 2year recurrence interval runoff event provided all of the following are met:

- The depth of water detained does not exceed 1 foot at any location in the parking lot for runoff events up to and including the 100year recurrence interval event.
- The gradient of the parking lot area subject to ponding is 1 percent or greater.
- The emergency overflow path is identified and noted on the engineering plan. The overflow must not create a significant adverse impact to downhill properties or drainage system.
- Fire lanes used for emergency equipment are free of ponding water for all runoff events up to and including the 100year recurrence interval event.

3.12.6 Use of Roofs for Detention

Detention ponding on roofs of structures may be used to meet flow control requirements provided all of the following are met:

- The roof support structure is analyzed by a structural engineer to address the weight of ponded water
- The roof area subject to ponding is sufficiently waterproofed to achieve a minimum service life of 30 years
- The minimum pitch of the roof area subject to ponding is one-fourth-inch per foot
- An overflow system is included in the design to safely convey the 100year recurrence interval peak flow from the roof
- A mechanism is included in the design to allow the ponding area to be drained for maintenance purposes or in the event the restrictor device is plugged.

Chapter 4. Conveyance Systems and Hydraulic Structures

4.1 Overview

This section presents acceptable methods for the analysis and design of conveyance systems. It also includes sections on hydraulic structures which link the conveyance system to the runoff treatment and flow control BMPs.

This section can be separated into the following eight categories:

- Design and analysis methods (Sections 4.2 through 4.6)
- Pipe systems (Section 4.7)
- Outfalls (Section 4.8)
- Flow spreaders (Section 4.9)
- Culverts (Section 4.10)
- Open conveyances (Section 4.11)
- Private drainage systems (Section 4.12)
- Floodplains/floodways (covered in PCC Title 18E.70).

Where space and topography permit, open conveyances are the preferred means of collecting and conveying stormwater.

4.2 Design Event Storm Frequency

Ideally every conveyance system and hydraulic structure would be designed for the largest possible amount of flow that could ever occur. Unfortunately this would require unusually large structures and would add an unjustifiable cost to the projects; therefore hydraulic structures are analyzed for a specific storm frequency. When selecting a storm frequency for design purposes, consideration is given to the potential degree of damage to adjacent properties, potential hazard and inconvenience to the public, the number of users, and the initial construction cost of the conveyance system or hydraulic structure. The way in which these factors interrelate can become quite complex.

The design event recurrence interval is related to the probability that such an event will occur in any one year. For example, a peak flow having a 25year recurrence interval has a 4 percent probability of being equaled or exceeded in any future year. A peak flow having a 2year recurrence interval has a 50 percent probability of being equaled or exceeded in any future year. The greater the recurrence interval is, the lower the probability that the event will occur in any given year.

The design event for each conveyance system category is as follows:

The project's internal conveyance system shall be designed for a 25year storm event. Culverts for and bridges over natural channels must convey the 100year storm event under fully developed conditions. Culverts and bridges must also be designed to meet fish passage and scour criteria, where applicable. All conveyances within public roads or right-of-way shall be designed to pass a 25year storm event from the contributing area under fully developed conditions.

4.3 Determination of Design Flows

All existing and proposed conveyance systems shall be analyzed and designed using the peak flows from the hydrographs developed through the hydrologic analysis in Chapter 2 and the release rates specified under Minimum Requirement #7. In general, either event-based or continuous runoff hydrologic modeling may be used for conveyance sizing. See Chapter 2 for full details.

Exception: For drainage subbasins 25 acres or less, and having a time of concentration of less than 100 minutes, the capacity of conveyance elements may be determined using the rational method.

If the county determines that, as a result of the project, runoff for any event from the 2year through the 100year recurrence interval event would cause damage or interrupt vital services, the county may require a backwater analysis.

4.4 Backwater Analysis

When a backwater calculation is required, the design engineer shall analyze for the 25 and 100year, 24hour design storm events.

For the 25year event, there shall be a minimum of one-half a foot of freeboard between the water surface and the top of any manhole or catch basin.

For the 100 year event, overtopping of the pipe conveyance system may occur; however, the additional flow shall not extend beyond half the lane width of the outside lane of the traveled way and shall not exceed 4 inches in depth at its deepest point. Off-channel storage on private property is allowed with recording of the proper easements (see Section 4.6). The additional flow shall be analyzed by open channel flow methods.

A backwater profile analysis computer program such as the King County Backwater computer program by King County Department of Natural Resources is recommended over hand calculations. The subroutine, BPIPE, of King County Backwater may be used for quick computation of backwater profiles, given a range of flows through the existing or proposed pipe system.

4.5 Conveyance System Route Design

All pipes shall be located under the pavement flow line or lie outside of the pavement, unless otherwise specified below. Perpendicular crossings and cul-de-sacs are exempted from this requirement. For curved sections only of local road minors and local road culde-sacs, pipe placement may be located underneath pavement areas, but no closer than 6 feet from the roadway centerline. Pipes under permeable pavement sections will need to ensure flows are prevented from short circuiting through the pipe zone bedding.

New conveyance system alignments that are not in dedicated tracts or right-of-way shall be located in drainage easements that are adjacent and parallel to property lines. The width of the permanent easement must be completely within a single parcel or tract and not split between adjacent properties. Topography and existing conditions are the only conditions under which a drainage easement may be placed not adjacent and parallel to a property line. Requirements for conveyance system tracts and easements are discussed in Section 4.6 below.

Exception: Streams and natural drainage channels cannot be relocated to meet this routing requirement.

4.6 Easements, Access, and Dedicated Tracts

4.6.1 Natural Channels and Stormwater Facilities

All man-made drainage facilities and conveyances and all natural channels (on the project site) used for conveyance of altered flows due to development (including swales, ditches, stream channels, lake shores, wetlands, potholes, estuaries, gullies, ravines, etc.) shall be located within easements or dedicated tracts as required by the county. Easements shall contain the natural features and facilities and shall allow county access for purposes of inspection, maintenance, repair or replacement, flood control, water quality monitoring, and other activities permitted by law.

All drainage facilities such as detention or retention ponds or infiltration systems to be maintained by the county shall be located in separate tracts dedicated to the county. Conveyance systems can be in easements. Drainage facilities shall not be located in dedicated public road right-of-way areas, with the exception of county and highway facilities.

Drainage facilities that are designed to function as multi-use recreational facilities shall be located in separate tracts or in designated open space and shall be privately maintained and owned, unless accepted by and dedicated to the county.

4.6.2 Maintenance Access

A maintenance access road (and easement) must be provided for all manholes, catch basins, vaults, or other underground drainage facilities. This requirement does not apply to onsite stormwater management BMPs. A minimum 15foot wide access easement shall be provided to the facilities from a public street or right-of-way. Access easements shall be surfaced with a minimum 12foot width of crushed rock, or other approved surface to allow year-round equipment access to the facility. See also Section 3.12.1 for pond access requirements.

Maintenance shall be through an access easement or dedicated tract. Drainage structures for conveyance without vehicular access must be channeled.

4.6.3 Access to Conveyance Systems

All publicly and privately maintained conveyance systems shall be located in dedicated tracts, drainage easements, or public rights-of-way in accordance with this manual. Exception: roof downspout, minor yard, and footing drains unless they serve other adjacent properties.

Conveyance systems to be maintained and operated by Pierce County must be located in a dedicated tract or drainage easement granted to Pierce County. Any new conveyance system located on private property designed to convey drainage from other private properties must be located in a private drainage easement granted to the contributors of stormwater to the systems to convey surface and stormwater and to permit access for maintenance or replacement in the case of failure.

All drainage tracts and easements, public and private, must have a minimum width of 15 feet. In addition, all pipes and channels must be located within the tract, easement, or rights-of-way so that each pipe face or top edge of channel is no closer than 5 feet from its adjacent easement boundary. Pipes greater than 5 feet in diameter and channels with top widths greater than 5 feet shall be placed in easements adjusted accordingly, so as to meet the required dimensions from the boundaries.

Easements as shown in Table 4.1 are minimums for drainage facilities.

Table 4.1. - Minimum Easement Widths for Conveyance Systems for Access, Inspection and Maintenance.

Conveyance Width	Easement Width
Channels ≤ 30 feet wide	Channel Width + 15 feet from top, one side
Channels > 30 feet wide	Channel Width + 15 feet from top, both sides
Pipes/Outfalls ≤ 36 inches	15 feet centered on pipe
Pipes/Outfalls ≤ 60 inches	20 feet centered on pipe[1]
Pipes/Outfalls > 60 inches	30 feet centered on pipe[1]

[1] May be greater, depending on depth and number of pipes in easement.

4.7 Pipe System Design Criteria

Pipe systems are networks of storm drain pipes, catch basins, manholes, and inlets designed and constructed to convey storm and surface water. These generally do not include individual stormwater management BMPs, but rather serve to route flows into or away from BMPs. The hydraulic analysis of flow in storm drain pipes typically is limited to "gravity flow;" however, in analyzing existing systems it may be necessary to address pressurized conditions.

4.7.1 Analysis Methods

Two methods of hydraulic analysis using Manning's Equation are used for the analysis of pipe systems. The first method is the Uniform Flow Analysis Method, commonly referred to as the Manning's Equation, and is used for the design of new pipe systems and analysis of existing pipe systems. The second method is the Backwater Analysis Method (see Section 4.4) and is used to analyze the capacity of both proposed, and existing, pipe systems. If the county determines that, as a result of the project, runoff for any event up to and including the 100year, 24hour event would cause damage or interrupt vital services, a backwater (pressure sewer) analysis shall be required. Results shall be submitted in tabular and graphic format showing hydraulic and energy gradient.

When using the Manning's Equation for design, each pipe within the system shall be sized and sloped such that its barrel capacity at normal full flow is equal or greater than the required conveyance capacity as identified in Section 4.5. Table 4.2 provides the recommended Manning's "n" values for preliminary design for pipe systems. (Note: The "n" values for this method are 15 percent higher in order to account for entrance, exit, junction, and bend head losses.) Manning's "n" values used for final pipe design must be documented in the Drainage Control Plan.

Table 4.2. - Recommended Manning's "n" Values for Preliminary Pipe Design.

Type of Pipe Material	Analysis Method	
	Backwater Flow	Manning's Equation Flow
A. Concrete pipe and CPEP-smooth interior pipe	0.012	0.014
B. Annular Corrugated Metal Pipe or Pipe Arch:		
1. 2 2/3 x ½ inch corrugation (riveted)		
a. plain or fully coated	0.024	0.028
b. paved invert (40% of circumference paved):		
(1) flow full depth	0.018	0.021
(2) flow 0.8 depth	0.016	0.018
(3) flow 0.6 depth	0.013	0.015
c. treatment 5	0.013	0.015
2. 2.3 x 1-inch corrugation	0.027	0.031
3. 3.6 x 2-inch corrugation (field bolted)	0.030	0.035
C. Helical 2 2/3 x ½-inch corrugation and CPEP-single wall	0.024	0.028
D. Spiral rib metal pipe and PVC pipe	0.011	0.013
E. Ductile iron pipe cement lined	0.012	0.014
F. High density polyethylene pipe (butt fused only)	0.009	0.009

Nomographs may also be used for sizing the pipes. For pipes flowing partially full, the actual velocity may be estimated from engineering nomographs by calculating Qfull and Vfull and using the ratio of Qdesign/Qfull to find V and d (depth of flow). Appendix IIIC includes several nomographs that may be useful for culvert sizing.

4.7.2 Acceptable Pipe Sizes

All storm drainage pipe, except as otherwise provided for in these standards, must have a minimum of 12-inch diameter. One exception is for cross-street connections from a concrete inlet to a Type 1 or 2 catch basin or manhole (CB leads). Under these conditions, plain concrete, 8inch diameter, storm sewer pipe may be used. Storm sewer pipe used for private roof/footing/ yard drain systems or other onsite stormwater management BMPs can be less than 12inch diameter and sized according to the application and design standards presented in Chapter 3.

4.7.3 Pipe Materials

All storm drainage pipe, except as otherwise provided for in these standards, shall be as per current WSDOT Standard Specifications 9-05. When extreme slope conditions or other unusual topographic conditions exist, pipe materials and methods such as, but not limited to, PVC, HDPE, or ductile iron pipe should be used.

4.7.4 Pipe Slope and Velocity

Minimum velocity is 2 feet per second at design flow. The county may waive these minimums in cases where topography and existing drainage systems make it impractical to meet the standard.

Maximum slopes, velocities, and anchor spacings are shown in Table 4.3. If velocities exceed 15 feet per second for the conveyance system design event, provide anchors at bends and junctions. See Attachments Section A, Detail 20.0.

Table 4.3. - Maximum Pipe Slopes and Velocities.

Pipe Material	Pipe Slope Above Which Pipe Anchors Required and Minimum Anchor Spacing	Max. Slope Allowed	Max. Velocity @ Full Flow
Spiral Rib, PVC, CPEP-single wall[1]	20% (1 anchor per 100 L.F. of pipe)	30%[3]	30 fps
Concrete or CPEP-smooth interior[1]	10% (1 anchor per 50 L.F. of pipe)	20%[3]	30 fps
Ductile Iron	40% (1 anchor per pipe section)	None	None
HDPE[2]	50% (1 anchor per 100 L.F. of pipe – cross slope installations only)	None	None

[1] Not allowed in landslide hazard areas.

[2] Butt-fused pipe joints required. Above-ground installation is required on slopes greater than 40% to minimize disturbance to steep slopes.

[3] Maximum slope of 200% allowed for these pipe materials with no joints (one section) with structures at each end and properly grouted.

Key: PVC = Polyvinyl chloride pipe
CPEP = Corrugated high density polyethylene pipe
HDPE = High density polyethylene

Pipe direction changes or size increases or decreases are allowed only at manholes and catch basins. This does not apply to detention tanks or vaults.

Downsizing of pipes is only allowed under special conditions (i.e., no hydraulic jump can occur; downstream pipe slope is significantly greater than the upstream slope; velocities remain in the 3 to 8 fps range, etc.).

Downsizing of downstream culverts within a closed system with culverts 18inches in diameter or smaller will not be permitted.

Pipes connecting into a structure shall match crown elevations.

4.7.5 Pipes on Steep Slopes

Steep slopes (greater than 20 percent) shall require all drainage to be piped from the top to the bottom in HDPE pipe (butt fused) or ductile iron pipe welded or mechanically restrained. Additional anchoring design is required for these pipes.

4.7.6 Pipe System Layout Criteria

Pipes must be laid true to line and grade with no curves, bends, or deflections in any direction (except for HDPE and Ductile Iron with flanged restrained mechanical joint bends, not greater than 30 degrees, on steep slopes).

A break in grade or alignment or changes in pipe material shall occur only at catch basins or manholes.

Connections to a pipe system shall be made only at catch basins or manholes. No wyes or tees are allowed except on private roof/footing/yard drain systems on pipes 8inches in diameter, or less, with cleanouts upstream of each wye or T.

Provide 6 inches minimum vertical and 3 feet minimum horizontal clearance (outside surfaces) between storm drain pipes and other utility pipes and conduits. Pierce County Sewer Utility criteria will apply for crossings of or parallel runs with Pierce County sewer lines. For crossings of water lines the Tacoma-Pierce County Health Department criteria will apply. Contact the Water Resources Section of the Tacoma-Pierce County Health Department at (253) 7986470 for more

information.

Suitable pipe cover over storm pipes in road rights-of-way shall be calculated for loading by the Project Engineer that meet the standards in PCC Title 17B. Pipe cover is measured from the finished grade elevation down to the top of the outside surface of the pipe. Pipe manufacturers' recommendations are acceptable if verified by the Project Engineer.

PVC, SDR 35, minimum cover shall be 3 feet in areas subject to vehicular traffic. Unless calculated for loading by the Project Engineer that meet the standards in PCC Title 17B. Pipe cover is measured from the finished grade elevation down to the top of the outside surface of the pipe. Pipe manufacturers' recommendations are acceptable if verified by the Project Engineer; maximum cover shall be 25 feet per WSDOT/APWA Standard Specifications Section 704.

Pipe cover in areas not subject to vehicular loads, such as landscape planters and yards, may be reduced to a 1 foot minimum.

Access barriers are required on all pipes 18 inches and larger exiting a closed pipe system. Debris barriers (trash racks) are required on all pipes entering a pipe system. See Attachments Section A, Details 17.0 and 17.1 for required debris barriers on pipe ends outside of roadways and for requirements on pipe ends (culverts) projecting from driveways or roadway sideslopes.

Where a minimal fall is necessary between inlet and outlet pipes in a structure, pipes must be aligned vertically by one of the following in order of preference:

- Match pipe crowns
- Match 80 percent diameters of pipes
- Match pipe inverts.

Where inlet pipes are higher than outlet pipes, drop manhole connections may be required or increased durability in the structure floor may be required.

High Density Polyethylene (HDPE) pipe systems longer than 100 feet must be anchored at the upstream end if the slope exceeds 25 percent and the downstream end placed in a minimum 4 foot long section of the next larger pipe size. This sliding sleeve connection allows for the high thermal expansion/contraction coefficient of the pipe material.

4.7.7 Pipe Structure Criteria

Catch Basins and Manholes

For the purposes of this manual, all catch basins, manholes, and connecting pipe sizes shall meet current WSDOT Standard Specifications and Plans. The following criteria shall be used when designing a conveyance system which utilizes catch basins or manholes:

Unless otherwise required by the county, Type 1 catch basins shall be used at the following locations or for the following situations:

- When overall structure height does not exceed 8 feet or when invert does not exceed 5 feet
- When all pipes tying into the structure connect at or very near to right angles.

Unless otherwise required by the county, Type 1L catch basins must be used at the following locations or for the following situations:

- When overall structure height does not exceed 8 feet or when invert does not exceed 5 feet

Unless otherwise required by the county, Type 2 (48inch minimum diameter) catch basins shall be used at the following locations or for the following situations:

- When overall structure height does not exceed 15 feet.
- When all pipes tying into the structure do not exceed the limits set forth by the manufacturers. Type 2 catch basins over 4 feet in height shall have standard ladders.

Where an approved connection of a private stormwater drainage system into a county system occurs, a minimum of a Type 1 catch basin shall be used in Pierce County.

Catch basin (or manhole) diameter shall be determined by pipe diameter and orientation at the junction structure. A plan view of the junction structure, drawn to scale, will be required when more than four pipes enter the structure on the same plane, or if angles of approach and clearance between pipes is of concern. The plan view (and sections if necessary) must ensure a minimum distance (of solid concrete wall) between pipe openings of 8 inches for 48 inch and 54 inch diameter catch basins and 12 inches for 72 inch and 96 inch diameter catch basins.

Catch basin evaluation of structural integrity for loading defined in PCC Title 17B will be required for multiple junction catch basins and other structures which exceed the recommendations of the manufacturers.

The WSDOT Hydraulics Manual can be used in determining the capacity of inlet grates when capacity is of concern. When verifying capacity, assume grate areas on slopes are 80 percent free of debris, and “vaned” grates are 95 percent free. In sags or low spots, assume grates are 50 percent free of debris, and “vaned” grates, 75 percent free.

The maximum slope of the ground surface for a radius of 5 feet around a catch basin grate shall be 3:1.

Catch basins shall be provided within 50 feet of the entrance to a pipe system to provide for silt and debris removal.

Maximum spacing of structures for storm drainage conveyance lines shall be 350 feet for pipe grades greater than 0.3 percent and 200 feet for grades less than 0.3 percent. Structures not acting as points of entry for stormwater shall have locking lids and have solid covers.

Locking lids will be installed on all structures containing restrictor or flow devices. Locking lids shall use WSDOT Standard Plan B-30.70-04 with the lettering of “STORM” or other county pre-approved design.

Maximum surface runs between inlet structures on the paved roadway surface shall be as follows:

Roadway Slope (%)	Pierce County Max. Spacing (ft)
0.4 to 1	200
>1 to 6	350
>6 to 8	250
>8 to 12	150

A metal frame and grate for catch basin and inlet, most current version of WSDOT Standard Plan B-30.10-03 and B-30.15-00 or preapproved county standard grate that is deemed bicycle safe, shall be used for all structures collecting drainage from the paved roadway surface. Bolt-down grates must be provided on all structures in public tracts and rights-of-ways.

When the road profile equals or exceeds 6 percent between structures the catch basin may be

recessed into the curb per County Standard Drawing PC.B1.1 or spacing between catch basins must be shortened to account for decreased inflow.

All catch basins, inlets, etc., shall be marked as shown in Attachments Section A, Detail 22.0.

Flow Splitter Designs

Many water quality facilities can be designed as flow-through or on-line systems with flows above the water quality design flow or volume simply passing through the facility at a lower pollutant removal efficiency. However, it is sometimes desirable to restrict flows to water quality treatment facilities and bypass the remaining higher flows around them through off-line facilities. This can be accomplished by splitting flows in excess of the water quality design flow upstream of the facility and diverting higher flows to a bypass pipe or channel. The bypass typically enters a flow control facility or the downstream receiving drainage system, depending on flow control requirements. In most cases, it is a designer's choice whether water quality facilities are designed as on-line or off-line; an exception is oil/water separators, which must be designed off-line.

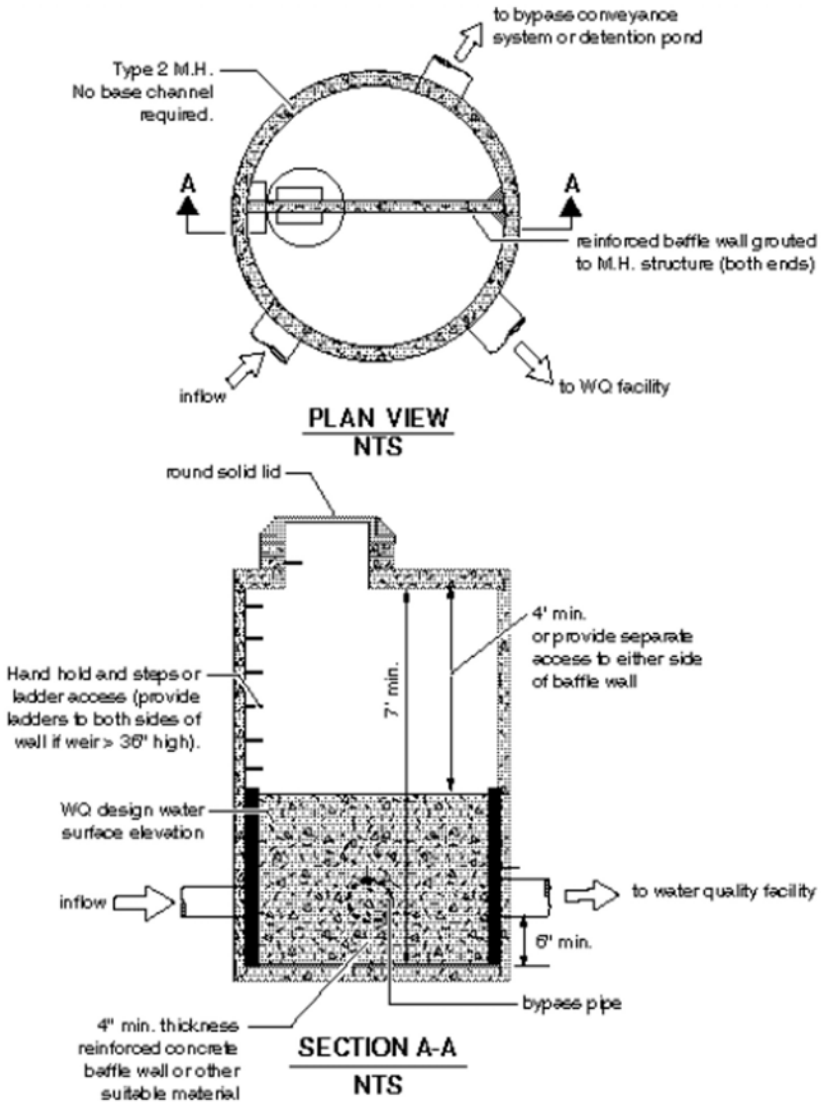
A crucial factor in designing flow splitters is to ensure that low flows are delivered to the treatment facility up to the water quality design flow rate. Above this rate, additional flows are diverted to the bypass system with minimal increase in head at the flow splitter structure to avoid surcharging the water quality facility under high flow conditions. Flow splitters may be used for purposes other than diverting flows to water quality facilities. However, the following discussion is generally focused on using flow splitters in association with water quality facilities.

Flow splitters are typically manholes or vaults with concrete baffles. In place of baffles, the splitter mechanism may be a half Tsection with a solid top and an orifice in the bottom of the Tsection. A full T option may also be used as described below in the "General Design Criteria." Two possible design options for flow splitters are shown in Figure 4.1 and Figure 4.2 (source: King County). Other equivalent designs that achieve the result of splitting low flows and diverting higher flows around the facility are also acceptable.

General Design Recommendations

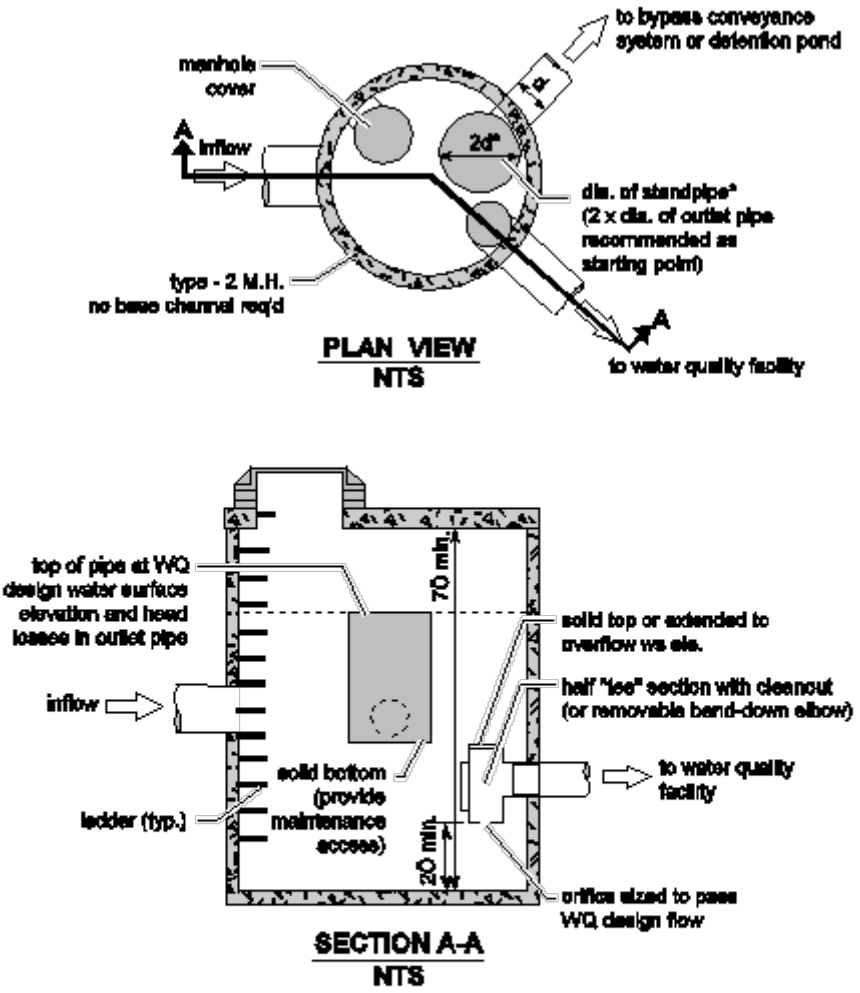
- Unless otherwise specified, a flow splitter should be designed to deliver the water quality design flow rate specified to the water quality treatment facility (see also Volume V). Flows modeled using a continuous simulation runoff model shall use 15minute time steps.

Figure 4.1. - Flow Splitter, Option A.



Note: The water quality discharge pipe may require an orfice plate be installed on the outlet to control the height of the design water surface (weir height). The design water surface should be set to provide a minimum headwater/diameter ratio of 2.0 on the outlet pipe.

Figure 4.2. - Flow Splitter, Option B.



- The top of the weir should be located at the water surface for the design flow. Remaining flows enter the bypass line.
- The maximum head should be minimized for flow in excess of the water quality design flow. Specifically, flow to the water quality facility at the 100year water surface should not increase the design water quality flow by more than 10 percent.
- Either design shown in Figure 4.1 or Figure 4.2 or an equivalent design may be used.
- As an alternative to using a solid top plate in Figure 4.2, a full Tsection may be used with the top of the Tsection at the 100year water surface. This alternative would route emergency overflows (if the overflow pipe were plugged) through the water quality facility rather than

back up from the manhole.

- Special applications, such as roads, may require the use of a modified flow splitter. The baffle wall may be fitted with a notch and adjustable weir plate to proportion runoff volumes other than high flows.
- For ponding facilities, backwater effects must be included in designing the height of the standpipe in the manhole.
- Ladder or step and handhold access must be provided. If the weir wall is higher than 36 inches, two ladders, one to either side of the wall, should be used.

Materials

- The splitter baffle may be installed in a Type 2 manhole or vault.
- The baffle wall should be made of reinforced concrete or another suitable material resistant to corrosion, and have a minimum 4inch thickness. The minimum clearance between the top of the baffle wall and the bottom of the manhole cover should be 4 feet; otherwise, dual access points should be provided.
- All metal parts must be corrosion resistant. Examples of preferred materials include aluminum, stainless steel, and plastic. Zinc and galvanized materials are discouraged because of aquatic toxicity. Painted metal parts should not be used because of poor longevity.

4.8 Outfalls

All piped discharges to streams, rivers, ponds, lakes, or other open bodies of water are designated outfalls and shall provide for energy dissipation to prevent erosion at or near the point of discharge. Properly designed outfalls are critical to reducing the chance of adverse impacts as the result of concentrated discharges from pipe systems and culverts, both onsite and downstream. Outfall systems include rock splash pads, flow dispersal trenches, gabion or other energy dissipaters, and tightline systems. A tightline system is typically a continuous length of pipe used to convey flows down a steep or sensitive slope with appropriate energy dissipation at the discharge end.

4.8.1 General Design Criteria for Outfall Features

All energy dissipation at outfalls shall be designed for peak flows from a 100year, 24hour storm event. For outfalls with a maximum flow velocity of less than 10 feet per second, a rock splash pad is acceptable. For velocities equal to or greater than 10 feet per second, an engineered energy dissipater must be provided. See Table 4.4 and Attachments Section A, Details 8.0 and 9.0 for a summary of the rock protection requirements at outfalls.

Table 4.4. - Rock Protection at Outfalls.

Discharge Velocity at Design Flow in feet per second (fps)	Required Protection				
	Minimum Dimensions				
	Type	Thickness	Width	Length	Height
0 – 5	Rock lining(1)	1 foot	Diameter + 6 feet	8 feet or 4 x diameter, whichever is greater	Crown + 1 foot
5+ – 10	Riprap(2)	2 feet	Diameter + 6 feet or 3 x diameter, whichever is greater	12 feet or 4 x diameter, whichever is greater	Crown + 1 foot
10+ – 20	Gabion outfall	As required	As required	As required	Crown + 1 foot
20+	Engineered energy dissipater required				

Footnotes:

(1) **Rock lining** shall be quarry spalls with gradation as follows:
Passing 8-inch square sieve: 100%
Passing 3-inch square sieve: 40 to 60% maximum
Passing 0.75-inch square sieve: 0 to 10% maximum

(2) **Riprap** shall be reasonably well graded with gradation as follows:
Maximum stone size: 24 inches (nominal diameter)
Median stone size: 16 inches
Minimum stone size: 4 inches

Note: Riprap sizing governed by side slopes on outlet channel is assumed to be approximately 3:1.

The following sections provide general design criteria for various types of outfall features.

General Design Criteria to Protect Aquatic Species and Habitat

Outfall structures should be located where they minimize impacts to fish, shellfish, and their habitats. However, new pipe outfalls can also 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 to the stream. Overwintering juvenile and migrating adult salmonids may use the alcove as shelter during high flows. Potential habitat improvements should be discussed with the Washington Department of Fish and Wildlife (WDFW) biologist prior to inclusion in design.

Bank stabilization, bioengineering, and habitat features may be required for disturbed areas. Outfalls that discharge to the Puget Sound or a major water body may require tide gates. Contact the county for specific requirements.

Rock Splash Pad

At a minimum, all outfalls must be provided with a rock splash pad (see Attachments Section A, Detail 8.0) except as specified below and in Table 4.4.

Flow Dispersal Trench

The flow dispersal trenches (see also Attachments Section A, Detail 1.0) should only be used when both criteria below are met:

- An outfall is necessary to disperse concentrated flows across uplands where no conveyance system exists and the natural (existing) discharge is unconcentrated
- The 100year peak discharge rate is less than or equal to one-half of a cubic foot per second.

4.8.2 Tightline Systems

Tightline systems may be needed to prevent aggravation or creation of a downstream erosion problem. The following general design criteria apply to tightline systems:

- Outfall tightlines may be installed in trenches with standard bedding on slopes up to 20 percent. In order to minimize disturbance to slopes greater than 20 percent, it is recommended that tightlines be placed at grade with proper pipe anchorage and support.
- Except as indicated above, tightlines or conveyances that traverse the marine intertidal zone and connect to outfalls should be buried to a depth sufficient to avoid exposure of the line during storm events or future changes in beach elevation. If non-native material is used to bed the tightline, such material should be covered with at least 3 feet of native bed material or equivalent.
- High density polyethylene pipe (HDPP) tightlines must be designed to address the material limitations, particularly thermal expansion and contraction and pressure design, as specified by the manufacturer. The coefficient of thermal expansion and contraction for solid wall polyethylene pipe (SWPE) is on the order of 0.001 inch per foot per Fahrenheit degree. Sliding sleeve connections should be used to address this thermal expansion and contraction. These sleeve connections consist of a section of the appropriate length of the next larger size diameter of pipe into which the outfall pipe is fitted. These sleeve connections should be located as close to the discharge end of the outfall system as is practical.
- Due to the ability of HDPP tightlines to transmit flows of very high energy, special consideration for energy dissipation must be made. Details of a sample gabion mattress energy dissipater have been provided in Attachments Section A, Detail 9.0. Flows of very high energy will require a specifically engineered energy dissipater structure.

4.9 Flow Spreading Options

Flow spreaders function to uniformly spread flows across the inflow portion of several types of stormwater management facilities (e.g., sand filters, biofiltration swales, filter strips, bioretention areas). There are five flow spreader options presented in this section:

- Option A – Anchored plate
- Option B – Concrete sump box
- Option C – Notched curb spreader
- Option D – Through-curb ports
- Option E – Interrupted curb.

Options A through C can be used for spreading flows that are concentrated. Any one of these

options can be used when spreading is required by the facility design criteria. Options A through C can also be used for unconcentrated flows, and in some cases must be used, such as to correct for moderate grade changes along a filter strip.

Options D and E are only for flows that are already unconcentrated and enter a filter strip, bioretention area or continuous inflow biofiltration swale. Other flow spreader options are possible with approval from the reviewing authority.

4.9.1 General Design Criteria

- Where flow enters the flow spreader through a pipe, it is recommended that the pipe be submerged to the extent practical to dissipate energy as much as possible.
- For higher inflows (velocities greater than 5 feet per second for the 100year recurrence interval storm), a Type 1 catch basin should be positioned in the spreader and the inflow pipe should enter the catch basin with flows exiting through the top grate. The top of the grate should be lower than the level spreader plate, or if a notched spreader is used, lower than the bottom of the Vnotches.

Option A – Anchored Plate (Figure 4.3)

- An anchored plate flow spreader should be preceded by a sump having a minimum depth of 8 inches and minimum width of 24 inches. If not otherwise stabilized, the sump area should be lined to reduce erosion and to provide energy dissipation.
- The top surface of the flow spreader plate should be level, projecting a minimum of 2 inches above the ground surface of the water quality facility, or Vnotched with notches 6 to 10 inches on center and 1 to 6 inches deep (use shallower notches with closer spacing). Alternative designs may also be used.
- A flow spreader plate should extend horizontally beyond the bottom width of the facility to prevent water from eroding the side slope. The horizontal extent should be such that the bank is protected for all flows up to the 100year recurrence interval flow or the maximum flow that will enter the water quality facility.
- Flow spreader plates should be securely fixed in place.
- Flow spreader plates may be made of either wood, metal, fiberglass reinforced plastic, or other durable material. If wood, pressure treated 4- by 10inch lumber or landscape timbers are acceptable.
- Anchor posts should be 4inch square concrete, tubular stainless steel, or other material resistant to decay.

Option B – Concrete Sump Box (Figure 4.4)

- The wall of the downstream side of a rectangular concrete sump box should extend a minimum of 2 inches above the treatment bed. This serves as a weir to spread the flows uniformly across the bed.
- The downstream wall of a sump box should have “wing walls” at both ends. Side walls and returns should be slightly higher than the weir so that erosion of the side slope is minimized.
- Concrete for a sump box can be either cast-in-place or precast, but the bottom of the sump should be reinforced with wire mesh for cast-in-place sumps.

- Sump boxes should be placed over bases that consists of 4 inches of crushed rock, five-eighths-inch minus to help assure the sump remains level.

Option C – Notched Curb Spreader (Figure 4.5)

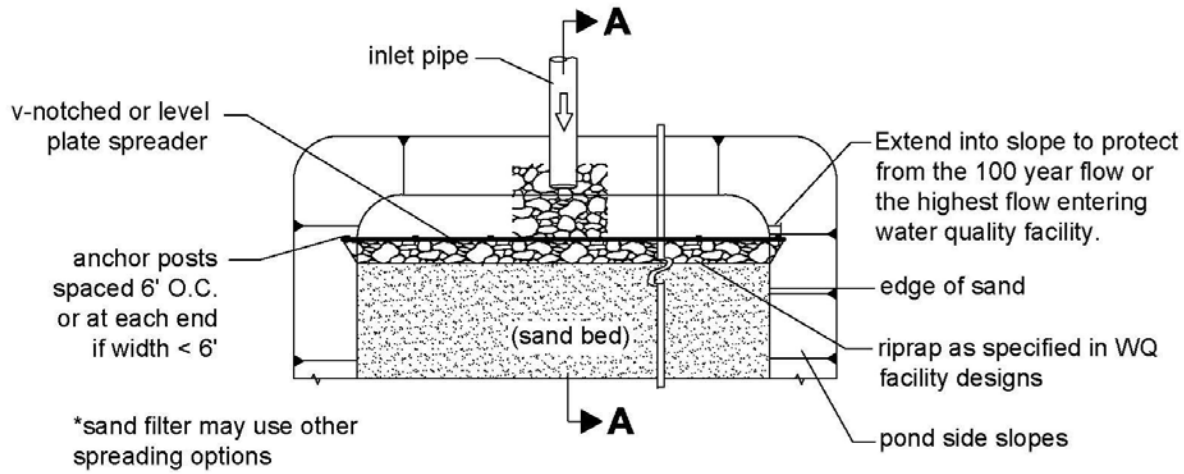
Notched curb spreader sections should be made of extruded concrete laid side-by-side and level. Typically five “teeth” per 4foot section provide good spacing. The space between adjacent “teeth” forms a Vnotch.

Option D –Through-Curb Ports (Figure 4.6)

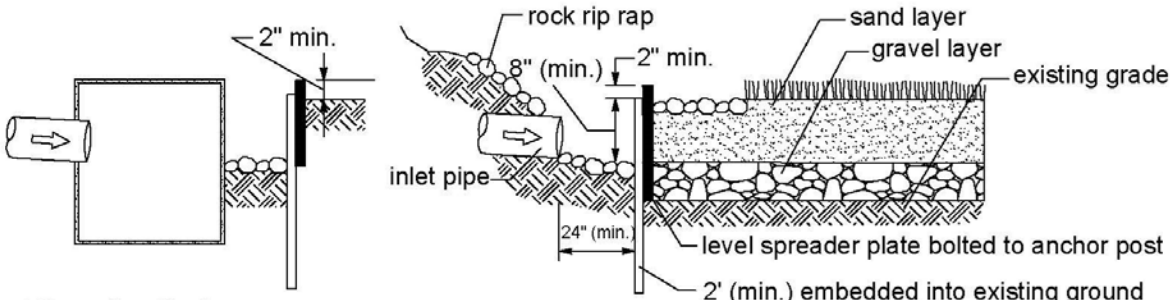
Unconcentrated flows from paved areas entering filter strips, bioretention areas, or continuous inflow biofiltration swales can use curb ports or interrupted curbs (Option E) to allow flows to enter the strip or swale. Curb ports use fabricated openings that allow concrete curbing to be poured or extruded while still providing an opening through the curb to admit water to the water quality facility.

Figure 4.3. - Flow Spreader Option A: Anchored Plate.

Example of anchored plate
used with a sand filter*
(may also be used with other
water quality facilities).



PLAN VIEW
NTS

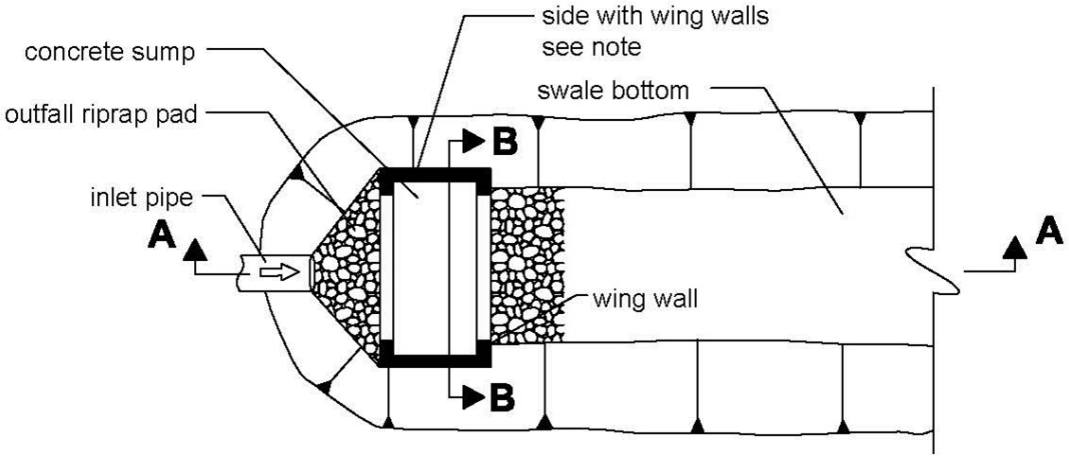


Alternative Design
Catch basin recommended for
higher flow situations (generally
for inflow velocities of 5 fps or
greater for 100 year storm).

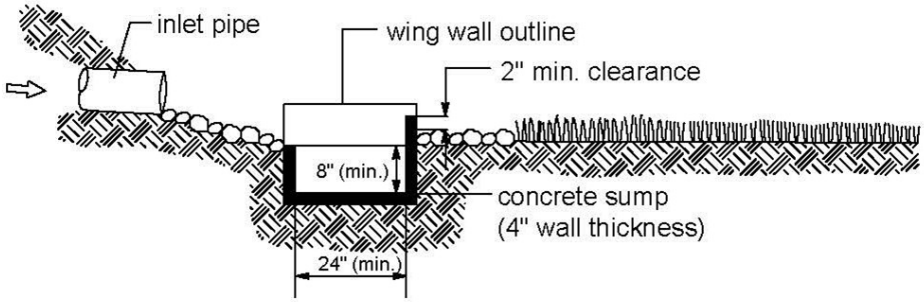
SECTION A-A
NTS

Figure 4.4. - Flow Spreader Option B: Concrete Sump Box.

Example of a concrete sump flow spreader used with a biofiltration swale (may be used with other WQ facilities).

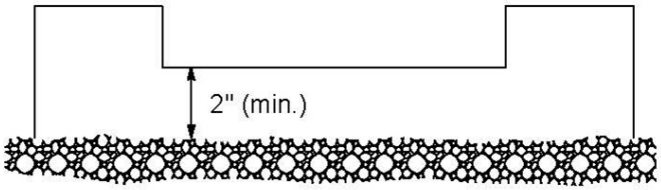


PLAN VIEW
NTS



Note: Extend sides into slope. Height of side wall and wing walls must be sufficient to handle the 100-year flow or the highest flow entering the facility.

SECTION A-A
NTS



SECTION B-B
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Figure 4.5. - Flow Spreader Option C: Notched Curb Spreader.

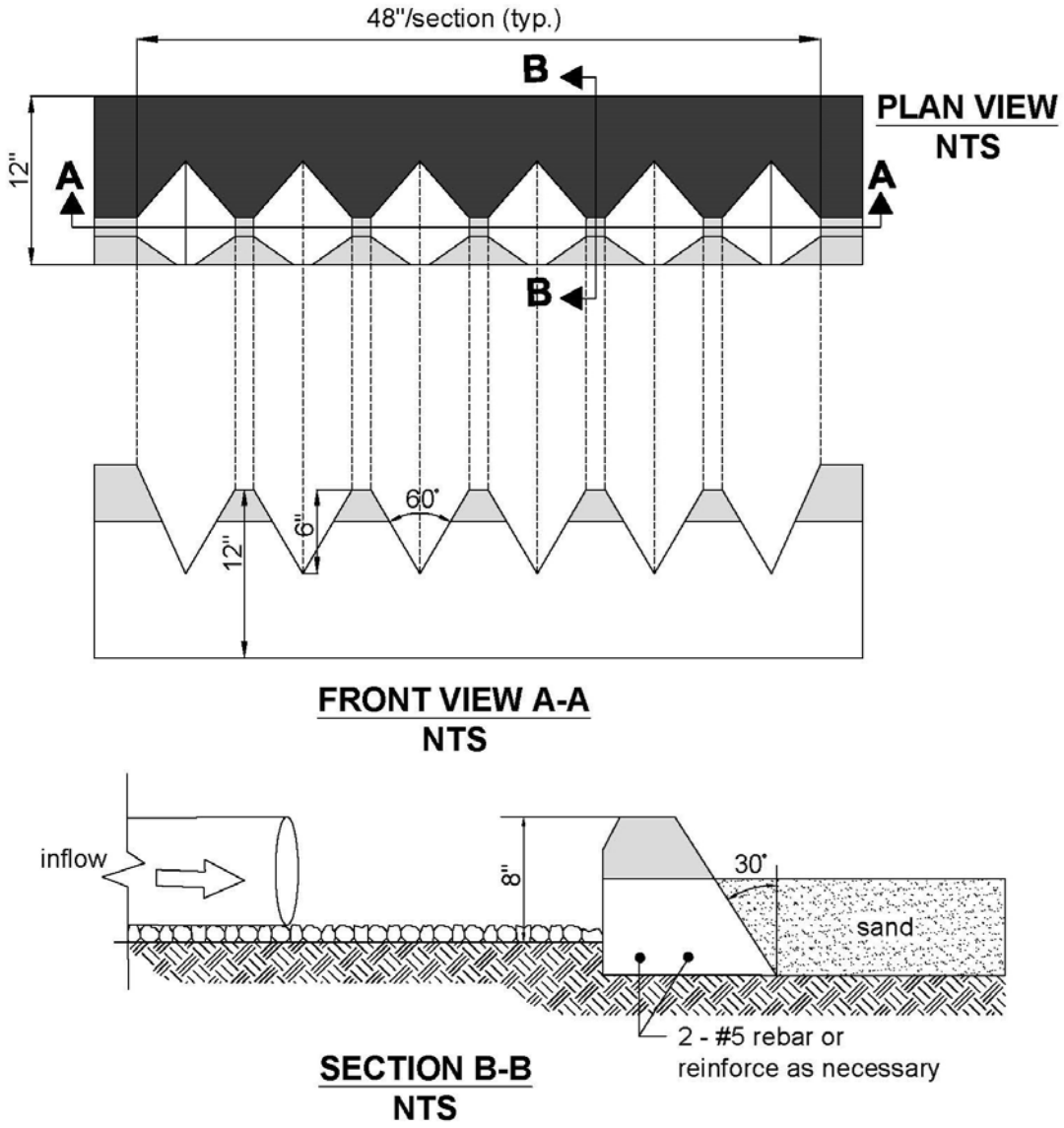
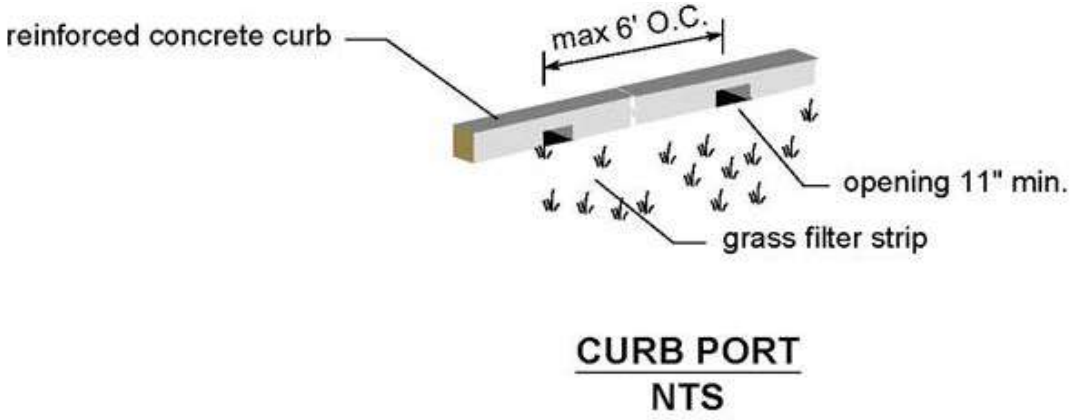


Figure 4.6. - Flow Spreader Option D: Through-Curb Port.



Openings in the curb should be at regular intervals but at least every 6 feet (minimum). The width of each curb port opening should be a minimum of 11 inches. Approximately 15 percent or more of the curb section length should be in open ports, and no port should discharge more than about 10 percent of the flow.

Option E – Interrupted Curb (No Figure)

Interrupted curbs are sections of curb placed to have gaps spaced at regular intervals along the total width (or length, depending on facility) of the treatment area. At a minimum, gaps should be every 6 feet to allow distribution of flows into the treatment facility before they become too concentrated. The opening should be a minimum of 12 inches. As a general rule, no opening should discharge more than 10 percent of the overall flow entering the facility. This option is not allowed along roadways.

4.10 Culvert Criteria

For the purpose of this manual, culverts are single runs of pipe that are open at each end and have no structures such as manholes or catch basins.

Approved pipe materials are detailed in Section 4.7.3. Galvanized or aluminized pipe are not permitted in marine environments or where contact with salt water may occur, even infrequently through backwater events.

4.10.1 Culvert Design Criteria

Flow capacity shall be determined by analyzing inlet and outlet control for headwater depth. Nomographs used for culvert design shall be included in the submitted engineering Report. Appendix IIIC also includes several nomographs that may be useful for culvert sizing.

All culverts shall be designed to convey the flows per Section 4.2. The maximum design headwater depth shall be 1.5 times the diameter of the culvert with no saturation of roadbeds. Minimum culvert diameters are as follows:

- For cross culverts under public roadways – minimum 18 inches, 12 inches if grade and cover do not allow for 18 inches
- For roadside culverts, including driveway culverts, minimum 12 inches
- For culverts on private property, minimum 8 inches.

Inlets and outlets shall be protected from erosion by rock lining, riprap, or biostabilization as detailed in Table 4.5.

Debris and access barriers are required on inlet and outlet ends of all culverts greater than 18 inches in diameter. Culverts greater than 36 inches in diameter within stream corridors are exempt.

Table 4.5. - Open Conveyance Protection.

Velocity at Design Flow (fps)				
Greater Than	**Less Than or Equal To**	**Protection**	**Thickness**	**Min. Height Required Above Design Water Surface**
0	5	Grass Lining[3]	N/A	0.5 ft.
5	8	Riprap[1,3]	1 ft.	2 ft.
8	12	Riprap[2]	2 ft.	2 ft.
12	20	Slope mattress, gabion, etc.	Varies	1 ft.

[1] Riprap shall be in accordance with Section 9-13.1 of the WSDOT/APWA standard specifications.
Riprap shall be a reasonably well graded assortment of rock with the following gradation:
Maximum stone size 12"
Median stone size 8"
Minimum stone size 2"

[2] Riprap shall be reasonably well graded assortment of rock with the following gradation:
Maximum stone size 24"
Median stone size 16"
Minimum stone size 4"
Note: Riprap sizing governed by side slopes on channel, assumed ~3.1.

[3] Bioengineered lining allowed for design flow up to 8 fps.

Minimum culvert velocity shall be 2 feet per second and maximum culvert velocity shall be 15 feet per second. Thirty (30) feet per second may be used with an engineered outlet protection designed. No maximum velocity for ductile iron or HDPE pipe shall be established but outlet protection shall be provided.

All CPEP and PVC culverts and pipe systems shall have concrete or rock headwalls at exposed pipe ends.

Bends are not permitted in culvert pipes.

The following minimum cover shall be provided over culverts:

- 2 feet under roads
- 1 foot under roadside applications and on private property, exclusive of roads
- If the minimum cover cannot be provided on a flat site, use ductile iron pipe and analyze for loadings
- Maximum culvert length: 250 feet
- Minimum separation from other pipes:
    - 6 inches vertical (with bedding) and in accordance with the Pierce County Sewer Utility Design criteria
    - 3 feet horizontal.

Trench backfill shall be bankrun gravel or suitable native material compacted to 95 percent Modified Proctor test to a depth of 2 feet; 90 percent below 2 feet compacted in 8 inch to 12 inch lifts.

All driveway culverts shall be of sufficient length to provide a minimum 3:1 slope from the edge of the driveway to the bottom of the ditch. Culverts shall have beveled end sections to match the side slope.

4.10.2 Fish Passage Criteria

Culverts in stream corridors must meet any fish passage requirements of the WDFW.

4.11 Open Conveyances

Open conveyances can be either roadside ditches, grass lined swales, or a combination thereof. Consideration must be given to public safety when designing open conveyances adjacent to traveled ways and when accessible to the public. Where space and topography permit, open conveyances are the preferred means of collecting and conveying stormwater.

Open conveyances shall be designed by one of the following methods:

- Manning's Equation (for uniform flow depth, flow velocity, and constant channel cross-section)
- Direct Step Backwater Method (utilizing the energy equation)
- Standard Step Backwater Method (utilizing a computer program).

Velocities must be low enough to prevent channel erosion based on the native soil characteristics or the compacted fill material. For velocities above 5 feet per second, channels shall have either rock-lined bottoms and side slopes to the roadway shoulder top with a minimum thickness of 8 inches, or shall be stabilized in a fashion acceptable to the county. Water quality shall not be degraded due to passage through an open conveyance. See Table 4.5.

Channels having a slope less than 6 percent and having peak velocities less than 5 feet per second shall be lined with vegetation.

Channel side slopes shall not exceed 2:1 for undisturbed ground (cuts) as well as for disturbed ground (embankments). All constructed channels shall be compacted to a minimum 95 percent compaction as verified by a Modified Proctor test. Channel side slopes adjacent to roads shall not exceed 4:1 and will meet all other AASHTO and county road standards.

Channels shall be designed with a minimum freeboard of one-half-foot when the design flow is 10 cubic feet per second or less and 1 foot when the design discharge is greater than 10 cubic feet per second.

Check dams for erosion and sedimentation control may be used for stepping down channels being used for biofiltration.

4.12 Private Drainage Systems

The engineering analysis for a private drainage system is the same as for a county system.

4.12.1 Discharge Locations

Stormwater will not be permitted to discharge directly onto county roads or into a county system without the prior approval of the county. Discharges to a county system shall be into a structure such as an inlet, catch basin, manhole, through an approved sidewalk underdrain or curb drain, or into an existing or created county ditch. Concentrated drainage will not be allowed to discharge across sidewalks, curbs, or driveways.

4.12.2 Drainage Stub-Outs

If drainage outlets (stub-outs) are to be provided for each individual lot, the stub-outs shall

conform to the requirements outlined below. Note that all applicable Minimum Requirements in Volume I, in particular Minimum Requirement #5, must also be addressed for the project site.

- Each outlet shall be suitably located at the lowest elevation on the lot, so as to service all future roof downspouts and footing drains, driveways, yard drains, and any other surface or subsurface drains necessary to render the lots suitable for their intended use. Each outlet shall have free-flowing, positive drainage to an approved stormwater conveyance system or to an approved discharge location.
- Outlets on each lot shall be located with a 5foot-high, 2- x 4inch stake marked “storm” or “drain.” For stub-outs to a surface drainage, the stub-out shall visibly extend above surface level and be secured to the stake.
- The developer and/or contractor is responsible for coordinating the locations of all stub-out conveyance lines with respect to the utilities (e.g., power, gas, telephone, television).
- All individual stub-outs shall be privately owned and maintained by the lot home owner including from the property line to the riser on the main line.

Volume III References and Information Sources

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Appendix III-A – Methods for Determining Design Infiltration Rates

Determine Design Infiltration Rate:

There are three acceptable methods for estimating initial infiltration rates. Each is described in detail in this appendix. A safety/correction factor is applied to the initial rate to determine the design infiltration rate. Note that the subgrade safety/correction factors in this appendix may not apply to bioretention, permeable pavement, and rain gardens. Refer to Sections 3.4, 3.5, and 3.8 for additional guidance on infiltration testing methods and application of appropriate safety/correction factors specific to bioretention, permeable pavement, and rain gardens.

- Method 1. Field Testing Procedures (must incorporate safety factor)
    - U.S. EPA Falling Head Percolation Test Procedure (as Modified for Pierce County). This test applies to all infiltration facilities, but may not be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.
    - Large-Scale Pilot Infiltration Test (PIT). This test applies to infiltration facilities with drainage areas greater than one acre and may be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.
    - Small-Scale (PIT). This test applies to infiltration facilities with drainage areas less than one acre and may be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.
- Method 2. USDA Soil Textural Classification. This method only applies to projects sites that trigger Minimum Requirement #1 through #5 (not #1 through #10) AND are underlain by Spanaway soils (as defined by the Soils Survey of Pierce County Area, 1979, and field verified by a qualified professional). This method may not be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.
- Method 3. Soil Grain Size Analysis. This method applies to project sites that are that are underlain by type A soils (see Appendix III-B Table B.5 Major Soil Groups in Pierce County), and may not be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.

Method 1 – Field Testing Procedures

- Excavate to the bottom elevation of the proposed infiltration facility. Measure the infiltration rate of the underlying soil using either the U.S. EPA falling head percolation test procedure as modified for Pierce County (presented below), the double ring infiltrometer test (ASTM D3385, not presented in this appendix), or Ecology large and small scale Pilot Infiltration Test (PIT) described below and presented in the 2014 Ecology Stormwater Management Manual for Western Washington.
- Fill test hole or apparatus with water and maintain at depths above the test elevation for the saturation periods specific for the appropriate test.
- Following the saturation period, the infiltration rate shall be determined in accordance with the specified test procedures.

- See individual BMP descriptions for requirements related to the number and location of tests required.
- For all field testing procedures, apply safety factor to obtain design infiltration rate (see next section).

Safety Factor for Field Measurements

The following equation incorporates safety factors to adjust for uncertainties related to testing, depth to the water table or impervious strata, infiltration receptor geometry, and long-term reductions in permeability due to biological activity and accumulation of fines. Note that the safety factors below may not apply to the infiltration testing conducted for bioretention, permeable pavement and/or rain gardens (see Sections 3.4, 3.5, and 3.8 for additional information). This equation estimates the maximum design infiltration rate, I_{design}. Additional reduction of the design infiltration rate may be appropriate depending on site conditions. In no case may the design infiltration rate exceed 30 inches/hour.

$$I_{design} = I_{measured} \times F_{testing} \times F_{geometry} \times F_{plugging}$$

$F_{testing}$ accounts for uncertainties in the testing methods. For the full scale PIT method, $F_{testing}$ = 0.75; for the small-scale PIT method, $F_{testing}$; for smaller-scale infiltration tests such as the double-ring infiltrometer test, $F_{testing}$ = 0.40; for grain size analysis, $F_{testing}$ = 0.40. These values are intended to represent the difference in each test's ability to estimate the actual saturated hydraulic conductivity. The assumption is the larger the scale of the test, the more reliable the result.

$F_{geometry}$ accounts for the influence of facility geometry and depth to the water table or impervious strata on the actual infiltration rate. A shallow water table or impervious layer will reduce the effective infiltration rate of a large pond, but this would not be reflected in a small scale test. $F_{geometry}$ must be between 0.25 and 1.0 as determined by the following equation:

$$F_{geometry} = 4\ D/W + 0.05$$

Where:

D = depth from the bottom of the proposed facility to the maximum wet season water table or nearest impervious layer, whichever is less.

W = width of facility

$F_{plugging}$ accounts for reductions in infiltration rates over the long term due to plugging of soils. This factor is:

- 0.7 for loams and sandy loams
- 0.8 for fine sands and loamy sands
- 0.9 for medium sands
- 1.0 for coarse sands or cobbles.

Falling Head Percolation Test Procedure (as Modified for Pierce County) (Source: U.S. EPA, On-site Wastewater Treatment and Disposal Systems, 1980)

Note: This test may not be used to demonstrate infeasibility of bioretention, permeable pavement, or rain gardens in meeting Minimum Requirement #5.

1. **Location of Tests**

   Tests shall be spaced uniformly throughout the area. If soil conditions are highly variable, more tests may be required.

2. **Preparation of Test Hole (as modified for Pierce County)**

   The diameter of each test hole is 8 inches, dug or bored to the proposed depths of the absorption systems or to the most limiting soil horizon. To expose a natural soil surface, the bottom of the hole is scratched with a sharp pointed instrument and the loose material is removed from the test hole. A 6inch-inner-diameter, 4foot long, PVC pipe is set into the hole and pressed into the soil 6 inches and then 2 inches of one-half to three-fourths-inch rock are placed in the pipe to protect the bottom from scouring when water is added.

3. **Soaking Period**

   The pipe is carefully filled with at least 12 inches of clear water. The depth of water must be maintained for at least 4 hours and preferably overnight if clay soils are present. A funnel with an attached hose or similar device may be used to prevent water from washing down the sides of the hole. Automatic siphons or float valves may be employed to automatically maintain the water level during the soaking period. It is extremely important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained.

   In sandy soils with little or no clay, soaking is not necessary. If, after filling the pipe twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

4. **Measurement of the Percolation Rate**

   Except for sandy soils, percolation rate measurements are made 15 hours but no more than 30 hours after the soaking period began. The water level is adjusted to 6 inches above the gravel (or 8 inches above the bottom of the hole). At no time during the test is the water level allowed to rise more than 6 inches above the gravel. Immediately after adjustment, the water level is measured from a fixed reference point to the nearest 1/16th-inch at 30 minute intervals. The test is continued until two successive water level drops do not vary by more than 1/16-inch within a 90minute period. At least three measurements are to be made.

   After each measurement, the water level is readjusted to the 6inch level. The last water level drop is used to calculate the percolation rate.

   In sandy soils or soils in which the first 6 inches of water added after the soaking period seeps away in less than 30 minutes, water level measurements are made at 10 minute intervals for a 1hour period. The last water level drop is used to calculate the percolation rate.

5. **Calculation of the Percolation Rate**

   The percolation rate is calculated for each test site by dividing the time interval used between measurements by the magnitude of the last water level drop. This calculation

results in a percolation rate in terms of minutes/inch. To determine the percolation rate for the area, the rates obtained from each hole are averaged. (If tests in the area vary by more than 20 minutes/inch, variations in soil type are indicated. Under these circumstances, percolation rates should not be averaged.) **To compute the design infiltration rate (I_{design}), the final percolation rates must then be adjusted by the appropriate safety factors outlined previously.**

Example: If the last measured drop in water level after 30 minutes is five-eighths-inch, then:

percolation rate = (30 minutes)/(⅝ inch) = 48 minutes/inch. (At a minimum, a safety factor "$F_{testing}$" of 0.5 shall be applied to all field methods for determining infiltration rates.)

Alternative Washington Department of Ecology Infiltration Pit Method

Large-Scale Pilot Infiltration Test (PIT)

Large-scale in-situ infiltration measurements, using the Pilot Infiltration Test (PIT) described below is the preferred method for estimating the measured (initial) saturated hydraulic conductivity (K_{sat}) of the soil profile beneath the proposed infiltration facility. The PIT reduces some of the potential scale errors associated with relatively small-scale tests such as the Modified Falling Head Percolation Test, double ring infiltrometer or "stove-pipe" infiltration tests. It is not a standard test but rather a practical field procedure recommended by Ecology's Technical Advisory Committee.

Infiltration Test:

- Excavate the test pit to the depth of the bottom of the proposed infiltration facility. Lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be approximately 100 square feet.
- Accurately document the size and geometry of the test pit.
- Install a vertical measuring rod (minimum 5 feet long) marked in half-inch increments in the center of the pit bottom.
- Use a rigid 6inch diameter pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates.
- Add water to the pit at a rate that will maintain a water level between 6 and 12 inches above the bottom of the pit. A rotameter can be used to measure the flow rate into the pit.

Note: For infiltration facilities serving large drainage areas, designs with multiple feet of standing water can have infiltration tests with greater than 1 foot of standing water. The depth must not exceed the proposed maximum depth of water expected in the completed facility.

Every 15 to 30 minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point on the measuring rod.

Add water to the pit until 1 hour after the flow rate into the pit has stabilized (constant flow rate; a goal of 5 percent variation or less variation in the total flow) while maintaining the same pond water level (usually 6 hours). The total of the pre-soak time plus one hour after the flow rate has stabilized should be no less than 6 hours.

After the flow rate has stabilized for at least 1 hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty. Consider running this falling head phase of the test several times to estimate the dependency of infiltration rate with head.

Data Analysis:

Calculate and record the infiltration rate in inches per hour in 30 minutes or 1hour increments until 1 hour after the flow has stabilized.

Note: Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.

To compute the design infiltration rate (I_{design}), apply appropriate safety factors outlined previously.

Example:

The area of the bottom of the test pit is 8.5-feet by 11.5-feet.

Water flow rate was measured and recorded at intervals ranging from 15 to 30 minutes throughout the test. Between 400 minutes and 1,000 minutes, the flow rate stabilized between 10 and 12.5 gallons per minute or 600 to 750 gallons per hour, or an average of (9.8 + 12.3) / 2 = 11.1 inches per hour.

To compute the design infiltration rate (I_{design}), the infiltration rate must then be adjusted by the appropriate safety factors outlined previously.

Small-Scale Pilot Infiltration Test

A smaller-scale PIT can be used in any of the following instances:

- The drainage area to the infiltration site is less than one acre
- The testing is for bioretention areas or permeable pavement surfaces that either serve small drainage areas and/or are widely dispersed throughout a project site
- The site has a high infiltration rate, making a large-scale PIT difficult, and the site geotechnical investigation suggests uniform subsurface characteristics.

Infiltration Test

- Excavate the test pit to the estimated surface elevation of the proposed infiltration facility. In the case of bioretention, excavate to the estimated elevation at which the imported soil mix will lie on top of the underlying native soil. For permeable pavement, excavate to the elevation at which the imported subgrade materials, or the pavement itself, will contact the underlying native soil. If the native soils (road subgrade) will have to meet a minimum subgrade compaction requirement, compact the native soil to that requirement prior to testing. Note that the permeable pavement design guidance recommends compaction not exceed 90 – 92 percent. Finally, lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be 12 to 32 square feet. It may be circular or rectangular, but accurately document the size and geometry of the test pit.
- Install a vertical measuring rod adequate to measure the ponded water depth and that is marked in half-inch increments in the center of the pit bottom.
- Use a rigid pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates. Use a 3 inch diameter pipe for pits on the smaller end of the recommended surface area, and a 4 inch pipe for pits on the larger end of the recommended surface area.
- Pre-soak period: Add water to the pit so that there is standing water for at least 6 hours. Maintain the pre-soak water level at least 12 inches above the bottom of the pit.
- At the end of the pre-soak period, add water to the pit at a rate that will maintain a 6-12 inch

water level above the bottom of the pit over a full hour. The depth should not exceed the proposed maximum depth of water expected in the completed facility.

- Every 15 minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point (between 6 – 12 inches) on the measuring rod. The specific depth should be the same as the maximum designed ponding depth (usually 6 – 12 inches).
- After one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty.
- A self-logging pressure sensor may also be used to determine water depth and drain-down.

Data Analysis

See the explanation under the guidance for large-scale pilot infiltration tests.

Method 2 – USDA Soil Textural Classification

Infiltration rates may be estimated from soil grain size distribution (gradation) data using the USDA textural analysis approach. Conduct the grain size distribution test in accordance with the USDA test procedure (Soil Survey Manual, USDA, October 1993, page 136). This manual only considers soil passing the US #10 sieve to determine percentages of sand, silt, and clay for use in Figure A.1. **This method may only be applied to projects sites that trigger Minimum Requirement #1 through #5 and that are underlain by Spanaway soils (as defined by the Soils Survey of Pierce County Area, 1979, and field verified by a qualified professional).**

Short-term (field) infiltration rates, required correction factors, and design (long-term) infiltration rates based on gradations from soil samples and textural analysis are summarized in Table A.1. With prior approval by Pierce County, the correction factors may be reduced (to a minimum of 2.0) if there is little soil variability, there will be a high degree of long-term facility maintenance, and there is adequate pretreatment to reduce total suspended solids in influent stormwater.

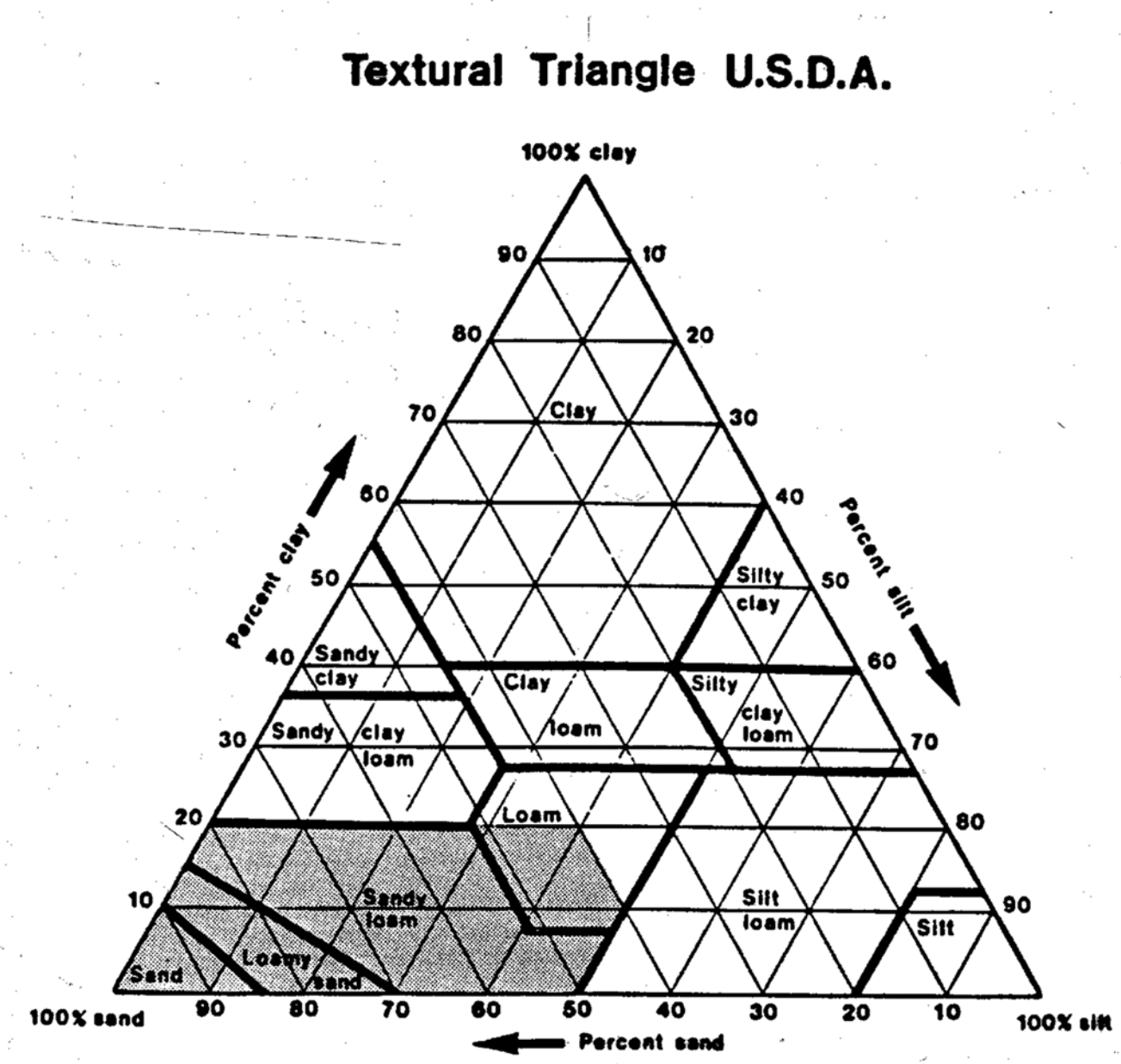
Table A.1. - Recommended Infiltration Rates Based on USDA Soil Textural Classification.

	Short-Term Infiltration Rate (in./hr)[1]	Correction Factor CF	Estimated Design (Longterm) Infiltration Rate (in./hr)
Clean sandy gravels and gravelly sands (i.e., 90% of the total soil sample is retained in the US #10 sieve)	20	2	10
Sand	8	4	2
Loamy Sand	2	4	0.5
Sandy Loam	1	4	0.25
Loam	0.5	4	0.13

Source: Stormwater Management Manual for Western Washington (Ecology 2005).

[1] From WEF/ASCE (1998).

Figure A.1. - USDA Textural Triangle



Shaded area is applicable for design of infiltration BMPs Source: USDA

Method 3 – Soil Grain Size Analysis Method

For each defined layer below the infiltration basin or trench to a depth below the facility bottom of 2.5 times the maximum depth of water in the pond, but not less than 6 feet, estimate the initial saturated hydraulic conductivity (K_{sat}) in cm/sec using the following relationship (see Massmann 2003). This method may only be applied to project sites that are underlain by type A soils. See Appendix III-B Table B.5 Major Soil Groups in Pierce County.

For large infiltration facilities serving drainage areas of 10 acres or more, soil grain size analyses should be performed on layers up to 50 feet deep (or no more than 10 feet below the water table).

$$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines} \qquad (1)$$

Where, D_{10}, D_{60}, and D_{90} are the grain sizes in mm for which 10 percent, 60 percent, and 90 percent of the sample is more fine and f_{fines} is the fraction of the soil (by weight) that passes the US #200 sieve (K_{sat} is in cm/s).

For bioretention areas, analyze each defined layer below the top of the final bioretention area subgrade to a depth of at least 3 times the maximum ponding depth, but not less than 3 feet (1 meter). For permeable pavement, analyze for each defined layer below the top of the final subgrade to a depth of at least 3 times the maximum ponding depth within the base (reservoir) course, but not less than 3 feet (1 meter).

If the licensed professional conducting the investigation determines that deeper layers will influence the rate of infiltration for the facility, soil layers at greater depths must be considered when assessing the site's hydraulic conductivity characteristics. Massmann (2003) indicates that where the water table is deep, soil or rock strata up to 100 feet below an infiltration facility can influence the rate of infiltration. Note that only the layers near and above the water table or low permeability zone (e.g., a clay, dense glacial till, or rock layer) need to be considered, as the layers below the groundwater table or low permeability zone do not significantly influence the rate of infiltration. Also note that this equation for estimating K_{sat} assumes minimal compaction consistent with the use of tracked (i.e., low to moderate ground pressure) excavation equipment.

If the soil layer being characterized has been exposed to heavy compaction (e.g., due to heavy equipment with narrow tracks, narrow tires, or large lugged, high pressure tires) the hydraulic conductivity for the layer could be approximately an order of magnitude less than what would be estimated based on grain size characteristics alone (Pitt, 2003). In such cases, compaction effects must be taken into account when estimating hydraulic conductivity.

For clean, uniformly graded sands and gravels, the reduction in K_{sat} due to compaction will be much less than an order of magnitude. For wellgraded sands and gravels with moderate to high silt content, the reduction in K_{sat} will be close to an order of magnitude. For soils that contain clay, the reduction in K_{sat} could be greater than an order of magnitude.

If greater certainty is desired, the in-situ saturated conductivity of a specific layer can be obtained through the use of a pilot infiltration test (PIT). Note that these field tests generally provide a K_{sat} combined with a hydraulic gradient. In some of these tests, the hydraulic gradient may be close to 1.0; therefore, in effect, the test infiltration rate result is the same as the hydraulic conductivity. In

other cases, the hydraulic gradient may be close to the gradient that is likely to occur in the full-scale infiltration facility. The hydraulic gradient will need to be evaluated on a case-by-case basis when interpreting the results of field tests. It is important to recognize that the gradient in the test may not be the same as the gradient likely to occur in the full-scale infiltration facility in the long-term (i.e., when groundwater mounding is fully developed).

Once the Ksat for each layer has been identified, determine the effective average K_{sat} below the pond. Ksat estimates from different layers can be combined using the harmonic mean:

$$K_{equiv} = \frac{d}{\sum \frac{d_i}{K_i}} \qquad (2)$$

Where, d is the total depth of the soil column, d_i is the thickness of layer "i" in the soil column, and K_i is the saturated hydraulic conductivity of layer "i" in the soil column. The depth of the soil column, d, typically would include all layers between the pond bottom and the water table. However, for sites with very deep water tables (>100 feet) where groundwater mounding to the base of the pond is not likely to occur, it is recommended that the total depth of the soil column in Equation 2 be limited to approximately 20 times the depth of pond, but not more than 50 feet. This is to ensure that the most important and relevant layers are included in the hydraulic conductivity calculations. Deep layers that are not likely to affect the infiltration rate near the pond bottom should not be included in Equation 2.

Equation 2 may over-estimate the effective K_{sat} value at sites with low conductivity layers immediately beneath the infiltration basin. For sites where the lowest conductivity layer is within five feet of the base of the pond, it is suggested that this lowest K_{sat} value be used as the equivalent hydraulic conductivity rather than the value from Equation 2. Using the layer with the lowest K_{sat} is advised for designing bioretention areas or permeable pavement surfaces. The harmonic mean given by Equation 2 is the appropriate effective hydraulic conductivity for flow that is perpendicular to stratigraphic layers, and will produce conservative results when flow has a significant horizontal component such as could occur due to groundwater mounding.

Recommended Modifications to ASTM D 2434 When Measuring Hydraulic Conductivity for Bioretention Soil Mixes

Developed by the City of Seattle in cooperation with local soils laboratories.

Proctor method ASTM D1557 Method C (6-inch mold) and ASTM D2434 shall be used to determine the hydraulic conductivity of bioretention soil samples with a compaction rate of 85 percent. Sample preparation for the Proctor test (ASTM D1557 Method C) shall be amended in the following ways:

1. Maximum grain size within the sample shall be no more than 0.5 inches in size.
2. Snip larger organic particles (if present) into 0.5 inch long pieces.
3. When adding water to the sample during the Proctor test, allow the sample to pre-soak for at least 48 hours to allow the organics to fully saturate before compacting the sample. This pre-soak ensures the organics have been fully saturated at the time of the test.

ASTM D2434 shall be used and amended in the following ways:

1. Apparatus:
    a. 6-inch mold size shall be used for the test

b. If using porous stone disks for the testing, the permeability of the stone disk shall be measured before and after the soil tests to ensure clogging or decreased permeability has not occurred during testing

c. Use the confined testing method, with 5- to 10-pound force spring

d. Use de-aired water.

2. Sample:

a. Maximum grain size within the sample shall not be more than 0.5inch in size.

b. Snip larger organic particles (if present) into 0.5inch long pieces.

c. Pre-soak the sample for at least 48 hours prior to loading it into the mold. During the pre-soak, the moisture content shall be higher than optimum moisture but less than full saturation (i.e., there shall be no free water). This pre-soak ensures the organics have been fully saturated at the time of the test.

3. Preparation of Sample:

a. Place soil in cylinder via a scoop.

b. Place soil in 1-inch lifts and compact using a 2-inch-diameter round tamper. Pre-weigh how much soil is necessary to fill 1-inch lift at 85 percent of maximum dry density, then tamp to 1-inch thickness. Once mold is full, verify that density is at 85 percent of maximum dry density (+ or – 0.5 percent). Apply vacuum (20 inches Hg) for 15 minutes before inundation.

c. Inundate sample slowly under a vacuum of 20 inches Hg over a period of 60 to 75 minutes.

d. Slowly remove vacuum (> 15 seconds).

e. Sample shall be soaked in the mold for 24 to 72 hours before starting test.

4. Procedure:

a. The permeability test shall be conducted over a range of hydraulic gradients between 0.1 and 2

b. Steady state flow rates shall be documented for four consecutive measurements before increasing the head

c. The permeability test shall be completed within 1 day (1-day test duration).

Appendix III-B – Design Aids: Design Storm Precipitation Values, Isopluvial Maps, SCS Curve Numbers, Roughness Coefficients, and Soil Types

Single Event Model Guidance

The only approved use of a single event model is for the sizing of conveyance systems. Approved continuous simulation runoff models will be used for the design of water quality and quantity BMPs.

SBUH or SCS Methods

The applicant shall use the western Washington SCS curve numbers, not the SCS national curve numbers. These have been included in Table B.4. Individual curve numbers for a drainage area may be averaged into a "composite" curve number for use in either the SCS or SBUH methods. The NRCS (formerly SCS) has, for many years, conducted studies of the runoff characteristics for various land types. After gathering and analyzing extensive data, NRCS has developed relationships between land use, soil type, vegetation cover, interception, infiltration, surface storage, and runoff. The relationships have been characterized by a single runoff coefficient called a "curve number." The National Engineering Handbook – Section 4: Hydrology (NEH4, SCS, August 1972) contains a detailed description of the development and use of the curve number method.

NRCS has developed "curve number" (CN) values based on soil type and land use. They can be found in "Urban Hydrology for Small Watersheds", Technical Release 55 (TR55), June 1986, published by the NRCS. The combination of these two factors is called the "soil-cover complex." The soil-cover complexes have been assigned to one of four hydrologic soil groups, according to their runoff characteristics. NRCS has classified over 4,000 soil types into these four soil groups. Table B.5 shows the hydrologic soil group of most soils in Pierce County and provides a brief description of the four groups. For details on other soil types refer to the NRCS publication mentioned above (TR55, 1986).

Isopluvial Maps

National Oceanic and Atmospheric Administration (NOAA) isopluvial maps for Pierce County and Tacoma are included below. The professional engineer shall use the best engineering judgment in selecting the runoff totals for the project site.

Time of Concentration

Time of concentration is the sum of the travel times for sheet flow, shallow concentrated flow, and channel flow. For lakes and submerged wetlands, the travel time can be determined with storage routing techniques if the stage-storage versus discharge relationship is known or it may be assumed to be "zero."

Sheet Flow

With sheet flow, the friction value (ns) (a modified Manning's effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges and rocks; and erosion and transportation of sediment) is used. These n_s values are for very shallow flow depths of about 0.1 foot and are only used for travel lengths up to 300 feet. Table B.2 gives Manning's n_s values for sheet flow for various surface conditions.

For sheet flow of up to 300 feet, use Manning's kinematic solution to directly compute T_t.

$$T_t = \frac{0.42^*(n_s L)^{0.8}}{(P_2)^{0.5}(S_o)^{0.4}}$$

where:

T_t = travel time (min),

n_s = sheet flow Manning's effective roughness coefficient (Table B.2).

L = flow length (ft),

P_2 = 2-year, 24-hour rainfall (in), and

S_o = slope of hydraulic grade line (land slope, ft/ft)

The maximum allowable distance for sheet flow shall be 300 feet, the remaining overland flow distance shall be shallow concentrated flow until the water reaches a channel.

Shallow Concentrated Flow

After a maximum of 300 feet, sheet flow is assumed to become shallow concentrated flow. The average velocity for this flow can be calculated using the ks values from Table B.2 in which average velocity is a function of watercourse slope and type of channel.

The average velocity of flow, once it has measurable depth, shall be computed using the following equation:

$$V = k\sqrt{S_o}$$

where:

V = velocity (ft/s)

k = time of concentration velocity factor (ft/s)

S_o = slope of flow path (ft/ft)

"k" is computed for various land covers and channel characteristics with assumptions made for hydraulic radius using the following rearrangement of Manning's equation:

$$k = (1.49(R)^{0.667})/n$$

where:

R = an assumed hydraulic radius

n = Manning's roughness coefficient for open channel flow (see Table B.3)

Open Channel Flow

Open channels are assumed to begin where surveyed cross-section information has been obtained, where channels are visible on aerial photographs, or where lines indicating streams appear (in blue) on United States Geological Survey (USGS) quadrangle sheets. The k_c values from Table B.2 used in the Velocity Equation above or water surface profile information can be used to estimate average flow velocity.

Lakes or Wetlands

This travel time is normally very small and can be assumed as zero. Where significant attenuation may occur due to storage effects, the flows should be routed using a "level pool routing" technique.

Limitations

The following limitations apply in estimating travel time (T_t).

- Manning's kinematic solution should not be used for sheet flow longer than 300 feet.
- In watersheds with storm drains, carefully identify the appropriate hydraulic flow path to estimate T_c.
- Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or non-pressure flow.
- A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. A hydrograph should be developed to this point and a level pool routing technique used to determine the outflow rating curve through the culvert or bridge.

Design Storm Hyetographs

The standard design hyetograph is the SCS Type 1A 24hour rainfall distribution resolved into 10minute time intervals. Various interpretations of the hyetograph are available and may differ slightly from distributions used in other unit hydrograph based computer simulations. Other distributions will be accepted with adequate justification and as long as they do not increase the allowable release rates.

For project sites with tributary drainage areas above elevation 1,000 feet MSL, an additional total precipitation must be added to the total depth of rainfall for the 25-, 50-, and 100year design storm events to account for the potential average snowmelt which occurs during major storm events.

The MSL "factor" is computed as follows:

$$M_s(\text{in inches}) = 0.004\,(MB_{el} - 1000)$$

where:

M_s = rainfall amount to be added to P_r

Mb_{el} = the mean tributary basin elevation above sea level (in feet)

Subbasin Delineation

Within an overall drainage basin it may be necessary to delineate separate subbasins based on similar land uses and/or runoff characteristics or when hydraulically "self-contained" areas are found to exist. When this is necessary, separate hydrographs shall be generated, routed, and recombined, after travel time is considered, into a single hydrograph to represent runoff flows into the quantity or quality control facility.

Hydrograph Phasing Analysis

Where flows from multiple basins or subbasins having different runoff characteristics and/or travel times combine, the design engineer shall sum the hydrographs after shifting each hydrograph according to its travel time to the discharge location of interest. The resultant hydrograph shall be either routed downstream as required in the downstream analysis, or routed through the control facility.

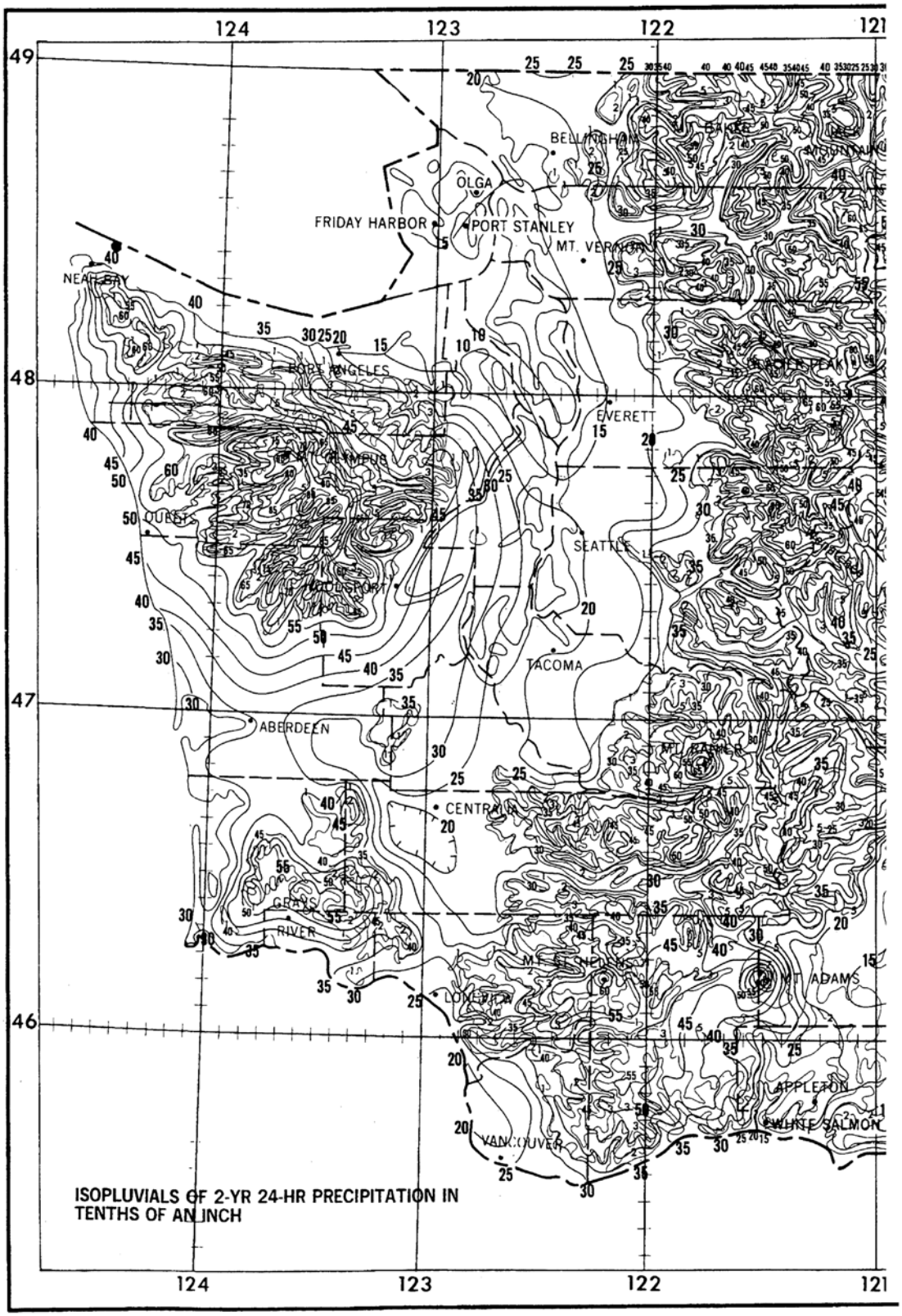
Included in this appendix are the 2-, 10-, and 100year, 24hour design storm and mean annual precipitation isopluvial maps for western Washington. These have been taken from NOAA Atlas 2 "Precipitation - Frequency Atlas of the Western United States, Volume IX, Washington. The applicant has the option of using the National Oceanic and Atmospheric Administration (NOAA) isopluvials for design purposes or utilizing the design storm precipitation values listed in Table B.1 below. The listed values can be used to an elevation of 650 feet, Mean Sea Level (MSL). Above 650 feet, MSL, the applicant shall use the NOAA isopluvials for selection of the design storm precipitation.

Table B.1. - Design Storm Precipitation Values

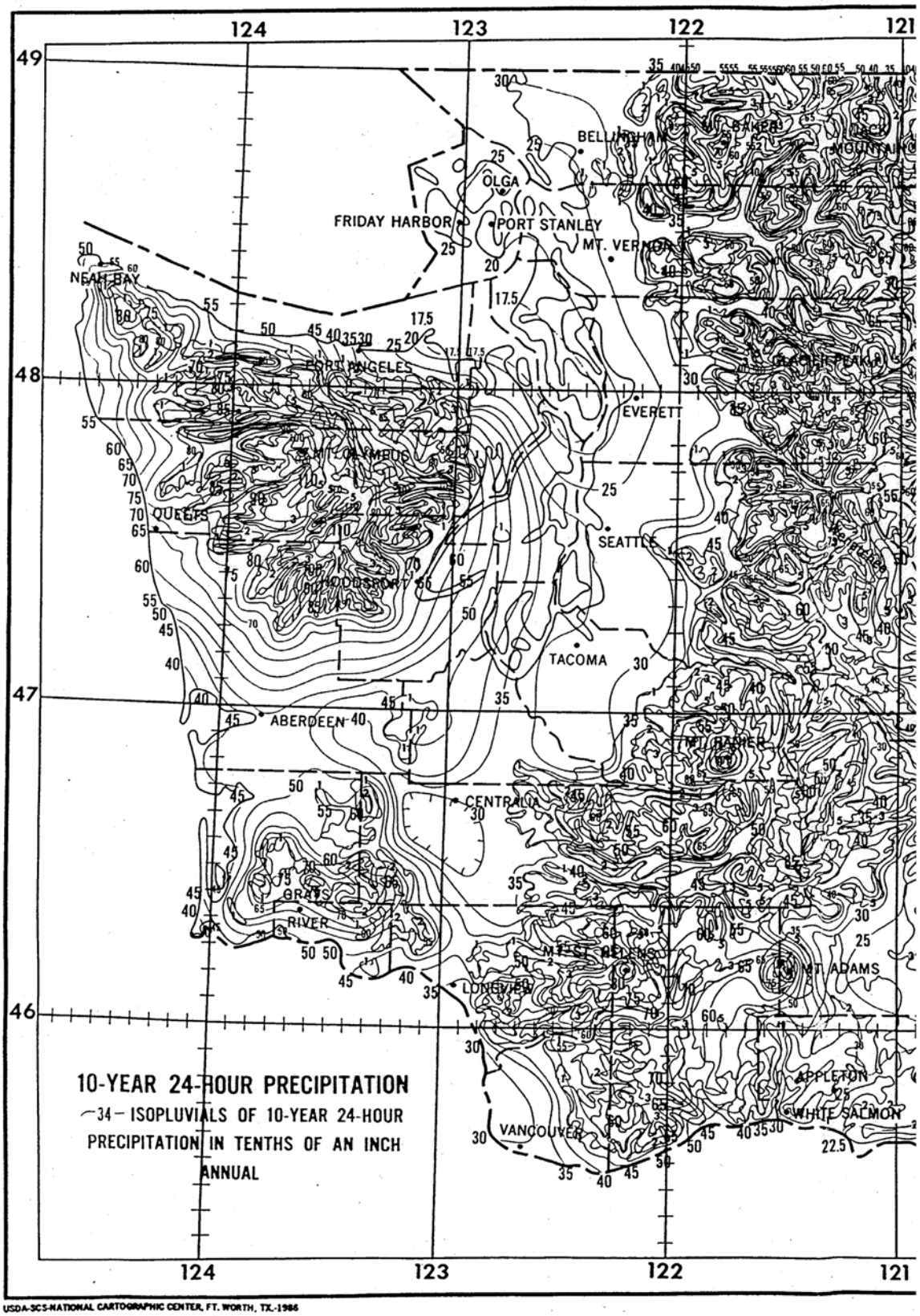
Return Frequency 24-Hour Storm Event (Years)	Tacoma/Puyallup Southern Pierce County	Gig Harbor	KPN[1]
0.5	1.28	1.6	1.92
2	2.0	2.5	3.0
5	2.5	3.0	3.5
10	3.0	3.5	4.3
25	3.5	4.0	4.5-5.0
50	3.8	4.5	5.0-5.5
100	4.1	4.8	5.5-6.0

1 KPN = Key Peninsula, North

Western Washington Isopluvial 2year, 24hour.



Western Washington Isopluvial 10year, 24hour.



Western Washington Isopluvial 100year, 24hour.

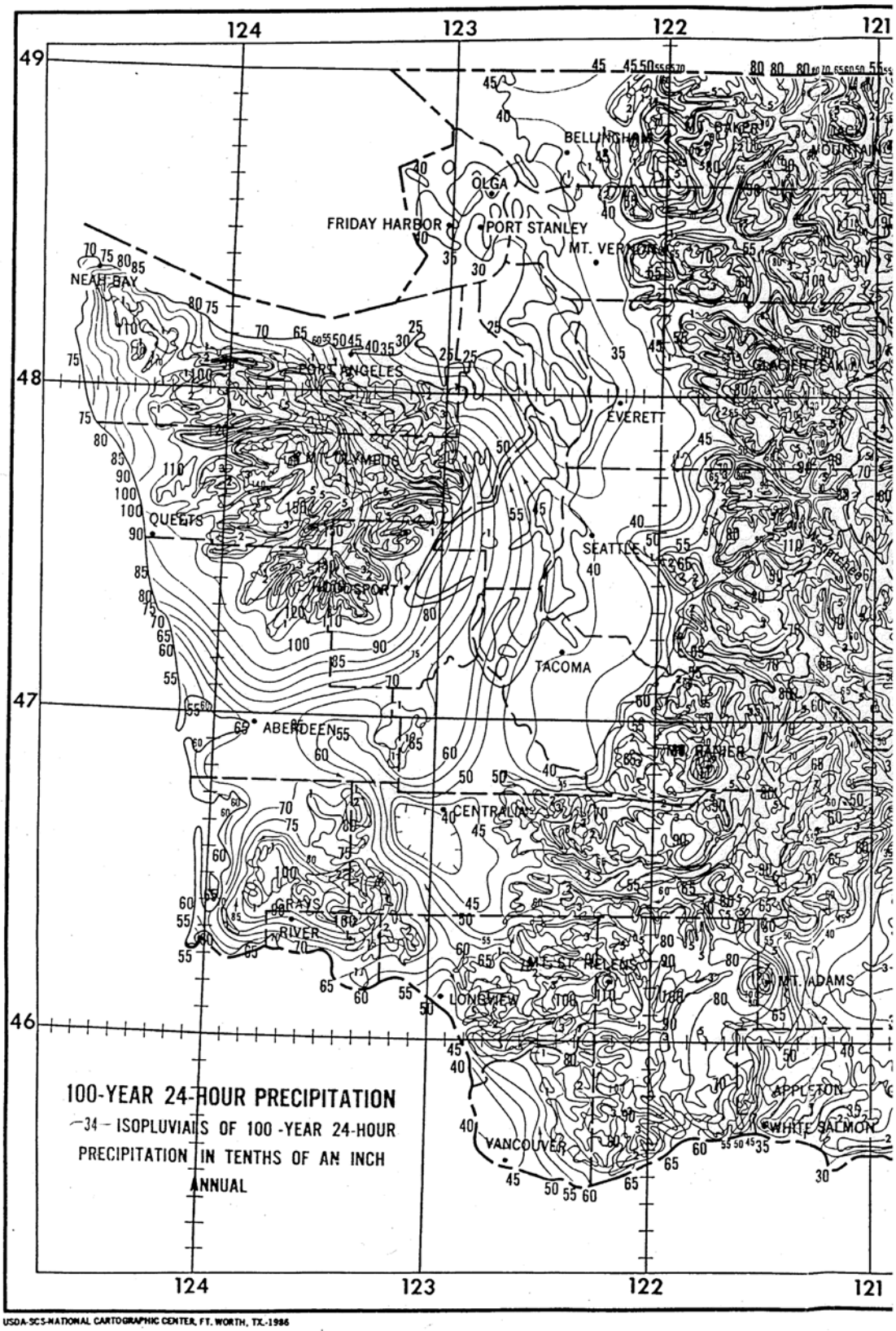


Table B.2. - "n" and "k" Values Used in Time Calculations for Hydrographs.

"n" Sheet Flow Equation Manning's Values (for the initial 300 ft. of travel)	**n_s[1]**
Smooth surfaces (concrete, asphalt, gravel, or bare hand packed soil)	0.011
Fallow fields or loose soil surface (no residue)	0.05
Cultivated soil with residue cover (s≤ 0.20 ft/ft)	0.06
Cultivated soil with residue cover (s> 0.20 ft/ft)	0.17
Short prairie grass and lawns	0.15
Dense grasses	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods or forest with light underbrush	0.40
Woods or forest with dense underbrush	0.80
Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1)	**k_s**
1. Forest with heavy ground litter and meadows (n = 0.10)	3
2. Brushy ground with some trees (n = 0.060)	5
3. Fallow or minimum tillage cultivation (n = 0.040)	8
4. High grass (n = 0.035)	9
5. Short grass, pasture and lawns (n = 0.030)	11
6. Nearly bare ground (n = 0.025)	13
7. Paved and gravel areas (n = 0.012)	27
Channel Flow (intermittent) (At the beginning of visible channels R = 0.2)	**k_c**
1. Forested swale with heavy ground litter (n = 0.10)	5
2. Forested drainage course/ravine with defined channel bed (n = 0.050)	10
3. Rock-lined waterway (n = 0.035)	15
4. Grassed waterway (n = 0.030)	17
5. Earth-lined waterway (n = 0.025)	20
6. CMP pipe (n = 0.024)	21
7. Concrete pipe (0.012)	42
8. Other waterways and pipe	0.508/n
Channel Flow (Continuous stream, R = 0.4)	**k_c**
9. Meandering stream with some pools (n = 0.040)	20
10. Rock-lined stream (n = 0.035)	23
11. Grass-lined stream (n = 0.030)	27
12. Other streams, man-made channels and pipe	0.807/n2

[1] Manning values for sheet flow only, from Overton and Meadows 1976 (See TR-55, 1986) "k" Values Used in Travel Time/Time of Concentration Calculations

[2] Determined from Table B.3

Ref: DOE Stormwater Management Manual for the Puget Sound Basin, February 1992.

Table B.3. - Values of the Roughness Coefficient "n".

Type of Channel and Description	Manning's "n"
Constructed Channels	
a. Earth, straight and uniform	
1. Clean, recently completed	0.018
2. Gravel, uniform section, clean	0.025
3. With short grass, few weeds	0.027
b. Earth, winding and sluggish	0.025
1. No vegetation	0.025
2. Grass, some weeds	0.030
3. Dense weeds or aquatic plants in deep channels	0.035
4. Earth bottom and rubble sides	0.030
5. Stony bottom and weedy banks	0.035
6. Cobble bottom and clean sides	0.040
c. Rock lined	
1. Smooth and uniform	0.035
2. Jagged and irregular	0.040
d. Channels not maintained, weeds and brush uncut	
1. Dense weeds, high as flow depth	0.080
2. Clean bottom, brush on sides	0.050
3. Same as above, highest stage of flow	0.070
4. Dense brush, high stage	0.100
Natural Streams	
B-1 Minor streams (top width at flood stage < 100 ft.)	
a. Streams on plain	
1. Clean, straight, full stage no rifts or deep pools	0.030
2. Same as above, but more stones and weeds	0.035
3. Clean, winding, some pools and shoals	0.040
4. Same as above, but some weeds	0.040
5. Same as 4, but more stones	0.050
6. Sluggish reaches, weedy deep pools	0.070
7. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.100
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages	
1. Bottom: gravel, cobbles, and few boulders	0.040
2. Bottom: cobbles with large boulders	0.050
B-2 Flood plains	
a. Pasture, no brush	
1. Short grass	0.030
2. High grass	0.035
b. Cultivated areas	
1. No crop	0.030
2. Mature row crops	0.035
3. Mature field crops	0.040
c. Brush	
1. Scattered brush, heavy weeds	0.050
2. Light brush and trees	0.060
3. Medium to dense brush	0.070
4. Heavy, dense brush	0.100
d. Trees	
1. Dense willows, straight	0.150
2. Cleared land with tree stumps, no sprouts	0.040
3. Same as above, but with heavy growth of sprouts	0.060
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.100
5. Same as above, but with flood stage reaching branches	0.120

Ref: DOE Stormwater Management Manual for the Puget Sound Basin, February 1992.

Table B.4. - Runoff Curve Numbers for Selected Agricultural, Suburban, and Urban Areas.

(Sources: TR 55, 1986, and Stormwater Management Manual, 1992.)											
								CNs for hydrologic soil group			
Cover type and hydrologic condition.	A		B		C		D				
Curve Numbers for Predevelopment Conditions											
Pasture, grassland, or range-continuous forage for grazing:											
Fair condition (ground cover 50% to 75% and not heavily grazed).							49	69	79	84	
Good condition (ground cover >75% and lightly or only occasionally grazed)							39	61	74	80	
Woods:											
Fair (Woods are grazed but not burned, and some forest litter covers the soil).								36	60	73	79
Good (Woods are protected from grazing, and litter and brush adequately cover the soil).								30	55	70	77
Curve Numbers for Postdevelopment Conditions											
Open space (lawns, parks, golf courses, cemeteries, landscaping, etc.)1											
Fair condition (grass cover on 50% - 75% of the area).					77		85	90	92		
Good condition (grass cover on >75% of the area)					68		80	86	90		
Impervious areas:											
Open water bodies: lakes, wetlands, ponds etc.					100		100	100	100		
Paved parking lots, roofs2, driveways, etc. (excluding right-of-way)							98	98	98	98	
Permeable Pavement											
Landscaped area	77		85		90		92				
50% landscaped area/50% impervious					87		91	94	96		
100% impervious area	98		98		98		98				
Paved	98		98		98		98				
Gravel (including right-of-way)	76		85		89		91				
Dirt (including right-of-way)	72		82		87		89				
Pasture, grassland, or range-continuous forage for grazing:											
Poor condition (ground cover <50% or heavily grazed with no mulch).							68	79	86	89	
Fair condition (ground cover 50% to 75% and not heavily grazed).							49	69	79	84	
Good condition (ground cover >75% and lightly or only occasionally grazed)							39	61	74	80	
Woods:											
Poor (Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning).								45	66	77	83
Fair (Woods are grazed but not burned, and some forest litter covers the soil).								36	60	73	79
Good (Woods are protected from grazing, and litter and brush adequately cover the soil).								30	55	70	77
Single family residential3: Dwelling Unit/Gross Acre		Should only be used for subdivisions > 50 acres					Average Percent impervious area3,4				
1.0 DU/GA	15	Separate curve number									
1.5 DU/GA	20	shall be selected for									
2.0 DU/GA	25	pervious and impervious									

2.5 DU/GA	30	portions of the site or
3.0 DU/GA	34	basin
3.5 DU/GA	38	
4.0 DU/GA	42	
4.5 DU/GA	46	
5.0 DU/GA	48	
5.5 DU/GA	50	
6.0 DU/GA	52	
6.5 DU/GA	54	
7.0 DU/GA	56	
7.5 DU/GA	58	
PUDs, condos, apartments, commercial businesses, industrial areas and subdivisions < 50 acres	% impervious must be computed	Separate curve numbers shall be selected for pervious and impervious portions of the site
For a more detailed and complete description of land use curve numbers refer to chapter 2 of the Soil Conservation Service's Technical Release No. 55 , (210-VI-TR-55, Second Ed., June 1986).		

1 Composite CNs may be computed for other combinations of open space cover type.

2 Where roof runoff and driveway runoff are infiltrated or dispersed according to the requirements in Section 3.9.3 and 3.9.4, the average percent impervious area may be adjusted in accordance with the procedure described under "Flow Credit for Roof Downspout Infiltration" and "Flow Credit for Roof Downspout Dispersion.".

3 Assumes roof and driveway runoff is directed into street/storm system.

4 All the remaining pervious area (lawn) are considered to be in good condition for these curve numbers.

Table B.5. - Major Soil Groups in Pierce County.

Soil Type[1]	Hydrologic Soil Group	Soil Type[1]	Hydrologic Soil Group
ALDERWOOD (68)	C	NIMUE (18)	B
ALKIRIDGE (3)	C	NISQUALLY (2)	A
AQUIC XEROFLUVENTS (4)	D	NORMA (6)	D
BARNESTON (36)	B	OAKES (16)	B
BELLICUM (7)	B	OGARTY (5)	C
BELLINGHAM (5)	D	OHOP (7)	C
BOROHEMISTS (4)	D	ORTING (6)	D
BOW (25)	D	PHEENEY (12)	C
BRISCOT (5)	C	PILCHUCK (9)	C
BUCKLEY (17)	D	PITCHER (22)	B
CATTCREEK (16)	B	PLAYCO (22)	B
CINEBAR (7)	B	PUYALLUP (13)	B
DUPONT (9)	D	RAGNAR (3)	B
ETHANIA (22)	B	REICHEL (7)	B
EVERETT (48)	A	RIVERWASH (2)	D
FOSS (2)	B	ROCK OUTCROP (7)	D
GREENWATER (6)	A	RUGLES (7)	B
GROTTO (4)	A	SCAMMAN (21)	D
HARSTINE (78)	C	SHALCAR (2)	D
HAYWIRE (10)	C	SPANA (2)	D
HUMAQUEPTS (6)	D	SPANAWAY (47)	A
INDEX (2)	A	STAHL (5)	C
INDIANOLA (24)	A	SULSAVAR (2)	B
JONAS (30)	B	SULTAN (7)	C
KAPOWSIN (127)	D	TISCH (4)	D
KITSAP (11)	C	TUSIP (7)	B
KLABER (2)	D	TYPIC UDIFLUVENTS (3)	B
LARRUPIN (5)	B	UDIFLUVENTS (2)	B
LITTLEJOHN (8)	C	VAILTON (8)	B
LYNNWOOD (3)	A	VOIGHT (3)	B
MASHEL (15)	B	WILKESON (19)	B
MCKENNA (5)	D	WINSTON (4)	B
MOWICH (4)	D	XEROCHREPTS (19)	B
NAGROM (7)	C	ZYNBAR (29)	B
NATIONAL (7)	B	ZYNBAR Till Substratum (6)	C
NEILTON (8)	A		

The number in ( ) refers to the approximate total square miles of the soil type within Unincorporated Pierce County excluding federal lands.

Soils Table Notes:

Hydrologic Soil Group Classifications, as Defined by the Soil Conservation Service:

A = (Low runoff potential) Soils having low runoff potential and high infiltration rates, even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission (greater than 0.30 in/hr.).

B = (Moderately low runoff potential). Soils having moderate infiltration rates when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission (0.15-0.3 in/hr.).

C = (Moderately high runoff potential). Soils having low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine textures. These soils have a low rate of water transmission (0.05-0.15 in/hr.).

D = (High runoff potential). Soils having high runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very low rate of water transmission (0-0.05 in/hr.).

1 = From NRCS Database for Pierce and Snoqualmie surveys, SCS, TR-55, Second Edition, June 1986, Exhibit A-1. Revisions made from SCS, Soil Interpretation Record, Form No. 5, September 1988 and various county soil surveys.

Additional Note: Where field infiltration tests indicate a measured (initial) infiltration rate less than 0.30 in/hr, continuous simulation model users may model the site as a C soil if needed to meet the MR#5 LID performance standard.

Appendix III-C – Nomographs for Various Culvert Sizing Needs

Figure C.1. - Headwater Depth for Smooth Interior Pipe Culverts with Inlet Control.

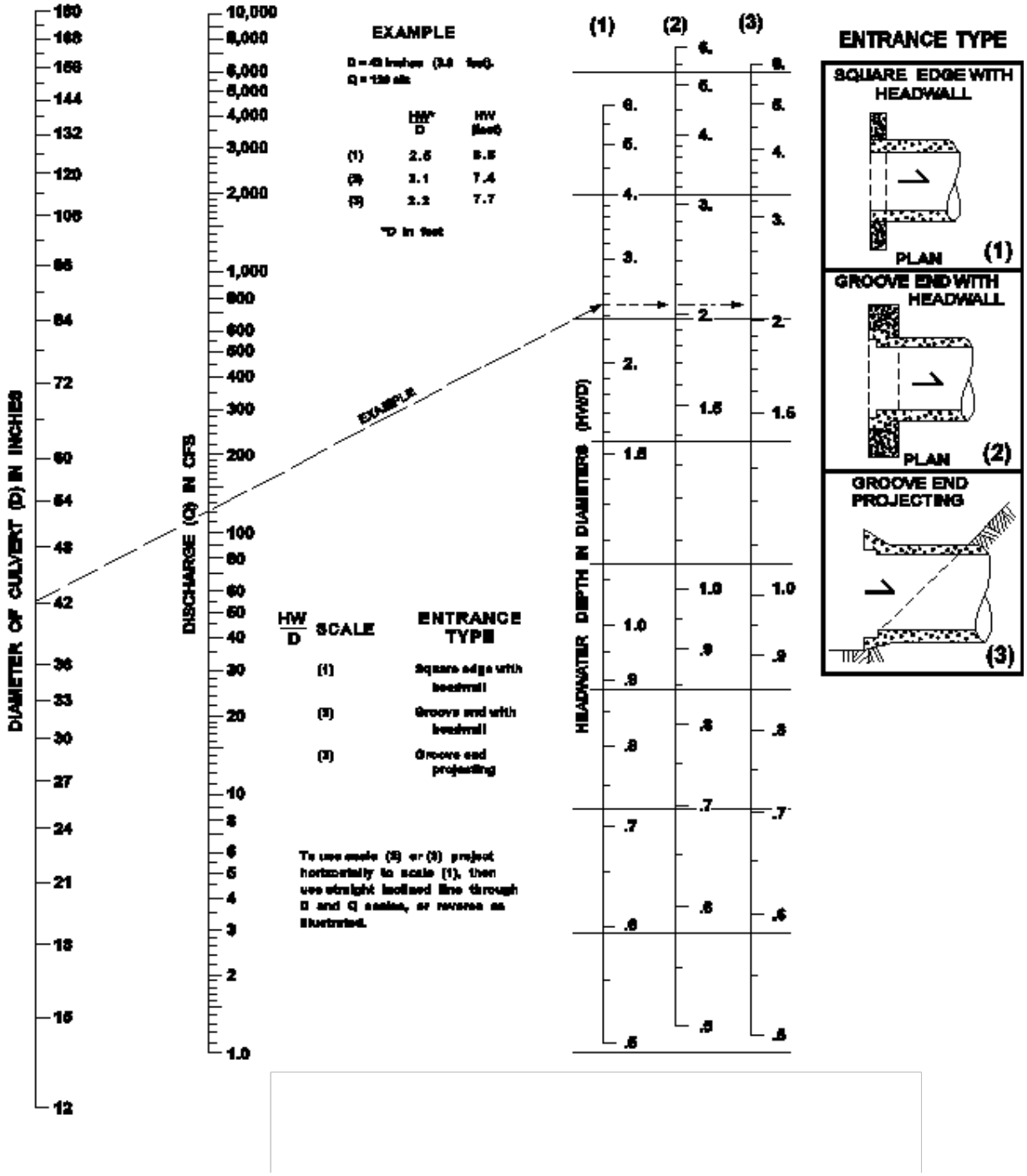


Figure C.2. - Headwater Depth for Corrugated Pipe Culverts with Inlet Control.

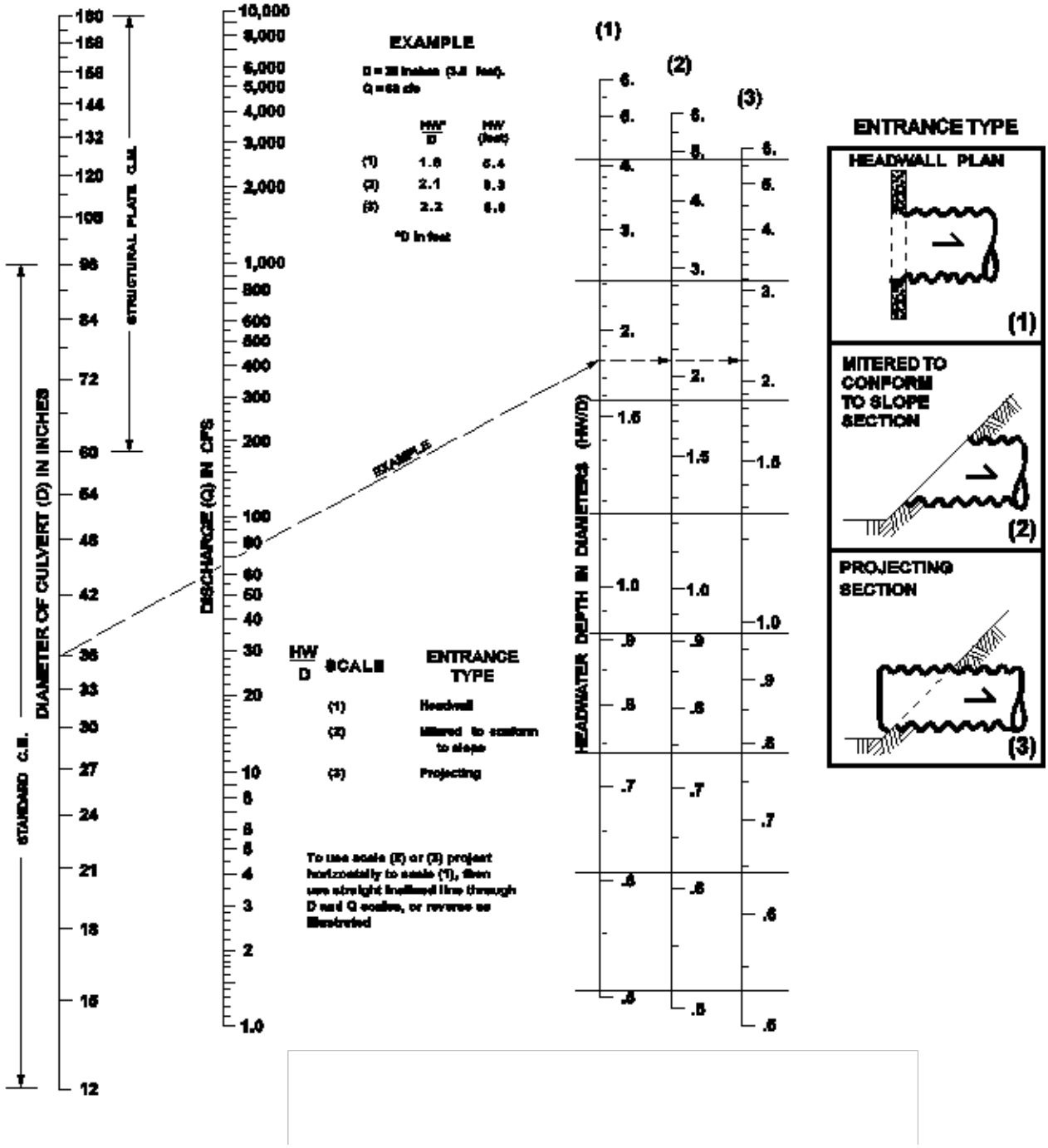
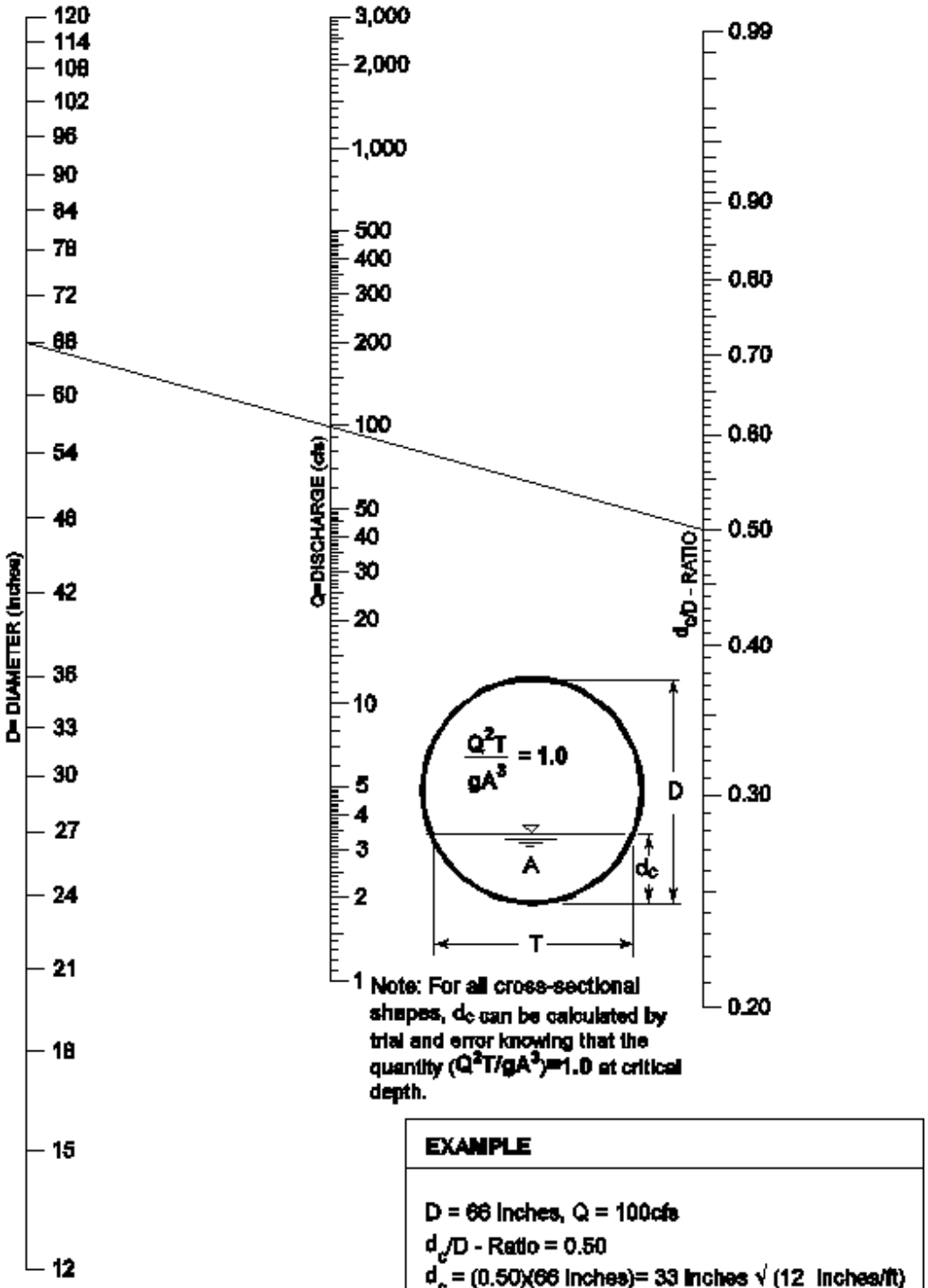


Figure C.3. - Critical Depth of Flow for Circular Culverts.



EXAMPLE

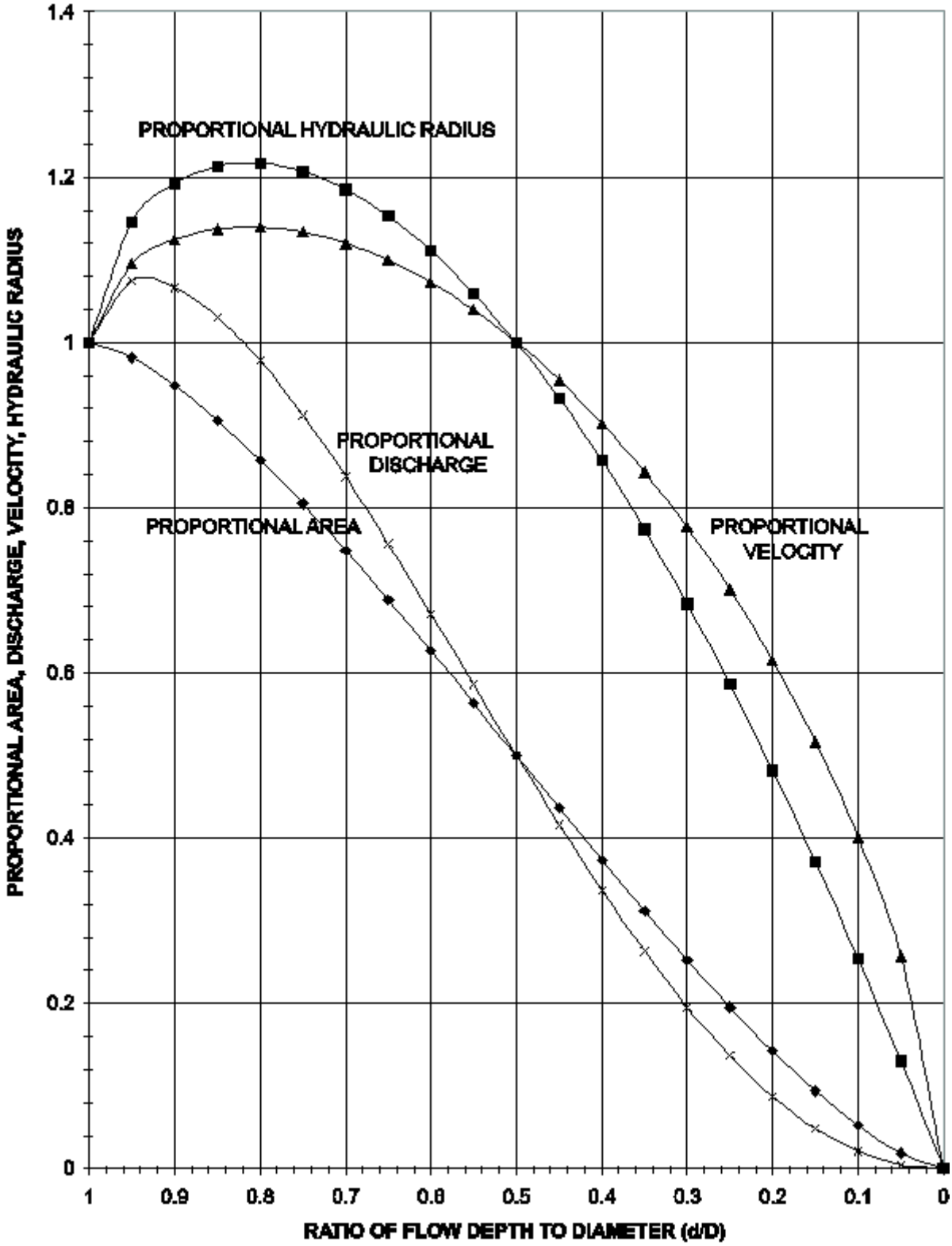
D = 66 Inches, Q = 100cfs

d_c/D - Ratio = 0.50

d_c = (0.50)(66 Inches)= 33 Inches √ (12 Inches/ft)

d_c= 2.75 feet

Figure C.4. - Circular Channel Ratios.



Appendix III-D – Onsite Stormwater Management BMP Infeasibility Criteria

The following tables present infeasibility criteria that can be used to justify not using various onsite stormwater management BMPs for consideration in the List #1 or List #2 option of Minimum Requirement #5. This information is also included under the detailed descriptions of each BMP, but is provided here in this appendix for additional clarity and efficiency. Where any inconsistencies or lack of clarity exists, the requirements in the main text of each volume shall be applied. If a project is limited by one or more of the infeasibility criteria specified below, but still wishes to use the given BMP, they may propose a functionally equivalent design to the county for review and approval.

Lawn and Landscaped Areas	
BMP	Infeasibility Criteria
Soil Preservation and Amendment	• Siting and design criteria provided in Volume III, Section 3.1 cannot be achieved.
Roofs	
BMP	Infeasibility Criteria
Full Dispersion	• Site setbacks and design criteria provided in Volume VI, Section 2.3 cannot be achieved. • A 6.5 to 1.0 ratio of forested or native vegetation area to impervious area cannot be achieved. • A minimum forested or native vegetation flow path length of 100 feet (25 feet for sheet flow from a non-native pervious surface) cannot be achieved.
Downspout Infiltration Systems	• Site setbacks and design criteria provided in Volume III, Section 3.9 cannot be achieved. • The lot(s) or site does not have outwash or loam soils. • There is not at least 12 inches or more of permeable soil from the proposed bottom (final grade) of the infiltration system to the seasonal high groundwater table or other impermeable layer .
Downspout Dispersion Systems	• Site setbacks and design criteria provided in Volume III, Section 3.9 cannot be achieved. • A vegetated flow path at least 50 feet in length from the downspout to the downstream property line, structure, slope over 20 percent, stream, wetland, or other impervious surface is not feasible. • A vegetated flow path of at least 25 feet in between the outlet of the trench and any property line, structure, stream, wetland, or impervious surface is not feasible.

Roofs (continued)	
BMP	Infeasibility Criteria
Bioretention or Rain Gardens	Note: criteria with setback distances are as measured from the bottom edge of the bioretention soil mix. • Site setbacks provided in Volume III, Section 3.4.6 cannot be achieved. Citation of any of the following infeasibility criteria must be based on an evaluation of site-specific conditions and a written recommendation from an appropriate licensed professional (e.g., engineer, geologist, hydrogeologist): • Where professional geotechnical evaluation recommends infiltration not be used due to reasonable concerns about erosion, slope failure, or downgradient flooding. • In accordance with PCC Title 18E limitations may exist and reports may be required when bioretention area is within 300 feet of a landslide hazard area or within 200 feet of an erosion hazard area. • Where the only area available for siting would threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures, or pre-existing road or parking lot surfaces. • Where the only area available for siting does not allow for a safe overflow pathway to a stormwater drainage system. • Where there is a lack of usable space for bioretention areas at re-development sites, or where there is insufficient space within the existing public right-of-way on public road projects. • Where infiltrating water would threaten existing below grade basements. • Where infiltrating water would threaten shoreline structures such as bulkheads. The following criteria can be cited as reasons for infeasibility without further justification (though some require professional services to make the observation): • Where they are not compatible with surrounding drainage system as determined by the county (e.g., project drains to an existing stormwater collection system whose elevation or location precludes connection to a properly functioning bioretention area).

Roofs (continued)	
BMP	Infeasibility Criteria
Bioretention or Rain Gardens (continued)	• Where land for bioretention is within an erosion hazard, or landslide hazard area (as defined by PCC Title 18E.80). • Where the site cannot be reasonably designed to locate bioretention areas on slopes less than 8 percent. • For properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)): ◦ Within 100 feet of an area known to have deep soil contamination. ◦ Where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in the groundwater. ◦ Wherever surface soils have been found to be contaminated unless those soils are removed within 10 horizontal feet from the infiltration area. ◦ Any area where these facilities are prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW. • Within 100 feet of a closed or active landfill. • Within 30 feet upgradient, or 10 feet downgradient, of the drainfield primary and reserve areas. This requirement may be modified by the Tacoma-Pierce County Health Department if site topography clearly prohibits flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary. • Within 10 feet of an underground storage tank and connecting underground pipes when the capacity of the tank and pipe system is 1100 gallons or less. (As used in these criteria, an underground storage tank means any tank used to store petroleum products, chemicals, or liquid hazardous wastes of which 10 percent or more of the storage volume (including volume in the connecting piping system) is beneath the ground surface. • Within 100 feet of an underground storage tank and connecting underground pipes when the capacity of the tank and pipe system is greater than 1,100 gallons.
Bioretention or Rain Gardens (continued)	• Where field testing indicates potential bioretention/rain garden sites have a measured (a.k.a., initial) native soil saturated hydraulic conductivity less than 0.30 inches per hour. A small-scale or large-scale PIT in accordance with Appendix III-A shall be used to demonstrate infeasibility of bioretention areas. If the measured native soil infiltration rate is less than 0.30 in/hour, bioretention/rain garden BMPs are not required to be evaluated as an option in List #1 or List #2. In these slow draining soils, a bioretention area with an underdrain may be used to treat pollution-generating surfaces to help meet Minimum Requirement #6, Runoff Treatment. If the underdrain is elevated within a base course of gravel, it will also provide some modest flow reduction benefit that will help achieve Minimum Requirement #7.

Roofs (continued)	
BMP	Infeasibility Criteria
Perforated Stub-Out Connections	• Site setbacks and design criteria provided in Volume III, Section 3.9.5 cannot be achieved. • There is not at least 12 inches or more of permeable soil from the proposed bottom (final grade) of the perforated stub-out connection trench to the highest estimated groundwater table or other impermeable layer. • The only location available for the perforated stub-out connection is under impervious or heavily compacted soils. • For sites with septic systems, the only location available for the perforated portion of the pipe is located upgradient of the drainfield primary and reserve areas. • The connecting pipe discharges to a stormwater facility designed to meet Minimum Requirement #7.

Other Hard Surfaces	
BMP	Infeasibility Criteria
Full Dispersion	• See Full Dispersion under “roofs” section above.
Permeable Pavement	• Setbacks and site constraints provided in Volume III, Section 3.5.6 cannot be achieved. Citation of any of the following infeasibility criteria must be based on an evaluation of site-specific conditions and a written recommendation from an appropriate licensed professional (e.g., engineer, geologist, hydrogeologist)

Other Hard Surfaces	
BMP	Infeasibility Criteria
Permeable Pavement (continued)	Wherever surface soils have been found to be contaminated unless those soils are removed within 10 horizontal feet from the infiltration area. Any area where these facilities are prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW. Within 100 feet of a closed or active landfill. Within 10 feet of any underground storage tank and connecting underground pipes, regardless of tank size. As used in these criteria, an underground storage tank means any tank used to store petroleum products, chemicals, or liquid hazardous wastes of which 10 percent or more of the storage volume (including volume in the connecting piping system) is beneath the ground surface. At multi-level parking garages, and over culverts and bridges. Where the site design cannot avoid putting pavement in areas likely to have long-term excessive sediment deposition after construction (e.g., construction and landscaping material yards). Where the site cannot reasonably be designed to have a porous asphalt surface at less than 5 percent slope, or a pervious concrete surface at less than 10 percent slope, or a permeable interlocking concrete pavement surface (where appropriate) at less than 12 percent slope. Grid systems upper slope limit can range from 6 to 12 percent; check with manufacturer and local supplier. Where the subgrade soils below a pollution-generating permeable pavement (e.g., road or parking lot) do not meet the soil suitability criteria for providing treatment. See soil suitability criteria for treatment in Chapter 6 of Volume V. Note: In these instances, the county may approve installation of a six-inch sand filter layer meeting county specifications for treatment as a condition of construction. Where underlying soils are unsuitable for supporting traffic loads when saturated. Soils meeting a California Bearing Ratio of 5 percent are considered suitable for residential access roads. Where appropriate field testing indicates soils have a measured (a.k.a., initial) subgrade soil saturated hydraulic conductivity less than 0.3 inches per hour. Only small-scale PIT or large-scale PIT methods in accordance with Appendix III-A shall be used to evaluate infeasibility of permeable pavement areas. (Note: In these instances, unless other infeasibility restrictions apply, roads and parking lots may be built with an underdrain, preferably elevated within the base course, if flow control benefits are desired.)

Other Hard Surfaces	
BMP	Infeasibility Criteria
Permeable Pavement (continued)	Roads that receive more than very low traffic volumes, and areas having more than very low truck traffic. Roads with a projected average daily traffic volume of 400 vehicles or less are very low volume roads (AASHTO, 2001)(U.S. Dept. of Transportation, 2013). Areas with very low truck traffic volumes are roads and other areas not subject to through truck traffic but may receive up to weekly use by utility trucks (e.g., garbage, recycling), daily school bus use, and multiple daily use by pick-up trucks, mail/parcel delivery trucks, and maintenance vehicles. Note: This infeasibility criterion does not extend to sidewalks and other non-traffic bearing surfaces associated with the collector or arterial. Where replacing existing impervious surfaces unless the existing surface is a non-pollution generating surface over an outwash soil with a saturated hydraulic conductivity of four inches per hour or greater. At sites defined as "high-use sites." For more information on high-use sites, refer to the Glossary in Volume I; and Volume V, Section 2.1, Step 3. In areas with "industrial activity" as defined in the Glossary (located in Volume I). Where the risk of concentrated pollutant spills are more likely, e.g., gas stations, truck stops, and industrial chemical storage sites. Where routine, heavy applications of sand occur in frequent snow zones to maintain traction during weeks of snow and ice accumulation.
Bioretention or Rain Gardens	See Bioretention or Rain Gardens under "roofs" section above.
Sheet Flow Dispersion	Site setbacks and design criteria provided in Volume III, Section 3.2 cannot be achieved. Positive drainage for sheet flow runoff cannot be achieved. Area to be dispersed (e.g., driveway, patio) cannot be graded to have less than a 15 percent slope. For flat to moderately sloped area, at least a 10-foot wide vegetation buffer for dispersion of the adjacent 20 feet of contributing surface cannot be achieved. For variably sloped areas, at least a 25-foot vegetated flow path between berms cannot be achieved.
Concentrated Flow Dispersion	Site setbacks and design criteria provided in Volume III, Section 3.2 cannot be achieved. A minimum 3 foot length of rock pad and 50-foot flow path OR a dispersion trench and 25-foot flow path for every 700 sf of drainage area followed with applicable setbacks cannot be achieved. More than 700 sf drainage area drains to any dispersion device.

Pierce County
Stormwater Management and Site Development Manual

Volume IV
Source Control

Prepared by: Pierce County Planning and Public Works

Ordinance No. 2021-45

Effective Date: July 1, 2021

Table of Contents

Volume IV Source Control

Chapter 1. Introduction to Volume IV 1-1

1.1 What is the Purpose of this Volume? 1-1

1.2 How Do I Know Whether Any of this Applies to Me? 1-1

1.3 What Type of Pollutants are Targeted with This Volume? 1-1

1.3.1 pH 1-2

1.3.2 Total Suspended Solids 1-2

1.3.3 Oils and Greases 1-2

1.3.4 Oxygen-Demanding Substances 1-2

1.3.5 Metals 1-2

1.3.6 Bacteria and Viruses 1-3

1.3.7 Nutrients 1-3

1.3.8 Toxic Organic Compounds 1-3

1.3.9 Other Chemicals and Substances 1-3

1.4 What are Best Management Practices? 1-3

1.4.1 Source Control Best Management Practices 1-3

1.4.2 Treatment Best Management Practices 1-4

1.5 Explanation of Required BMPs 1-4

1.6 What if I am Already Implementing Best Management Practices? 1-5

1.7 How Do I Get Started? 1-6

1.8 Some Important Requirements to Note 1-6

Chapter 2. Worksheet for Commercial and Industrial Activities 2-1

Chapter 3. Best Management Practices for Single-Family Residences 3-1

3.1 Automobile Washing 3-1

3.1.1 Suggested BMPs 3-1

3.2 Automobile Maintenance 3-2

3.2.1 Required BMPs 3-2

3.2.2 Suggested BMPs 3-2

3.3 Storage of Solid Wastes and Yard Wastes 3-2

3.3.1 Suggested BMPs 3-3

3.4 Composting 3-4

3.4.1 Suggested BMPs 3-4

3.5 Yard Maintenance and Gardening 3-5
3.5.1 Required BMPs 3-5
3.5.2 Suggested BMPs 3-5
3.6 Swimming Pool and Spa Cleaning and Maintenance 3-6
3.6.1 Required BMPs 3-6
3.6.2 Suggested BMPs 3-6
3.7 Household Hazardous Material Use, Storage, and Disposal 3-7
3.7.1 Required BMPs 3-7
3.7.2 Suggested BMPs 3-7
3.8 Pet Waste Management 3-9
3.8.1 Suggested BMPs for Pet Owners 3-9
3.9 On-Site Sewage Maintenance and Operation 3-10
3.9.1 Required BMPs 3-11
3.10 Activities in Wetlands and Wetland Buffers 3-11
3.10.1 Required BMPs 3-12
3.10.2 Suggested BMPs 3-12
Chapter 4. Best Management Practices for Commercial and Industrial Activities 4-1
Section A1 Cleaning or Washing Activities 4-5
A1.1 Cleaning or Washing of Tools, Engines, and Manufacturing Equipment 4-6
A1.2 Cleaning or Washing of Cooking Equipment 4-8
A1.3 Washing, Pressure Washing, and Steam Cleaning of Vehicles / Equipment / Building Structures 4-10
A1.4 Collection and Disposal of Wastewater in Mobile Interior Washing Operations 4-12
Section A2 Transfer of Liquid or Solid Materials 4-13
A2.1 Loading and Unloading Areas for Liquid or Solid Material 4-14
A2.2 Fueling at Dedicated Stations 4-18
A2.3 Engine Repair and Maintenance 4-20
A2.4 Mobile Fueling of Vehicles and Heavy Equipment 4-23
A2.5 In-Water and Over-Water Fueling 4-26
Section A3 Production and Application Activities 4-29
A3.1 Concrete and Asphalt Mixing and Production at Stationary Sites 4-30
A3.2 Concrete Pouring, Concrete Cutting, and Asphalt Application at Temporary Sites 4-32
A3.3 Manufacturing and Postprocessing of Metal Products 4-34

A3.4 Wood Treatment Areas 4-35
A3.5 Commercial Composting 4-37
A3.6 Landscaping and Lawn/Vegetation Management 4-38
A3.7 Painting, Finishing, and Coating of Vehicles, Boats, Buildings, and Equipment 4-45
A3.8 Commercial Printing Operations 4-47
A3.9 Manufacturing Operations (Outside) 4-48
A3.10 Agricultural Crop Production 4-50
A3.11 Application of Pesticides, Herbicides, Fungicides, and Rodenticides for Purposes Other than Landscaping 4-52
A3.12 Nurseries and Greenhouses 4-53
Section A4 Storage and Stockpiling Activities 4-55
A4.1 Storage or Transfer (Outside) of Solid Raw Materials, Byproducts, or Finished Products 4-56
A4.2 Storage and Treatment of Contaminated Soils 4-59
A4.3 Temporary Storage or Processing of Fruits or Vegetables 4-60
A4.4 Storage of Solid Wastes and Food Wastes 4-62
A4.5 Recyclers and Scrap Yards 4-64
A4.6 Treatment, Storage, or Disposal of Dangerous Wastes 4-66
A4.7 Storage of Liquid or Dangerous Waste Containers 4-67
A4.8 Storage of Liquids in Permanent Aboveground Tanks 4-71
A4.9 Parking and Storage for Vehicles and Equipment 4-73
A4.10 Storage of Pesticides, Fertilizers, or Other Products That Can Leach Pollutants 4-74
Section A5 Construction and Demolition Activities 4-76
A5.1 Construction Demolition 4-77
A5.2 Building Repair, Remodeling, Painting, and Construction 4-79
Section A6 Dust Control and Soil and Sediment Control 4-81
A6.1 Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots 4-82
A6.2 Dust Control at Manufacturing Sites 4-83
A6.3 Soil Erosion and Sediment Control at Industrial Sites 4-85
Section A7 Other Activities 4-86
A7.1 Commercial Animal Handling Areas 4-87
A7.2 Keeping Livestock in Stables, Pens, Pastures, or Fields 4-88

A7.3 Log Sorting and Handling 4-90
A7.4 Boat Building, Mooring, Maintenance, and Repair 4-91
A7.5 Logging 4-94
A7.6 Mining and Quarrying of Sand, Gravel, Rock, Minerals, Peat, Clay, and Other Materials 4-95
A7.7 Swimming Pool and Spa Cleaning and Maintenance 4-96
A7.8 De-icing and Anti-icing Operations for Airports and Streets 4-99
A7.9 Roof Vents and Building Drains at Manufacturing and Commercial Buildings 4-101
A7.10 Urban Streets 4-103
A7.11 Railroad Yards 4-105
A7.12 Maintenance of Public and Utility Corridors and Facilities 4-106
A7.13 Maintenance of Roadside Ditches 4-108
A7.14 Maintenance of Stormwater Drainage and Treatment Facilities 4-110
A7.15 Spills of Oil and Hazardous Substances 4-112
A7.16 Well, Utility, Directional and Geotechnical Drilling 4-114

Chapter 5. Source Control Best Management Practices 5-1

5.1 Index of BMP Descriptions 5-1

5.2 Source Control BMPs 5-2

S.1 Eliminate Illicit Storm Drain Connections 5-2
S.2 Dispose of Collected Runoff and Waste Materials Properly 5-4
S.3 Connect Process Water Discharges to a Sanitary Sewer, Holding Tank, or Wastewater Treatment System 5-5
S.4 Cover the Activity with a Roof or Awning 5-6
S.5 Cover the Activity with an Anchored Tarpaulin or Plastic Sheet 5-9
S.6 Pave the Activity Area and Slope to a Sump or Holding Tank 5-10
S.7 Surround the Activity Area with a Curb, Berm, or Dike, or Elevate the Activity 5-11
S.8 Implement Integrated Pest Management Measures 5-14
S.9 Cleaning Catch Basins 5-15
S.10 Labeling Storm Drain Inlets on Your Property 5-17
S.11 Dock Washing 5-19
S.12 Potable Water Line Flushing, Water Tank Maintenance, and Hydrant Testing 5-21
S.13 Color Events 5-23
S.14 Goose Waste 5-26

Chapter 6. Regulations and Requirements 6-1

6.1 Pierce County Codes and Ordinances 6-1

6.2 State, Federal, and Other Regulations and Requirements 6-2

R.1 Ecology Requirements for the Discharge of Process Wastewaters Directly to Surface Waters 6-3

R.2 Ecology Requirements for Dangerous Waste Generators 6-4

R.3 Ecology Stormwater NPDES Permit Requirements 6-6

R.4 Ecology Requirements for Underground and Aboveground Storage Tanks 6-7

R.5 U.S. EPA and Ecology Emergency Spill Cleanup Requirements 6-8

R.6 Washington State Department of Agriculture Pesticide Regulations 6-9

R.7 Puget Sound Clean Air Agency Air Quality Regulations 6-10

R.8 Requirements of Native American Tribes 6-11

Chapter 7. Quick Reference Phone Numbers and Websites 7-1

Volume IV References Ref-1

Appendix IV-A –Recycling/Disposal of Vehicle Fluids/Other Wastes* A-1

Appendix IV-B –Example of an Integrated Pest Management Program B-1

Appendix IV-C –Recommendations for Management of Street Wastes C-1

List of Tables

Table C.1. - Typical TPH Levels in Street Sweeping and Catch Basin Solids. C-9
Table C.2. - Typical c-PAH Values in Street Waste Solids and Related Materials. C-9
Table C.3. - Typical Metals Concentrations in Catch Basin Sediments. C-10
Table C.4. - Recommended Parameters and Suggested Values for Determining Reuse and Disposal Options..... C-10
Table C.5. - Recommended Sampling Frequency for Street Waste Solids..... C-11
Table C.6. - Pollutants in Catch Basin Solids – Comparison to Dangerous Waste Criteria. C-11
Table C.7. - Typical Catch Basin Decant Values Compared to Surface Water Quality Criteria. . C-12
Table C.8. - Typical Values for Conventional Pollutants in Catch Basin Decant..... C-12
Table C.9. - Catch Basin Decant Values Following Settling. C-13

Table of Figures

Figure 3.1. - Recycling Cart with Properly Sealed Lid. 3-3
Figure 3.2. - Covered Compost Bin. 3-4
Figure 3.3. - Drip Pan for Capturing Spills and Drips During Engine Repair and Maintenance. .3-8
Figure 4.1. - Wash Pad for Tool and Equipment Washing....4-7
Figure 4.2. - Uncovered Washing Area for Tools, Engines, Equipment, and Portable Objects, with Drains to a Sanitary Sewer, Process Treatment, or a DeadEnd Sump. 4-7
Figure 4.3. - Cleaning and Washing Cooking Equipment Indoors....4-9
Figure 4.4. - Drip Pan for Connections at Loading and Unloading Areas for Liquid Material...4-15
Figure 4.5. - Loading Docks with an Overhang to Prevent Material Contact with Rainwater. .4-17
Figure 4.6. - Door Skirts to Enclose the Trailer End of a Truck to Prevent Material Contact with Rainwater. 4-17
Figure 4.7. - Roof at Fueling Island to Prevent Stormwater Runon. 4-19
Figure 4.8. - Drip Pan for Use at Mobile Sites. 4-22
Figure 4.9. - Spill Containment Boom. 4-25
Figure 4.10. - Commercially Available Bermed Workspace. 4-48
Figure 4.11. - Structure Used to Cover Manufacturing Operations. 4-49
Figure 4.12. - Covered and Secured Storage Area for Bulk Solids....4-57
Figure 4.13. - Temporary Plastic Sheeting Anchored over Raw Materials Stored Outdoors.... 4-58
Figure 4.14. - Solid Waste Dumpsters with Properly Sealed Lids. 4-63
Figure 4.15. - Outdoor Drum Storage Unit with Locking Doors. 4-68
Figure 4.16. - Containment Berm Used to Control Liquid-Material Leaks or Spills. 4-69
Figure 4.17. - Temporary Secondary Containment. 4-69
Figure 4.18. - Mounted Containers with Drip Pans. 4-70
Figure 4.19. - Aboveground Storage Tanks with Secondary Containment. 4-72
Figure 4.20. - Commercially Available Gutter Guard Being Replaced. 4-78
Figure 4.21. - Dust Suppression by Water Spray. 4-82
Figure 4.22. - Drop Cloth Used During Hull Sanding. 4-92
Figure 4.23. - Catch Basin Cleaning with a Vacuum Truck. 4-110
Figure 4.24. - “Dump No Waste” Storm Drain Stencil.... 4-111
Figure 4.25. - Example of Spill Kit Contents.... 4-113
Figure 5.1. - Structure Used to Cover Manufacturing Operations. 5-6
Figure 5.2. - Loading Docks with an Overhang to Prevent Material Contact with Rainwater. ...5-7
Figure 5.3. - Roof at Fueling Island to Prevent Stormwater Runon. 5-7

Figure 5.4. - Temporary Plastic Sheeting Anchored over Raw Materials Stored Outdoors. 5-9
Figure 5.5. - Paved Area With Sump Drain.....5-10
Figure 5.6. - Temporary Spill Containment.....5-12
Figure 5.7. - Containment Berm Used to Control Liquid-Material Leaks or Spills.....5-13
Figure 5.8. - Catch Basin Cleaning with a Vacuum Truck.....5-15
Figure 5.9. - “Dump No Waste” Storm Drain Stencil.....5-18

Chapter 1. Introduction to Volume IV

1.1 What is the Purpose of this Volume?

This volume is designed to help guide businesses, homeowners, and public agencies in Pierce County implement source control best management practices (BMPs) to prevent pollutants from contaminating stormwater runoff and entering our rivers, lakes, streams, and Puget Sound. Source control is the practice of preventing pollution at its source. Human and ecosystem health, safety, and welfare can be at risk from polluted stormwater. The implementation of BMPs is required by several programs, which are listed in Section 1.2 below. Every person/business in Pierce County is required to use BMPs. You must select BMPs from this volume to prevent stormwater pollution. Refer to Section 1.4 below for additional information on BMPs. Information on stormwater treatment BMPs can be found in Volume I, Section 1.6, and Volume V.

1.2 How Do I Know Whether Any of this Applies to Me?

Because of the provisions of the federal Clean Water Act (CWA) and Coastal Zone Management Act, as well as the National Pollutant Discharge Elimination System (NPDES) permit, the implementation of BMPs applies to all businesses, residences, and public agencies in Pierce County. It includes all permanent and temporary activities at public facilities, commercial and industrial facilities, agriculture and livestock farms, and residential dwellings. Anyone involved in a particular activity, whether as an employee, supervisor, manager, landlord, tenant, or homeowner, must take part in implementing appropriate BMPs. BMPs need to be selected from this volume. See Section 1.5 below for further explanation of required and suggested BMPs presented in this volume.

Operators under Ecology's Industrial Stormwater General Permit, Boatyard General Permit, or Sand and Gravel General Permit should use this volume to identify required and suggested operational and structural source control BMPs for inclusion in their Stormwater Pollution Prevention Plans (SWPPPs). Operators of commercial, industrial, and multifamily properties not under an Ecology permit should use this volume in developing their SWPPPS.

Pierce County adopted the Regional Road Maintenance – Endangered Species Act (ESA) – Program Guidelines in 2002. This document was developed by the Tri-County Road Maintenance ESA Technical Working Group and contains guidelines for roadway maintenance operations, utility maintenance, maintenance of stormwater facilities, and other right-of-way structure maintenance within the right-of-way. The goal of the program guidelines is to provide a consistent, regional program that can be used by any agency wishing to limit, reduce, or eliminate the prohibition on take of threatened species under the 4(d) rule of the ESA. There is some overlap between this document and the above mentioned program guidelines. The Stormwater Management and Site Development Manual, Volume IV Source Control BMPs are required as the minimum standard for source controls. The Regional Road Maintenance Manual may contain additional requirements above the Stormwater Management and Site Development Manual minimum standards.

1.3 What Type of Pollutants are Targeted with This Volume?

Under the NPDES permit mentioned above, the county is required to show progress in eliminating virtually all non-stormwater discharges to the stormwater drainage system. In other words, **nothing but uncontaminated stormwater may be discharged** to the Pierce County stormwater drainage system. There are severe state and federal penalties for anyone violating the terms

of these permits. Illicit discharges may be intentional or unintentional, but either way are not allowed, see Pierce County Code (PCC) Title 11 Illicit Stormwater Discharges. **You must keep pollutants from leaving your property and entering the county stormwater drainage system.**

Pollutants can be placed into several broad categories. The descriptions provided below are quite brief, but further information on a particular pollutant can be obtained by calling one of the information numbers listed in Chapter 7.

1.3.1 pH

The pH value of a substance gives you a relative measure of whether it is acidic or basic. The pH value of a body of water is vitally important, since most aquatic life can operate within a relatively narrow band of pH values (6 to 8). Some sources that can contribute to a change in pH of stormwater and water bodies are cement in concrete pouring, paving, and recycling operations; solutions from metal plating; chemicals from printing businesses and other industrial processes; and household cleaners such as bleaches and deck washes.

1.3.2 Total Suspended Solids

This represents particulate solids such as eroded soil, heavy metal precipitates, and biological solids (all considered as conventional pollutants), which can cause sedimentation in streams and turbidity in receiving surface waters. Sediment is the most common pollutant present in stormwater runoff. These sediments can destroy the desired habitat for fish and can impact drinking water supplies. The sediment may be carried to rivers, streams, lakes, or Puget Sound where they may be toxic to aquatic life and make dredging necessary.

1.3.3 Oils and Greases

Oils and greases can be either petroleum-based or food-related sources. Petroleum-based compounds can be immediately toxic to fish and wildlife, and if they reach our drinking water aquifers, will make us sick too. Food-based oils and greases may not be toxic to us, but they can coat fish gills and insects, and suffocate them.

1.3.4 Oxygen-Demanding Substances

Degradable organic matter, such as yard, food, and pet wastes, and some chemical wastes, can have a drastic effect on water quality if they are allowed to enter stormwater. As these substances are broken down by bacteria, the oxygen in the water is consumed. This stresses and can eventually kill fish and other creatures in the water. Chemical oxygen demand (COD) and biological oxygen demand (BOD) are two parameters that indicate the amount of oxygen that is used up by various pollutants.

1.3.5 Metals

Metals are utilized in many products important to our daily lives. Certain metals, known as heavy metals, wear off of our car brakes and tires, and come from the paint and moss-killing roof strips and herbicides we use at our homes. These metals can cause severe health and reproductive problems in fish and animals that live in water and sediments that become contaminated by runoff.

1.3.6 Bacteria and Viruses

Bacteria and viruses from pet wastes, failing septic systems and agricultural areas can contaminate drinking water and close down swimming and shellfish areas. A group of bacteria called **fecal coliform bacteria** are typically used as the indicators for pollution by more serious disease-causing microorganisms. The Washington State Department of Ecology (Ecology) has made changes to the State Water Quality Standards that include the use of new bacterial indicators: *E. coli* for fresh water and enterococci for marine water will replace fecal coliform bacteria, except that fecal coliform will still be used for marine waters that contain shellfish beds.

1.3.7 Nutrients

In the context of water quality, nutrients are mainly compounds of nitrogen and phosphorus. When nutrients are allowed to enter water bodies, undesirable effects such as algae overgrowth, oxygen depletion, channel clogging due to overgrowth of vegetation, and fish and animal death can occur. Sources of nutrients can include fertilizers, failing septic systems, and yard and animal wastes.

1.3.8 Toxic Organic Compounds

A number of organic chemicals are toxic when they get into the aquatic environment. Many pesticides, herbicides, rodenticides, and fungicides are deadly to aquatic life. The same is true of compounds such as antifreeze, wood preservatives, cleansers, and a host of other, more exotic organics derived from industries or past practices (such as polychlorinated biphenyls [PCBs], DDT, and chlordane).

1.3.9 Other Chemicals and Substances

There are a host of other chemicals that can cause problems if allowed to enter the aquatic environment. Some of the most common chemicals and substances that pollute stormwater are oils, greases, soaps, and detergents. Common household bleach can be deadly to fish and other organisms if drained directly to water bodies. Diatomaceous earth backwash from swimming pool filters can clog gills and suffocate fish. Arsenic has been used in rat and mole killing compounds. Even those compounds classified as **biodegradable or environmentally friendly** can have devastating **immediate** effects on aquatic life.

1.4 What are Best Management Practices?

BMPs are designed to reduce stormwater pollution. BMPs are separated into two broad categories, namely source control BMPs and treatment BMPs.

1.4.1 Source Control Best Management Practices

Source control BMPs prevent contamination from entering stormwater runoff by controlling them at the source. There are two categories of source control BMPs: operational and structural.

1. Operational source control BMPs are considered to be the most cost effective pollutant minimization practices. Operational source control BMPs are non-structural practices that prevent or reduce pollutants from entering stormwater. They can also include process changes such as raw material/product changes and recycling wastes. Examples include:
    - Formation of a pollution prevention team
    - Good housekeeping practices

- Preventive maintenance procedures
- Spill prevention and clean up
- Employee training
- Inspections of pollutant sources
- Record keeping

2. Structural source control BMPs are physical, structural or mechanical devices or facilities intended to prevent pollutants from entering stormwater. Structural BMPs typically cost more to construct, operate, and maintain. Structural source control BMPs may include:
   - Enclosing and/or covering the pollutant source, i.e., within a building or other enclosure, a roof over storage and working areas, a temporary tarpaulin, etc.
   - Physically segregating the pollutant source to prevent runon of uncontaminated stormwater
   - Devices that direct contaminated stormwater to appropriate treatment BMPs, i.e., discharge to a sanitary sewer if a permit is first obtained from the County Industrial Pretreatment Program at (253) 7983013.

1.4.2 Treatment Best Management Practices

Treatment BMPs are utilized to treat stormwater that is already contaminated. Most treatment BMPs require planning, designing, permitting and construction, and none can remove 100 percent of the contaminants in stormwater. These factors, added to the typical expense of treatment BMPs, makes source control BMPs the preferred choice. There may, however, be some instances where treatment BMPs may be required. This volume identifies specific treatment BMPs that apply to particular pollutant sources, such as fueling stations, railroad yards, material storage and transfer areas, etc. After identifying the required treatment BMPs, the reader can refer to Volume I, Section 1.6, and Volume V for additional information about treatment BMPs.

Facilities required to install additional treatment BMPs to comply with Ecology's Industrial Stormwater General Permit (or other General Stormwater Permits) should consider the treatment BMPs identified in Volumes IV and V. In addition, facilities should consider the sediment control and treatment BMPs in Volume II if turbidity and/or sediment reduction is required.

1.5 Explanation of Required BMPs

Every person/business in Pierce County is required to use BMPs. You need to select BMPs from this volume. The BMPs outlined in Chapters 3 and 4 include required and/or suggested BMPs. Any required BMPs are presented first for each section, and are identified by headings. Please note that in some instances there are required BMPs that are mandated by various federal, state, or county laws. Any additional suggested BMPs are also presented for each BMP. You are encouraged to utilize suggested BMPs to further protect our water quality. For instance, if only one BMP is required, you may couple it with another suggested BMP to prevent pollution from ever getting into stormwater.

Some businesses are or will be required to obtain a NPDES permit for stormwater discharges. These permits are issued and regulated by Ecology.

All sites covered under the Industrial Stormwater General Permit must include and implement the applicable (mandatory) BMPs in their Industrial SWPPP.

- Industrial sites covered by individual industrial stormwater permits must comply with the specific source control and treatment BMPs listed in their permits. Operators under individual industrial stormwater permits may include additional BMPs from this manual, if desired.
- All sites covered under the Boatyard Stormwater General Permit must include and implement the applicable (mandatory) BMPs in their Boatyard SWPPP.
- Facilities covered under the Sand and Gravel General Permit must include source control BMPs as necessary in their Sand and Gravel SWPPP to achieve AKART and compliance with the stormwater discharge limits in their permit.

The BMPs outlined in this volume are focused on source control, that is, using methods to prevent pollution from ever getting into stormwater. Many of these BMPs are common sense and "housekeeping" issues. For instance, you can sweep an indoor or outdoor work area instead of hosing it into a storm drain or other drainage conveyance. The use of source control BMPs is always the first line of defense in stormwater pollution prevention efforts for several reasons:

- In the majority of cases, source control BMPs are all that is needed to correct stormwater pollution problems.
- Most source control BMPs are relatively inexpensive and easy to implement.
- Treatment BMPs are utilized after pollution has entered stormwater. These BMPs are expensive, and can never remove 100 percent of the pollution in stormwater. It is far better to use source control BMPs where possible to prevent pollution. This volume identifies specific treatment BMPs that apply to particular pollutant sources, such as fueling stations, railroad yards, storage and transfer of materials, etc. Additional information about treatment BMPs are found in Volume V of this manual.
- (NOTE: At times, the type of pollutants present or the condition of a site could mean treatment BMPs are required.)

The minimum requirements for stormwater source control are contained in Volume I, Section 2.4.3 Minimum Requirement #3: Source Control of Pollution. In accordance with this minimum requirement, all known, available and reasonable source control BMPs shall be applied to all projects. Chapter 5 of this volume contains details on many source control BMPs, with references to appropriate documents for others.

Stormwater treatment may also be required for certain types of businesses, based on the information provided in this volume and in Volume I, Section 2.4.6 Minimum Requirement #6: Runoff Treatment and in Volume V. Volume V contains detailed information about stormwater treatment BMPs.

1.6 What if I am Already Implementing Best Management Practices?

Businesses already implementing BMPs in accordance with other federal, state, or county programs usually do not have to implement additional BMPs. Persons or businesses qualifying for exemptions include:

- Businesses required to obtain a general or individual NPDES permit for stormwater discharges must comply with the requirements of that permit. See regulatory requirement R.2 in Chapter 6 of this volume for details.

If you are on the above list, the county assumes that you are implementing the appropriate BMPs. If the county finds that you have not implemented your BMPs, or that the BMPs that you have implemented are not effectively addressing the discharge of contaminants, then you may be required to implement additional BMPs to meet requirements. **Everyone must implement BMPs**, but how each business goes about it, and through which government program, may differ from business to business.

1.7 How Do I Get Started?

If you are a landlord, tenant, or owner of a single-family residence, proceed to Chapter 3 for BMPs that are recommended for you.

If you own a business or industry, complete the worksheet in Chapter 2. If you checked off any of the activities that are being performed outdoors, use the activity code on the worksheet to find the BMPs recommended for you in Chapter 4.

If you have questions, please contact Pierce County Surface Water Management at (253) 7982725. They can provide assistance over the phone and also at your business site.

1.8 Some Important Requirements to Note

Under current state and county law, if you own commercial property and lease or rent it, you can be held responsible for water quality problems caused by your tenants. Make sure your tenants are informed of their responsibilities under the oversight of this manual and PCC Title 11 Illicit Stormwater Discharges.

Another important requirement is the need for an accidental spill plan if your business has the potential for a spill. If you are currently under a pretreatment permit for discharge to sewers, it will probably require a minor amount of effort to amend it to include stormwater. Please contact Pierce County Surface Water Management at (253) 7982725 for information on developing these plans.

You are responsible for obtaining prior approval for your stormwater discharge to the county system. This means obtaining proper building and environmental permits from the county and state. Please contact the Pierce County Planning and Public Works (PPW) at (253) 798-3739 for permit information. For Ecology permits, call (360) 407-7126.

Chapter 2. Worksheet for Commercial and Industrial Activities

This worksheet is designed for use by business and industry operators. This worksheet and the BMPs are organized by the different activities that businesses perform. The goal of the BMPs is to assure that nothing but uncontaminated stormwater be discharged to the Pierce County stormwater drainage system. If the listed activity is performed indoors and all discharges are controlled (e.g., process water, washwater, lubricants, solvents, fugitive dust, granular material, blow down waste) such that no exposure to stormwater occurs, then you do not have to institute new BMPs for that activity.

1. Complete the entire worksheet by checking the appropriate boxes for all activities that take place at your work place.
2. If you checked off any of the activities **that are being performed outdoors or can reach the stormwater drainage system**, use the activity code on the worksheet to find the BMPs recommended for you in Chapter 4.

If you checked off any of these activities that are occurring indoors at your business, then you are exempt from implementing BMPs, provided no indoor drains or processes can ultimately contact stormwater or be transported to surface waters such as rivers, lakes and streams. You must ensure that liquids, powders, dusts, and fine granular materials stay confined indoors; otherwise, you will be subject to all of the BMP requirements. For discharges to the sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 798-3013.

If you have questions, please contact Pierce County Planning & Public Works Surface Water Management at (253) 798-2725. They can provide assistance over the phone and also at your business.

Activity Code	Type of Activity	Check if You Are Involved in This
A1.1	Cleaning or Washing of Tools, Engines, and Manufacturing Equipment This includes parts washers and all types of manufactured equipment components.	
A1.2	Cleaning or Washing of Cooking Equipment This includes vents, filters, pots and pans, grills, and related items.	
A1.3	Washing, Pressure Washing, and Steam Cleaning of Vehicles/ Equipment/Building Structures This covers cleaning and washing at all types of establishments, including fleet vehicle yards, car dealerships, car washes, and maintenance facilities.	
A1.4	Collection and Disposal of Wastewater from Mobile Interior Washing Operations This includes carpet cleaners, upholstery cleaners, and drapery cleaners.	
A2.1	Loading and Unloading Areas for Liquid or Solid Material Loading and unloading of materials at industrial and commercial facilities.	
A2.2	Fueling at Dedicated Stations This includes gas stations, pumps at fleet vehicle yards or shops, and other privately owned pumps.	
A2.3	Engine Repair and Maintenance This covers oil changes and other engine fluids.	
A2.4	Mobile Fueling of Vehicles and Heavy Equipment Fleet fueling, wet fueling, and wet hosing.	
A2.5	In-Water and Over-Water Fueling Applies to transferring of fuels to vehicles or equipment in water.	
A3.1	Concrete and Asphalt Mixing and Production at Stationary Sites Applies to mixing of raw materials on site to produce concrete or asphalt.	
A3.2	Concrete Pouring, Concrete Cutting, and Asphalt Application at Temporary Sites This includes construction sites, and driveway and parking lot resurfacing.	
A3.3	Manufacturing and Postprocessing of Metal Products This includes machining, grinding, soldering, cutting, welding, quenching, rinsing, etc.	
A3.4	Wood Treatment Areas This includes wood treatment using pressure processes or by dipping or spraying.	
A3.5	Commercial Composting Includes commercial composting facilities operating outside.	
A3.6	Landscaping and Vegetation Management Activities, Including Vegetation Removal, Herbicide and Insecticide Application, Fertilizer Application, Irrigation, Watering, Gardening, and Lawn Care Includes businesses involved in landscaping, applying pesticides and managing vegetation.	

Activity Code	Type of Activity	Check if You Are Involved in This
A3.7	Painting, Finishing, and Coating of Vehicles, Boats, Buildings, and Equipment Includes surface preparation and the applications of paints, finishes, and/or coatings.	
A3.8	Commercial Printing Operations Includes materials used in the printing process.	
A3.9	Manufacturing Activities – Outside Includes outdoor manufacturing areas.	
A3.10	Agricultural Crop Production Includes commercial scale farming.	
A3.11	Application of Pesticides, Herbicides, Fungicides and Rodenticides for purposes other than landscaping Includes moss removal and outdoor insect extermination.	
A3.12	Nurseries and Greehouses Applies to commercial container plant, greenhouse grown, and cut foliage production operations.	
A4.1	Storage or Transfer (Outside) of Solid Raw Materials, By-products, or Finished Products	
A4.2	Storage and Treatment of Contaminated Soils This applies to contaminated soils that are excavated and left on site.	
A4.3	Temporary Storage or Processing of Fruits or Vegetables This includes processing activities at wineries, fresh and frozen juice makers, and other food and beverage processing operations.	
A4.4	Storage of Solid Wastes and Food Wastes This includes regular garbage and all other discarded non-liquid items.	
A4.5	Recyclers and Scrap Yards This includes scrapped equipment, vehicles, empty metal drums, and assorted recyclables.	
A4.6	Treatment, Storage, or Disposal of Dangerous Wastes Refer to Ecology and the Tacoma-Pierce County Health Department for more information, see Chapter 6.	
A4.7	Storage of Liquid, Food Waste, or Dangerous Waste Containers This includes containers located outside a building and used for temporary storage.	
A4.8	Storage of Liquids in Permanent Aboveground Tanks Includes all liquids in aboveground tanks.	
A4.9	Parking and Storage for Vehicles and Equipment Includes public and commercial parking lots.	
A4.10	Storage of Pesticides, Fertilizers, or other products that can leach pollutants.	
A5.1	Demolition of Buildings Applies to removal of existing buildings and subsequent clearing of the rubble.	
A5.2	Building Repair, Remodeling, and Construction Applies to construction of buildings, general exterior building repair work and remodeling of buildings.	

Activity Code	Type of Activity	Check if You Are Involved in This
A6.1	Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots	
A6.2	Dust Control at Manufacturing Sites Includes grain dust, sawdust, coal, gravel, crushed rock, cement, and boiler fly ash.	
A6.3	Soil Erosion and Sediment Control (ESC) at Industrial Sites Includes industrial activities that take place on soil.	
A7.1	Commercial Animal Handling Areas This includes kennels, fenced pens, veterinarians, and businesses that board animals.	
A7.2	Keeping Livestock in Stables, Pens, Pastures or Fields Applies to all types of livestock.	
A7.3	Log Sorting and Handling Applies to log yards typically located at sawmills, ports, and pulp mills.	
A7.4	Boat building, Mooring, Maintenance, and Repair This includes all types of maintenance, repair, and building operations.	
A7.5	Logging Applies to logging activities that fall under Class IV general forest practices.	
A7.6	Mining and Quarrying of Sand, Gravel, Rock, Minerals, Peat, Clay, and Other Materials This does not include excavation at construction sites.	
A7.7	Swimming Pool and Spa Cleaning and Maintenance This includes every swimming pool and spa not at a single family residence. Commercial pool cleaners are included here for all pools.	
A7.8	De-icing and Anti-icing Operations for Airports and Streets Includes aircraft, runways/taxiways, streets, and highways.	
A7.9	Roof Vents and Building Drains at Manufacturing and Commercial Buildings These sites will be referred to the Puget Sound Clean Air Agency.	
A7.10	Urban Streets Includes recommended BMPs.	
A7.11	Railroad Yards	
A7.12	Maintenance of Public and Private Utility Corridors and Facilities Includes public and private utility maintenance activities.	
A7.13	Maintenance of Roadside Ditches	
A7.14	Maintenance of Stormwater Drainage and Treatment Facilities	
A7.15	Spills of Oil and Hazardous Substances	
A7.16	Well, Utility, Directional and Geotechnical Drilling	

Chapter 3. Best Management Practices for Single-Family Residences

The actions we take each day in and around our homes have a profound effect on surface water quality and fish habitat in this region. Stormwater drains directly to our rivers, lakes, streams, groundwater, and to Puget Sound. It does not go to the wastewater treatment plant. Any pollutants that get into the stormwater go directly to surface waters or groundwater. Small amounts of pollution from many different sources can significantly affect our waterways. Yard maintenance, waste storage, car washing and maintenance, and pool cleaning are activities that adversely impact water quality. The BMPs discussed in this section are practical ways to keep stormwater from becoming polluted. It is recommended all residents in Pierce County use these BMPs. **Please note some of these procedures are required by various state, or county laws, and are noted as required BMPs.**

Below is a general list of BMPs for citizens. The list includes brief information on applicability. For more information on the following BMPs, refer to the information in Sections 3.1 through 3.10 of this chapter. Additionally, BMPs addressing roof runoff systems and LID features are presented in Volume III, Volume V, and Volume VI.

3.1 Automobile Washing

Most residents wash their cars in the driveway or on the street. Washwaters typically flow to a storm drain or ditch, which discharges stormwater directly to the nearest river, stream, lake, or Puget Sound. Soaps and detergents, even the biodegradable ones, can have immediate and long-term effects on organisms living in water bodies. Grime washed off the car also contains a variety of pollutants that can harm fish and wildlife.

3.1.1 Suggested BMPs

Away from Home (preferred option):

- Consider not washing your car at home. Take it to a commercial car wash that has a recycle system and discharges wastewater to the sanitary sewer for treatment.

At Home:

- Wash your car directly over your lawn or make sure the washwater drains to a vegetated area. This allows the water and soap to soak into the ground instead of running off into a local water body.
- Ideally, no soaps or detergents should be used, but if you do use one, select one without phosphates.
- Commercial products are available that allow you to clean a vehicle without water. These were developed for areas where water is scarce, so a water saving benefit is realized, as well as reduced pollution.
- Use a hose nozzle with a shut-off valve to save water.
- Do not wash your car if rain is expected. Rain events will rapidly wash chemicals and cleaning products from your property into the stormwater system (and to downstream waters).
- Pour the bucket of soapy, dirty washwater down your sink. This way the water doesn't pollute surface water. Instead, it's treated at the wastewater treatment plant.

3.2 Automobile Maintenance

We enjoy the cost savings of changing our own oil, antifreeze, topping off the battery with water, and generally making our car perform its' best. There is a lot of potential for stormwater pollution associated with these activities; however, the following BMPs will help you minimize pollution while servicing your car.

3.2.1 Required BMPs

- Recycle all oils, antifreeze, solvents, and batteries. Many local car parts dealers and gas stations accept used oil. The Household Hazardous Waste facilities at the Tacoma Landfill or LRI Landfill accept oil, oil filters, antifreeze, and solvents. Pierce County and Tacoma also hold Household Hazardous Waste turn-in days that will accept car wastes including old batteries. Old batteries can actually be worth money. Search for local battery recycling businesses to find out if any offer to buy used batteries. Use the numbers listed in Chapter 7 for more information.
- Never dump new or used automotive fluids or solvents on the ground, in a storm drain or street gutter, or in a water body. Eventually, it will make its way to local surface waters or groundwater, including the water we drink.
- Do not mix wastes. The chlorinated solvents in some carburetor cleaners can contaminate a huge tank of used oil, rendering it unsuitable for recycling. Always keep your wastes in separate containers which are properly labeled and store them out of the weather.

3.2.2 Suggested BMPs

- Fix all leaks, to keep the leaky material off streets and out of surface water.
- To dispose of oil filters, punch a hole in the top and let drain for 24 hours. This is where a large funnel in the top of your oil storage container will come in handy. After draining, wrap in 2 layers of plastic and dispose of in your regular garbage or recycle by taking it to the Tacoma Landfill or LRI Landfill Household Hazardous Waste facility for Tacoma residents and non-residents. Call the Hazardous Waste line at 18002876429 for up-to-date information on the appropriate disposal of consumer products.
- Use care in draining and collecting antifreeze to prevent accidental spills. Spilled antifreeze can be deadly to cats and dogs that ingest it.
- Perform your service activities on concrete or asphalt or over a plastic tarpaulin to make spill cleanup easier. Keep a bag of kitty litter on hand to absorb spills. If there is a spill, sprinkle a good layer on the spill, let it absorb for a little while and then sweep it up. Place the contaminated litter in a plastic bag, tie it up, and dispose of it in your regular garbage. Take care not to leave kitty litter out in the rain; it will form a sticky sludge that is hard to clean up.
- If you are doing body work outside, be sure to use a tarpaulin to catch material resulting from grinding, sanding, and painting. Dispose of this waste by double bagging in plastic and placing in your garbage.

3.3 Storage of Solid Wastes and Yard Wastes

Improper storage of recycling, yard waste, and trash at residences can lead not only to water pollution problems, but problems with neighborhood pets and vermin. Following the BMPs listed

below can help keep your property a clean and healthy place to live.

3.3.1 Suggested BMPs

All recycling and waste containers kept outside should have lids (Figure 3.1). If your lid is damaged, you should repair or replace it as soon as possible. If your container is supplied by your hauler, please call to have the lid repaired or replaced. Find your hauler's contact information at piercecountywa.gov/recycle.

- Leaking containers should be replaced. If your container is supplied by your hauler, contact the hauler to have damaged containers replaced.
- Store containers under cover if possible, or on grassy areas.
- Inspect the storage area regularly to pick up loose scraps of material and dispose of them properly.
- Tips for reducing waste:
  - Recycle as much as you can. Most Pierce County residents have access to curbside pickup for yard waste and recyclable materials. Use the online recycling menu to find more recycling options.
  - Purchase products with the least amount of packaging materials.

Figure 3.1. - Recycling Cart with Properly Sealed Lid.



  - Compost biodegradable materials such as grass clippings and vegetable scraps instead of throwing them away. Your flowerbeds will love the finished compost, and you will be helping to conserve limited landfill space. Visit piercecountywa.gov/compost or call Pierce County Planning and Public Works at (253) 798-2179 for more information on composting or yard waste collection. See the section on composting for BMPs relating to that activity.

- A fun alternative to traditional composting is worm composting. You can let worms do all the work for you by keeping a small vermiculture box just outside your kitchen. For more information on getting started with worms, visit piercecountywa.gov/compost or call the number listed above.

3.4 Composting

Composting is an earth-friendly activity. If you choose to compost, the following BMPs should be utilized. More information can be found online at piercecountywa.gov/compost.

3.4.1 Suggested BMPs

- Compost piles must be located on an unpaved area where runoff can soak into the ground or be filtered by grass and other vegetation. Compost piles should be located in an area of your yard not prone to water ponding during storms, and should be kept well away from wetlands, streams, lakes, and other drainage paths.
- Compost piles must be maintained and turned over regularly to work properly. Large piles of unattended compost may create odor and vermin problems.
- Avoid putting hazardous, inorganic, plastics or metal waste in the pile.
- Cover the compost pile (Figure 3.2) for two reasons:
  1. To keep stormwater from washing nutrients into waterways.
  2. To keep excess water from cooling down the pile, which will slow down the rate of decomposition.

Figure 3.2. - Covered Compost Bin.



(photo courtesy of Green Culture)

Build Bins of wood, chicken wire, or fencing material to contain compost so it cannot be washed away. Visit piercecountywa.gov/compost to download plans for building your own bin, or call Pierce County Planning and Public Works at (253) 798-2179.

- Building a small earthen dike around your compost pile is an effective means of preventing nutrient-rich compost drainage from reaching stormwater paths.

3.5 Yard Maintenance and Gardening

This section discusses normal yard maintenance activities we all perform at our homes. Overwatering, overfertilizing, improper herbicide application, and improper disposal of trimmings and clippings can all contribute to serious water pollution problems. Following the BMPs listed below will help alleviate pollutant runoff.

3.5.1 Required BMPs

- Follow the manufacturer's directions exactly for mixing and applying herbicides, fungicides, and pesticides, and use them sparingly. Never apply when it is windy or when rain is expected. Never apply over water, within 100 feet of a well-head, or adjacent to streams, wetlands, or other water bodies. Triple-rinse empty containers, using the rinsate for mixing your next batch of spray, and then double-bag and dispose of the empty container in your regular garbage. Never dispose of grass clippings or other vegetation in or near storm drains, streams, lakes, or Puget Sound.

3.5.2 Suggested BMPs

- Use natural, organic soil amendments like Pierce County's SoundGRO Mix. SoundGRO Mix is a 100 percent recycled blend of dewatered, Class A, "Exceptional Quality" biosolids, mixed with sawdust and sand. The excellent soil conditioning properties of the organic matter aid water retention in lighter soils and help to break up and aerate heavier soils, so roots can grow better and less watering is needed. It contains both readily available and long term nitrogen and other nutrients commonly lacking in Northwest soils. The slow release of nitrogen better matches the needs of plants. Thus, there is much less potential for nitrates to leach into surface or groundwater due both to less "excess nitrogen" and less water use. Better vegetative growth can also reduce erosion and runoff.
- Follow manufacturer's directions when applying fertilizers. More is not better, either for your lawn or for local water bodies. Never apply fertilizers over water or adjacent to ditches, streams, or other water bodies. Remember that organic fertilizers have a slow release of nitrogen, and less potential to pollute then synthetic fertilizers.
- Save water and prevent pollution problems by watering your lawn sensibly. Lawns and gardens typically need the equivalent of 1-inch of rainfall per week. You can check on how you're doing by putting a wide mouth jar out where you're sprinkling, and measure the water with a small plastic ruler. Overwatering to the point of runoff can carry polluting nutrients to the nearest water body.
- Consider planting a vegetated buffer zone adjacent to streams or other water bodies on your property. Call the Pierce County Conservation District at (253) 8459770 for advice and assistance in developing a planting plan. The Stream Team at the Conservation District may even be able to help you plant it.
- Reduce the need for pesticides and fertilizers on lawns by improving the health of the soil. Aerating, thatching, and topdressing with compost or the City of Tacoma's Tagro products will improve soil health and help wanted grasses compete with weeds and moss.
- Make sure all fertilizers and pesticides are stored in a covered location. Rain can wash the

labels off of bottles and convert 50 pounds of fertilizer into either a solid lump or a river of nutrients.

- Use a mulching mower and mow higher to improve soil/grass health and reduce or eliminate pesticide use.
- Compost all yard clippings, or use them as mulch to save water and keep down weeds in your garden. See Composting section for more information.
- Practice organic gardening and virtually eliminate the need to use pesticides and fertilizers. Contact Pierce County Cooperative Extension at (253) 7987180 or the Ask-A-Master Gardener program at (253) 7987170 for information and classes on earth-friendly gardening.
- Pull weeds instead of spraying and get some healthy exercise, too. If you must spray, use the least toxic formulations that will get the job done. The Master Gardener program listed above can help advise you on which spray to use.
- Till fertilizers into the soil instead of letting them lie on the ground surface exposed to the next rain storm.
- Plant native vegetation which is suited to Northwest conditions, they require less water and little to no fertilizers and pesticides.
- Contact your local waste disposal company for curbside pickup and recycling of yard waste.

3.6 Swimming Pool and Spa Cleaning and Maintenance

This section discusses water from pools, spas, hot tubs and fountains chemically treated or heated. Nutrients, pH, and chlorine can adversely affect fish and wildlife in water bodies. Following these BMPs will ensure the cleanliness of your pool and the environment.

3.6.1 Required BMPs

- Do not discharge water directly from a pool spa, hot tub or fountain process wastes, or wastewaters into storm drains except if the discharge water is dechlorinated to 0.1 mg/L if it is to be emptied into a ditch or to the stormwater drainage system. Contact your pool chemical supplier to obtain the neutralizing chemicals you will need. The rate of flow into the ditch or stormwater drainage system must be regulated so that it does not cause problems such as erosion, surcharging, or flooding. Water discharged to the ground or a lawn must not cross property lines and must not produce runoff.
- If pool, spa, hot tub, or fountain water cannot be dechlorinated, it must be discharged to the sanitary sewer. Prior to draining, your local wastewater treatment plant must be notified to ensure they are aware of the volume of discharge and the potential effects of chlorine levels (call (253) 7983013). A pool service company can help you determine the frequency of cleaning and backwash of filters.
- Diatomaceous earth used in pool filters cannot be disposed of in surface waters, on the ground, or into stormwater drainage systems or septic systems. Dry it out as much as possible, bag it in plastic, and dispose of at the landfill.

3.6.2 Suggested BMPs

- Hire a professional pool service company to collect all pool water for proper disposal. Make

sure to ask them where they will dispose of it and the kind of permits they hold to do so.

- Ensure that the pool, spa, hot tub, or fountain system is free of leaks and operates within the design parameters.
- Do not provide any permanent links to drainage systems. All connections should be visible and carefully controlled.
- If the dechlorination or cooling process selected requires the water to be stored for a time, it should be contained within the pool or appropriate temporary storage container.

3.7 Household Hazardous Material Use, Storage, and Disposal

Once we really start looking around our houses, the amount of hazardous materials we have onsite is a real eye-opener. Oil-based paints and stains, paint thinner, gasoline, charcoal starter fluid, cleaners, waxes, pesticides, fingernail polish remover, and wood preservatives are just a few hazardous materials that most of us have around the house.

When products such as these are dumped on the ground or in a storm drain, they can be washed directly to receiving waters where they can harm fish and wildlife. They can also infiltrate into the ground and contaminate drinking water supplies. The same problem can occur if they are disposed of with your regular garbage; the containers can leak at the landfill and contaminate groundwater. The same type of contamination can also occur if hazardous products are poured down a sink or toilet into a septic system. Do not pour them down the drain if you're on municipal sewers, either. Many compounds can "pass through" the wastewater treatment plant without treatment and contaminate receiving waters, or they can harm the biological process used at the treatment plant, reducing overall treatment efficiency.

With such a diversity of hazardous products present in all homes in Pierce County, a large potential for serious environmental harm exists if improper methods of storage, usage, and disposal are employed. Using the following BMPs will help keep these materials out of our soils, sediments, and waters.

3.7.1 Required BMPs

- Hazardous Materials must be used in accordance with the manufacturer recommendation or guidelines as shown on the label.
- Always store hazardous materials in properly labeled containers, never in food or beverage containers which could be misinterpreted by a child as something to eat or drink.
- Dispose of hazardous materials and their containers properly. Never dump products labeled as poisonous, corrosive, caustic, flammable, inflammable, volatile, explosive danger, warning, caution, or dangerous outdoors, in a storm drain, or into sinks, toilets or drains. Visit piercecountywa.gov/hhw, call the Hazardous Waste Line at 1 (800) 287-6429, Tacoma-Pierce County Health Department (253) 798-6047, or the Tacoma Solid Waste Utility Household Hazardous Waste at (253) 591-5418 for information on disposal methods, collection events, and alternative products. Household hazardous waste from Pierce County residents and non-residents are accepted at the Tacoma Landfill and LRI Landfill.

3.7.2 Suggested BMPs

- Check hazardous material containers frequently for signs of leakage. If a container is rusty and has the potential of leaking soon, place it in a secondary container before the leak

occurs and prevent a cleanup problem.

- Hazardous materials should be stored out of the reach of children.
- Store hazardous materials containers under cover and off the ground. Keep them out of the weather to avoid rusting, freezing, cracking, labels being washed off, etc.
- Keep appropriate spill cleanup materials on hand. Kitty litter is good for many oil-based spills.
- Ground cloths and drip pans must be used under any work outdoors which involves hazardous materials such as oil-based paints, stains, rust removers, masonry cleaners, and others bearing label warnings as outlined above (Figure 3.3).

Figure 3.3. - Drip Pan for Capturing Spills and Drips During Engine Repair and Maintenance.



- Latex paints are not a hazardous waste, but are not accepted in liquid form at the landfill. To dispose of, leave uncovered in a protected place until dry, then place in the garbage. If you want to dry waste paint quickly, mix kitty litter or sawdust in the can to absorb the paint. Once paint is dry, leave the lid off when you place it in the garbage so your garbage collector can see that it is no longer liquid.
- Use less toxic products whenever possible. The Hazardous Waste Line at 1 (800) 287-6429 and the Washington Toxics Coalition at (206) 632-1545 have information detailing alternatives to toxic products.
- If an activity involving the use of a hazardous material can be moved indoors out of the weather, then do so. Make sure you can provide proper ventilation, however.
- Follow manufacturers' directions in the use of all materials. Over-application of yard chemicals, for instance, can result in the washing of these compounds into receiving water bodies. Never apply pesticides when rain is expected.
- When hazardous materials are in use, place the container inside a tub or bucket to minimize spills and store materials above the local base flood elevation (BFE).

3.8 Pet Waste Management

Pets and pet-care can generate pollutants from waste, animal washing and cage or kennel cleaning. Pet waste that washes into rivers, lakes, streams or Puget Sound begins to decay, using up oxygen and releasing ammonia. Low oxygen levels and ammonia combined with warm water can kill fish. Pet waste also contains nutrients that encourage weed and algae growth in waters we use for swimming, boating and fishing. Most importantly, pet waste can carry diseases and bacteria that could make water unsafe for contact and lead to beach closures or effect shellfish harvest. These include:

- Campylobacteriosis—bacterial infection
- Salmonellosis—bacterial infection
- Toxocariasis—roundworm infection
- Toxoplasmosis—protozoan parasite infection
- Giardiasis—protozoan parasite infection
- Fecal Coliform—bacteria in feces, indicates contamination
- *E. coli*—bacteria in feces, may cause disease.

Cleaning up after your pet can be as simple as taking a plastic bag or pooper scooper along on your next walk. Then choose one of the following:

3.8.1 Suggested BMPs for Pet Owners



- Regularly pick up and dispose of pet waste deposited on walks and at home.
- Put waste in a securely closed bag and deposit it in the trash. Do not put it in your yard waste container because pet waste may carry diseases, and yard waste treatment may not kill disease organisms.
- Do not compost or use pet waste as a fertilizer – Harmful bacteria, worms, and parasites that can transmit disease can live in the soil for years even after the solid portion of the pet waste has dissolved.
- Do not dispose of unused pet pharmaceuticals in a storm drain, in a toilet, or down a sink. Check with your local refuse collector for proper disposal locations of pet medications.
- When cleaning out cages and kennels, dispose of washwater down the toilet or a mop sink. Otherwise, wash directly over lawn areas or make sure the washwater drains to a vegetated area.
- Bathe pets indoors or in a manner that washwater won't be discharged to storm drains, ditches, or surface waters of the state.

Suggested BMPs for Recreation Areas and Multi-Family Properties

- Post signs at recreation areas and multi-family properties (that allow pets) reminding residents and visitors to pick up after their pets.
- Carefully consider the placement of pet waste stations at recreation sites and near multi-family properties that allow pets. Choose locations convenient for dog walkers to pick up a bag at the start of their walk and locations for them to dispose of it at mid-walk or at the end of their walk.
- Check pet waste stations on a regular basis to keep pet waste bags stocked and disposal stations empty. Consider signage to keep regular trash out of pet waste disposal stations to avoid filling them too quickly. Make sure pet waste disposal stations have a cover to keep out water.
- At multi-family properties with roof-top dog runs, ensure that stormwater from the dog run is not discharged to the stormwater system. Check with the local jurisdiction regarding roof-top dog run connections to sanitary sewer.

3.9 On-Site Sewage Maintenance and Operation

Pierce County is responsible for making sure stormwater discharged from the stormwater management systems do not harm or impair the receiving waters (streams, rivers, lakes, groundwater or Puget Sound) it discharges into. Sample tests of stormwater discharges and receiving water occasionally indicate high levels of fecal coliform bacteria.

One potential source of bacteria is malfunctioning onsite sewage systems (septic systems). Septic system failures have been documented on private property in Pierce County.

Septic systems vary widely in their design and complexity. Owners of septic systems should contact the Tacoma-Pierce County Health Department at (253) 7986577 to request an as-built of their system. As-builts are also available on their website at tpchd.org/healthy-homes/septic-systems.

A septic tank is the first stage of a private sewage disposal system, and is a water-tight tank placed below ground, usually made from concrete, fiberglass, plastic or steel. Septic tanks have one or two access ports for inspection and maintenance which are usually buried a few inches below the ground.

The tank receives household wastewater through an inlet pipe at one end, settles out larger material to the bottom, breaks down waste material with bacteria present in the tank and delivers the partially treated wastewater out another pipe on the opposite end of the tank to the disposal field.

The disposal field is the second stage of the private sewage disposal system and completes the final breakdown of wastewater with organisms in the soil.

The disposal field (drainfield) consists of narrow trenches filled with gravel and perforated pipes that distribute the wastewater to the field. With proper maintenance, a well-designed system can last a long time; however, disposal fields will clog if forced to handle large particles that should settle out in the bottom of the septic tank.

3.9.1 Required BMPs

Regular Inspection and Maintenance

Owners of septic systems must follow all of the requirements of the Tacoma- Pierce County Health Department (Health Department). Septic systems are required to be inspected on a routine basis. The frequency of inspection is based on the type of septic system being used and is outlined in the Tacoma-Pierce County Board of Health Resolution No. 2014-4414, Environmental Health Chapter 2 Code, Section 39 through 42. For "high risk" systems the inspections are required annually. Septic system noted as "moderate risk" should be inspected every three years. Those systems classified as "low risk" are to be inspected at time of property sale, land development or upon notification by the Health Department.

The inspection should cover each component of the septic system from the septic tank through the final disposal field. Measuring accumulated sludge and scum in the septic tank is an important part of the overall inspection process. Pumping frequency of the septic tank can vary depending on tank size, family size and garbage disposal use. Inspection of the entire system and conducting needed maintenance can find and correct problems before they become major, thereby saving the homeowner in potential high repair cost. Contact the Tacoma-Pierce County Health Department at (253) 7984788 for further information and specific requirements applicable to your system.

Eliminate or Restrict Garbage Disposal Use

Eliminating or restricting garbage disposals can significantly reduce the loading of solids to the septic tank thus reducing the pumping frequency.

Reduce and Spread Water Use Out Over the Day

Septic systems are limited in their ability to handle large amounts of wastewater discharged at one time. Excessive wastewater flow can cause turbulence in the septic tank that may flush accumulated solids into the disposal field. Over time this will impair the ability of the disposal field to function. Limit water using appliances to one at a time. Do one load of clothes a day rather than several in one day. Practice water conservation at home.

Chemical Use

Septic systems are to be used for the disposal of household wastewater only. Never dispose of excess or unwanted chemicals into the septic system. Occasional use of household cleaners in accordance with the manufacturers' recommendations should not harm your septic system. Avoid using septic tank additives that advertise their use as septic system cleaners or a substitute for pumping.

For additional information on proper operation of your septic system or to report a failing septic system in your neighborhood, contact the Tacoma-Pierce County Health Department at (253) 649-1925 or at tpchd.org/healthy-homes/septic-systems.

3.10 Activities in Wetlands and Wetland Buffers

Wetlands and associated buffers are vegetated ecosystems through which water passes. These areas characteristically have a high water table and are often subject to periodic flooding. Wetlands can be very effective in removing sediments, nutrients and other pollutants from stormwater.

Maintaining wetlands and associated buffers helps to slow stormwater runoff, trap sediments and other pollutants and reduce the volume of runoff by allowing infiltration to occur. Reducing the velocity of runoff reduces soil erosion and increases contact time with soil and vegetation. Increasing contact of stormwater with soils and vegetation in a wetland or riparian area can be effective in removing sediments, nutrients and other pollutants from stormwater runoff.

Buffer areas are important to both the wetland and the upland areas as habitat for aquatic wetland-dependent wildlife and as buffers during extreme weather events. Other functions of buffer areas that contribute to water quality include shading, flood attenuation and shoreline stabilization.

Persons responsible for maintenance of wetland areas are encouraged to call Pierce County PPW at (253) 7983739 prior to performing work in wetlands or their buffers.

3.10.1 Required BMPs

- Remove by hand any manmade litter, noxious weeds noted on the state noxious weed list (Washington Administrative Code [WAC] 16750) or invasive plant species as identified by Pierce County. Control may be conducted by clipping, pulling, over-shading with native tree and shrub species, or non-mechanized digging.
- Vegetation removal shall be allowed subject to the following standards. Hazard trees may be cut provided that:
    - The applicant submits a report from a certified arborist, licensed architect, or professional forester that documents the hazard and provides a replanting schedule for the replacement trees and receives written approval from Pierce County authorizing tree removal.
    - Tree cutting shall be limited to limbing and crown thinning, unless otherwise justified by the landowner's expert. Where limbing or crown thinning is not sufficient to address the hazard, trees should be topped to remove the hazard rather than cut at or near the base of the tree. All vegetation cut (tree stems, branches, tops, etc.) shall be left within the critical area or buffer unless removal is warranted due to the potential for disease transmittal to other healthy vegetation.
    - The landowner shall replace any trees that are felled or topped with new trees at a ratio of two replacement trees for each tree felled or topped. Tree species that are native and indigenous to the site shall be used.
    - Hazard trees determined to pose an imminent threat or danger to public health or safety, or to public or private property, or serious environmental degradation may be removed or topped by the landowner prior to receiving written approval from Pierce County provided that within 14 days following such action, the landowner shall submit the necessary report and replanting schedule demonstrating compliance with 18E.40.040 B.2.a.(1) through (3) above. *Per PCC Title 18E – Development Regulations – Critical Areas 18E.40.040 B.2*.

3.10.2 Suggested BMPs

- To prevent possible contamination limit fertilizer and herbicide around wetlands and their buffers.
- Limit access to wetlands and their buffers. To avoid compaction do not establish trails within the wetland areas.

Chapter 4. Best Management Practices for Commercial and Industrial Activities

This chapter coordinates with the worksheet in Chapter 2. That worksheet and the BMPs are organized by the different activities businesses perform. If you perform the listed activity indoors, controlling all discharges from the activity (e.g., process water, washwater, lubricants, solvents, fugitive dust, granular material, blow down waste) such that no exposure to stormwater occurs, then you do not have to institute new BMPs for that activity. However, if you checked the column for activities performed outdoors, match the number from the worksheet to the activities listed in this section to find the BMPs you should utilize. See also Section 1.5 for explanation of required and suggested BMPs.

If you have questions, please contact Pierce County Planning and Public Works Surface Water Management (253) 798-2725. They can provide assistance over the phone and are also available for consultations at your business site.

Below is a summary of items that each business should consider. Most of these are common sense, housekeeping types of solutions; but if each business would take some action on each of these, the improvement in water quality would be substantial.

1. **Avoid the activity or reduce its occurrence**

   If possible, avoid the activity or do it less frequently. Is there a substitute process or a different material available to get the job done? Can a larger run of a process be performed at one time, thus reducing the number of times per week or month it needs to be repeated? For instance, raw materials could be delivered close to the time of use instead of being stockpiled and exposed to the weather. Perhaps the site could avoid one solvent-washing step altogether. Ecology or the Tacoma-Pierce County Health Department can provide pollution prevention assistance.

2. **Move the activity indoors**

   Sometimes it is fairly easy to move an activity indoors out of the weather. The benefits of this are twofold; preventing runoff contamination, and providing for easier, more controlled cleanup if a spill occurs. An example would be unloading and storing barrels of chemicals inside a garage area instead of doing it outside. Please be aware that moving storage areas indoors may require installation of fire suppression equipment or other building modifications as required by the International Building Code (IBC), the International Fire Code or local ordinances.

3. **Cleanup spills quickly**

   Promptly contain and cleanup solid and liquid pollutant leaks and spills on any exposed soil, vegetation, or paved area. Promptly repair or replace all leaking connections, pipes, hoses, valves, etc., which can contaminate stormwater.

4. **Use less material**

   Do not purchase or use more material than needed. This helps to keep potential disposal, storage, and pollution problems to a minimum too.

5. **Use the least toxic materials available**

   Investigate the use of materials that are less toxic than what is used now. Perhaps a

caustic-type detergent or a solvent could be replaced with a more environmentally friendly product. Such a change might allow the site to discharge process water to the sanitary sewer instead of paying for expensive disposal (contact Pierce County Planning and Public Works Sewer Division at (253) 798-3013 to find out about allowable sanitary discharges and pretreatment permits). Remember that even if using a biodegradable product, nothing but uncontaminated water is allowed to enter the stormwater drainage system.

6. **Create and maintain vegetated areas near activity locations**

   Vegetation of various kinds can help filter pollutants out of stormwater, so it is advisable to route stormwater through vegetated areas located near the activity. For instance, many parking lots contain grassy islands, typically formed in a "hump". By creating those islands as depressions instead of humps, they can be used to treat runoff from the parking lot or roof. For high-use sites, conveyance to an oil removal system may be required. For more information on high-use sites, refer to Volume V, Section 2.1, Step 3. Also, don't forget the erosion control benefits of vegetation at a site.

7. **Locate activities as far as possible from surface drainage paths**

   Activities located as far as possible from known drainage paths, ditches, streams, other water bodies, and drains will be less likely to pollute, since it will take longer for material to reach the drainage feature. This gives more time to react in the event of a spill, or if it is a "housekeeping" issue, may protect the local waters long enough for cleanup of the area around the activity. Don't forget that groundwater issues are always prominent, no matter where the activity is located, so the actions taken on the site on a day-to-day basis are always important, even in dry weather.

8. **Keep stormwater drainage systems clean and maintained**

   Pollutants can concentrate over time in storm drainage structures such as catch basins, ditches, and storm drains. When a large storm event occurs, it can mobilize these pollutants and carry them to receiving waters. Develop and implement maintenance practices, inspections, and schedules for treatment devices (e.g., detention ponds, oil/water separators, vegetated swales). Requirements for cleaning stormwater facilities will be discussed later in Chapter 5, specifically BMP S.9.

   Promptly repair or replace all substantially cracked or otherwise damaged paved secondary containment, high-intensity parking, and any other drainage areas that are subjected to pollutant material leaks or spills.

9. **Reduce, reuse, and recycle as much as possible**

   Always look for ways to recycle instead of just disposing. This can save money as well as keep both hazardous and non-hazardous materials out of the landfills. Learn more about other businesses that have made process changes allowing recycling of chemicals by calling Ecology at 1800RECYCLE and requesting publication No. 9245 and No. 9022. Another unique recycling opportunity for businesses is available through the Industrial Materials Exchange. This free service acts as a waste or surplus "matchmaker," helping one company's waste become another company's asset. For instance, waste vegetable oil can become biofuel for another business. Call Industrial Materials Exchange at (206) 263-8465 to list potentially usable solid or chemical waste in their publication.

10. **Be an advocate for stormwater pollution prevention**

    Help friends, partners, and business associates find ways to reduce stormwater pollution in

their activities. Most people want clean water and do not pollute intentionally. Share ideas and the BMPs in this volume to get them thinking about how their everyday activities effect water quality.

11. Report problems

We all must do our part to protect water, fish, wildlife, and our own health by employing proper BMPs, and reporting water quality problems that we observe. In Pierce County to report dumping to sewers, call Pretreatment Inspections at (253) 798-3013, to report incidents involving storm drains or ditches call Pierce County Planning and Public WOrks Surface Water Management at (253) 7982725. Also contact Ecology's Southwest Regional office at (360) 407-6300.

12. Oversight and training

Assign one or more individuals to be responsible for stormwater pollution control. Hold regular meetings to review the overall operation of the BMPs. Establish responsibilities for inspections, operation and maintenance (O&M), and availability for emergency situations. Train all team members in the operation, maintenance, and inspection of BMPs and reporting procedures.

13. Dust control

Sweep paved material handling and storage areas regularly as needed, to collect and dispose of dust and debris that could contaminate stormwater. Do not hose down pollutants from any area to the ground, storm drain, conveyance ditch, or receiving water unless necessary for dust control purposes to meet air quality regulations and unless the pollutants are conveyed to a treatment system approved by the county.

14. Maintenance

Clean oils, debris, sludge, etc. from all BMP systems regularly, including catch basins, settling/detention basins, oil/water separators, boomed areas, and conveyance systems, to prevent the contamination of stormwater.

Promptly repair or replace all substantially cracked or otherwise damaged paved secondary containment, high-intensity parking, and any other drainage areas that are subjected to pollutant material leaks or spills.

Promptly repair or replace all leaking connections, pipes, hoses, valves, etc. which can contaminate stormwater.

Maintenance standards can be found in Volume I, Appendix IA.

15. Eliminate illicit connections

An illicit connection is formally defined in the county's NPDES Municipal Stormwater permit, but generally includes any connection to the county stormwater system that is not intended, permitted, or used for collecting and conveying stormwater. A common problem with the stormwater drainage system for Pierce County is the existence of illegal hook-ups to the system. Many businesses and residences hooked internal building drains, sump overflows, process wastewater discharges, and even sanitary sewer and septic system pipes to the storm drain in the past. All businesses and residences in Pierce County must examine their plumbing systems to determine if illicit connections exist. Any time it is found that toilets, sinks, appliances, showers and bathtubs, floor drains, industrial process waters, or other indoor activities are connected to the stormwater drainage system, these

connections must be immediately rerouted to the sanitary or septic system, holding tanks, or process treatment system. Methods to eliminate illicit connections are described in detail in Chapter 5, BMP S.1.

16. Dispose of waste properly

Every business and residence in Pierce County must dispose of solid and liquid wastes and contaminated stormwater properly. There are generally four options for disposal depending on the type of materials. These options include:

- Sanitary sewer and septic systems
- Recycling facilities
- Municipal solid waste disposal facilities
- Hazardous waste treatment, storage, and disposal facilities.

Additional information on disposal is described in Chapter 5, BMP S.2.

Section A1 Cleaning or Washing Activities

A1.1 Cleaning or Washing of Tools, Engines, and Manufacturing Equipment

Description of Pollutant Sources: This activity applies to businesses and public agencies that clean manufacturing equipment such as saws, grinders, screens, and other processing devices outside of buildings, and to businesses engaged in pressure washing of engines, equipment, and portable objects.

Pollutants sources include toxic hydrocarbons, organic compounds, oils and greases, nutrients, heavy metals, pH, suspended solids, biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

Pollutant Control Approach: The preferred approach is to cover and/or contain the cleaning activity or conduct the activity inside a building, to separate the uncontaminated stormwater from the pollutant sources. Washwater must be conveyed to a sanitary sewer after approval by Pierce County, temporarily stored before proper disposal, or recycled, with no discharge to the ground, a storm drain, or surface water. Washwater may be discharged to the ground after proper treatment in accordance with Ecology guidance WQR9556, Vehicle and Equipment Washwater Discharges/Best Management Practices Manual November 2012, or most recent update. The quality of any discharge to the ground after proper treatment must comply with Ecology's Ground Water Quality Standards, Chapter 173200 WAC. Contact the Ecology Southwest Regional Office for an NPDES permit application for discharge of washwater to surface water or to a storm drain after onsite treatment.

Required BMPs

The following BMPs, or equivalent measures, are required of all businesses and public agencies engaged in cleaning or washing of tools, engines, equipment, and portable objects:

- Illicit connections to the stormwater drainage system must be eliminated. See BMP S.1 in Chapter 5 for detailed information.
- Employees should be educated to control washing operations to prevent stormwater contamination.
- All washwater must discharge to a holding tank, process treatment system, or sanitary sewer, never to the stormwater drainage system. See BMP S.3 in Chapter 5 for detailed information on how this must be accomplished.
- Pressure washing must be done in a designated area (such as a wash pad) provided with a sump drain and stormwater runon prevention (Figures 4.1 and 4.2). See BMPs S.6 and S.7 in Chapter 5 for information on sumps (or holding tanks) and runon prevention. Contact the Pierce County Pretreatment Program (253) 798-3013 for washing operation policy.

Figure 4.1. - Wash Pad for Tool and Equipment Washing.



(Photo courtesy of Seattle Public Utilities)

Figure 4.2. - Uncovered Washing Area for Tools, Engines, Equipment, and Portable Objects, with Drains to a Sanitary Sewer, Process Treatment, or a DeadEnd Sump.



Suggested BMPs

The following BMPs are not required, but they can provide additional pollution control:

- If soaps or detergents are used, use the least toxic cleaner capable of doing the job. Use non-phosphate detergent, if possible, to reduce loadings at your local wastewater treatment plant.
- Limit the amount of water used in washing activities to reduce the potential of runoff carrying pollutants beyond the designated wash pad or capture system.
- Recycle washwater for subsequent washings.

Implement one or more of the stormwater treatment BMPs found in Volume V.

- For discharging washwaters containing soaps and detergents, the use of infiltration, bioretention, biofiltration, wet ponds, and wetlands must not result in the violation of groundwater quality standards.

A1.2 Cleaning or Washing of Cooking Equipment

Description of Pollutant Sources: This activity applies to businesses that clean cooking equipment such as vent filters, grills, and grease traps outside of buildings.

Pollutants of concern consist of oil and grease, nutrients, suspended solids, biochemical oxygen demand (BOD) and chemical oxygen demand (COD).

Pollutant Control Approach: Businesses engaged in this activity that cannot connect discharges to a sanitary sewer, holding tank, or process water treatment system must contact Ecology and obtain a NPDES wastewater permit.

Required BMPs

The following BMPs or equivalent measures are required of all businesses engaged in cleaning or washing of cooking equipment:

- Illicit connections to the stormwater drainage system must be eliminated. See BMP S.1 in Chapter 5 for detailed requirements.
- Employees must be educated about the need to prevent stormwater contamination from washing operations.
- Washwater cannot be discharged to the stormwater drainage system.
- Paved washing areas must be swept daily to collect loose solid materials for proper disposal.
- Greasy buildup on cooking equipment must be removed and properly disposed of prior to washing to reduce the amount of material that can potentially contaminate runoff.
- Move the activity indoors, into either an existing building or a newly constructed building or shed, with drainage to a sanitary sewer, holding tank, or process treatment system (Figure 4.3). See BMP S.3 in Chapter 5 for further information on drainage alternatives. Any connection to the sanitary sewer requires the approval of Industrial Pretreatment Program at (253) 798-3013.

  OR

  Use a tub or similar device to contain washwater. This water must be recycled for subsequent washing, or disposed of in a holding tank or sanitary sewer.

OR

If the washing activity cannot be moved indoors or contained in a tub, then the washing area must drain to a sanitary sewer, holding tank, or process treatment system, and provisions must be made to prevent stormwater runon onto the washing area. See BMP S.3 in Chapter 5 for detailed drainage requirements and BMP S.7 for runon prevention schemes. If discharging to a sanitary sewer, permits must be obtained from Industrial Pretreatment Program at (253) 798-3013.

Figure 4.3. - Cleaning and Washing Cooking Equipment Indoors.



(Photo courtesy of Seattle Public Utilities)

- If a holding tank is used for storage of washwater, the contents must be pumped out before it is full and disposed of appropriately to a sanitary sewer or wastewater treatment system.

Suggested BMPs

The following BMPs are not required, but they can provide additional pollution protection:

- A cover should be placed over a designated wash area to keep rain from falling on dirty equipment and producing contaminated runoff.
- Implement one or more of the treatment BMPs found in Volume V.

For discharging washwaters containing soaps and detergents, the use of infiltration, bioretention, biofiltration, wet ponds, and wetlands must not result in the violation of groundwater quality standards.

A1.3 Washing, Pressure Washing, and Steam Cleaning of Vehicles / Equipment / Building Structures

Description of Pollutant Sources: Pollutant sources include the commercial cleaning of vehicles, aircraft, vessels, carpets, industrial equipment, and large buildings with low or high pressure water or steam. This includes frequent "charity" car washes at gas stations and commercial parking lots. The cleaning can include hand washing, scrubbing, sanding, etc. Washwater from cleaning activities can contain oil and grease, suspended solids, heavy metals, soluble organics, soaps, and detergents that can contaminate stormwater.

Pollutant Control Approach: The preferred approach is to cover and/or contain the cleaning activity, or conduct the activity inside a building, to separate the uncontaminated stormwater from the washwater sources. Contact the Pierce County Industrial Pretreatment Program (253) 798-3013 for advice and consultation on appropriate treatment and for approvals to discharge to sanitary sewer. Convey washwater to a sanitary sewer after approval by the Pierce County Industrial Pretreatment Program. Provide temporary storage before proper disposal, or recycling. Under this preferred approach, no discharge to the ground, a storm drain, or surface water should occur.

The Industrial Stormwater General Permit prohibits the discharge of process wastewater (e.g., vehicle washing wastewater) to groundwater or surface water. Stormwater that commingles with process wastewater is considered process wastewater.

Facilities not covered under the Industrial Stormwater General Permit that are unable to follow one of the preferred approaches listed above may discharge washwater to the ground after proper treatment in accordance with Ecology guidance WQR9556, Vehicle and Equipment Washwater Discharges/Best Management Practices Manual, November 2012, or most recent update. The quality of any discharge to the ground after proper treatment must comply with Ecology's Ground Water Quality Standards, Chapter 173200 WAC. Contact the Ecology Southwest Regional Office to discuss permitting options for discharge of washwater to surface water or to a storm drain after onsite treatment.

Required BMPs

Conduct vehicle/equipment washing in one of the following locations:

- At a commercial washing facility in which the washing occurs in an enclosure and drains to the sanitary sewer, or
- In a building constructed specifically for washing of vehicles and equipment, which drains to a sanitary sewer.

Conduct outside washing operation in a designated wash area with the following features:

- In a paved area, construct a spill containment pad to prevent the runon of stormwater from adjacent areas. Slope the spill containment area to collect washwater in a containment pad drain system with perimeter drains, trench drains, or catchment drains. Size the containment pad to extend out a minimum of four feet on all sides of the washed vehicles and/or equipment.
- Convey the washwater to a sump (like a grit separator) and then to a sanitary sewer (if allowed by the Pierce County Sewer Utility), or other appropriate wastewater treatment or recycle system.

- Collect the washwater from building structures and convey it to appropriate treatment such as a sanitary sewer system if it contains oils, soaps, or detergents. If the washwater does not contain oils, soaps, or detergents (in this case only a low pressure, clean, cold water rinse is allowed), then it could drain to soils that have sufficient natural attenuation capacity for dust and sediment.
- Any discharge to the sanitary sewer requires the approval of Industrial Pretreatment Program at (253) 798-3013. Contact the utility for details on approved systems.

Suggested BMPs

- Mark the wash area at gas stations, multifamily residences, and any other business where non-employees wash vehicles.

Operators may use a manually operated positive control valve for uncovered wash pads, but a pneumatic or electric valve system is preferable. The valve may be on a timer circuit and opened upon completion of a wash cycle. After draining the sump or separator, the timer would then close the valve.

- Use phosphate-free biodegradable detergents when practicable.
- Consider recycling the washwater.
- Operators may use soluble/emulsifiable detergents in the wash medium, but should use it with care and the appropriate treatment. Carefully consider the selection of soaps and detergents and treatment BMPs. Oil/water separators are ineffective in removing emulsified or water soluble detergents. Another treatment appropriate for emulsified and water soluble detergents may be required.

Note that the purpose of the valve is to convey only washwater and contaminated stormwater to a treatment system.

- At commercial parking lots, where it is not possible to discharge the washwater to a sanitary sewer, a temporary plug or a temporary sump pump can be used at the storm drain to collect the washwater for offsite disposal.
- New and used car dealerships may wash vehicles in the parking stalls without soap, or if an approved treatment system for the washwater is in place.

Pierce County encourages residents to make use of car wash fundraising programs through the Puget Sound Car Wash Association (206) 622-8425 or online, visit pscarwash.org; or contact Brown Bear at (206) 774-3742; or contact Classy Chassis at (253) 284-9274.

At industrial sites contact the Ecology Southwest Regional Office for NPDES permit requirements even when not using soaps, detergents, and/or other chemical cleaners in washing trucks.

A1.4 Collection and Disposal of Wastewater in Mobile Interior Washing Operations

Description of Pollutant Sources: This activity applies to businesses that wash carpets and other interior items on a mobile site-to-site basis. The typical fleet washing process includes use of machines that spray the washwater solution onto the carpet or upholstery and then vacuums the dirty solution up into a portable tank with limited capacity.

Pollutants of concern consist of nutrients, suspended solids, organic compounds (such as pesticides and chemicals used for flea and odor control), biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

Pollutant Control Approach: Common practice in the past was to discharge the dirty solution onto the ground or to a drain connected to the stormwater drainage system between site visits. *These practices are now illegal.* **Wastewater must be poured into a sanitary sewer drain at the site of collection, the business office, or at another proper location. If discharging to a sanitary sewer, permits must be obtained from Industrial Pretreatment Program at (253) 7983-013. If sanitary sewer disposal is not available or not allowed, the collected wastewater must be returned to the business site for process treatment or transfer to a holding tank.**

Required BMPs

This BMP is required of all businesses doing mobile interior wash activities:

- Absolutely no wastewater from mobile interior wash activities can be disposed of outdoors, or to a drain connected to the stormwater drainage system. This point must be made clear to all employees. Wastewater from mobile washing operations may be permitted for sanitary sewer disposal if it does not contain high concentrations of toxic materials. Some of the chemicals used for flea and odor control are listed by U.S. Environmental Protection Agency (U.S. EPA) as toxics. Industrial Pretreatment Program at (253) 7983013 will need to know the type of chemicals and amount of water you intend to discharge. If the discharge is approved, they will then issue a permit for your activity. Wastewater must be poured into a sanitary sewer drain at the site of collection, the business office, or at another proper location.
- If sanitary sewer disposal is not available or not allowed, the collected wastewater must be returned to the business site for process treatment or transfer to a holding tank. See BMP S.3 in Chapter 5 for details on these drainage/disposal alternatives.

Suggested BMPs

The following BMPs are not required, but can provide additional pollution protection:

- Use the least toxic detergents and cleaners that will get the job done. Select non-phosphate detergents when possible.
- Limit the amount of water used in interior washing operations. This will save you time, money, and effort when it comes to proper disposal.
- Recycle washwater for more than one use.

Section A2 Transfer of Liquid or Solid Materials

A2.1 Loading and Unloading Areas for Liquid or Solid Material

Description of Pollutant Sources: Operators typically conduct loading/unloading of liquid and solid materials at industrial and commercial facilities is typically conducted at shipping and receiving, outside storage, fueling areas, etc. Materials transferred can include products, raw materials, intermediate products, waste materials, fuels, scrap metals, etc. Leaks and spills of fuels, oils, powders, organics, heavy metals, salts, acids, alkalis, etc. during transfer are potential causes of stormwater contamination. Spills from hydraulic line breaks are a common problem at loading docks.

Pollutant Control Approach: Cover and contain the loading/unloading area where necessary to prevent runon of stormwater and runoff of contaminated stormwater.

Required BMPs

At All Loading/Unloading Areas:

- A significant amount of debris can accumulate outside, uncovered loading/unloading areas. Sweep these surfaces frequently to remove loose material that could contaminate stormwater. Sweep areas temporarily covered after removal of the containers, logs, or other material covering the ground.
- Place drip pans, storm drain covers or other appropriate temporary containment devices at locations where leaks or spills may occur such as hose connections, hose reels, and filler nozzles. Always use drip pans when making and breaking connections (Figure 4.4). Check loading/unloading equipment such as valves, pumps, flanges, and connections regularly for leaks and repair as needed.
    - Consistent with International Fire Code requirements and to the extent practicable, conduct unloading or loading of solids and liquids in a manufacturing building or under a roof, lean-to, or other appropriate cover.
    - Berm, dike, and/or slope the loading/unloading area to prevent runon of stormwater and to prevent the runoff or loss of any spilled material from the area.
    - Place curbs along the edge of the shoreline, or slope the edge such that the stormwater can flow to an internal stormwater drainage system that leads to an approved treatment BMP. Avoid draining directly to the surface water from loading areas.
    - Pave and slope loading/unloading areas to prevent the pooling of water. Minimize the use of catch basins and drain lines within the interior of the loading/unloading area or place in designated “alleyways” to avoid being covered by material, containers, or equipment.
    - Retain on site the necessary materials for rapid cleanup of spills.

Figure 4.4. - Drip Pan for Connections at Loading and Unloading Areas for Liquid Material.



Photo courtesy of Mark Dilley, Interstate Products, Inc.)

- To minimize the risk of accidental spillage, prepare an "Operations Plan" that describes procedures for loading/unloading. Train the employees, especially fork lift operators, in its execution and post it or otherwise have it readily available to employees and regulatory officials.
- Report spills of reportable quantities to Ecology Southwest Regional Office (refer to Chapter 7 for telephone number).
- Prepare and implement an emergency spill cleanup plan for the facility (BMP A7.15 Spills of Oil and Hazardous Substances) which includes the following BMPs:
    - Ensure cleanup of liquid/solid spills in the loading/unloading area immediately if a significant spill occurs, upon completion of the loading/unloading activity, or at the end of the working day.
    - Retain and maintain an appropriate oil spill cleanup kit on site for rapid cleanup of material spills (see BMP A7.15 Spills of Oil and Hazardous Substances).
    - Ensure that an employee trained in spill containment and cleanup is present during loading/unloading.

At Rail Transfer Areas to Above/Below-ground Storage Tanks:

- Install a drip pan system as illustrated (Figure 4.4) within the rails to collect spills/leaks from tank cars and hose connections, hose reels, and filler nozzles.

Loading/Unloading from/to Marine Vessels:

- Facilities and procedures for the loading or unloading of petroleum products must comply with Coast Guard requirements.

Transfer of Small Quantities from Tanks and Containers:

- Refer to BMPs A4.8 Storage of Liquids in Permanent Aboveground Tanks and A4.7 Storage of Liquid, Food Waste, or Dangerous Waste Containers for requirements on the transfer of small quantities from tanks and containers, respectively.

Suggested BMPs

- For the transfer of pollutant liquids in areas that cannot contain a catastrophic spill, install an automatic shutoff system in case of unanticipated off-loading interruption (e.g., coupling break, hose rupture, overfill).

At Loading and Unloading Docks:

- Install/maintain overhangs or door skirts that enclose the trailer end (Figures 4.5 and 4.6) to prevent contact with rainwater.
- Design the loading/unloading area with berms, sloping, etc. to prevent the runon of stormwater.

At Tanker Truck Transfer Areas to Above/Below-Ground Storage Tanks:

- Pave the area on which the transfer takes place. If any transferred liquid, such as gasoline, is reactive with asphalt, pave the area with Portland cement concrete.
- Slope, berm, or dike the transfer area to a dead-end sump, spill containment sump, spill control oil/water separator, or other spill control device (see also Volume I, Appendix I-A for dead-end sump maintenance guidelines). The minimum spill retention time should be 15 minutes at the highest fuel dispenser nozzle through-put rate or the peak flow rate of the 6month, 24hour storm event over the surface of the containment pad, whichever is greater. The volume of the spill containment sump should be a minimum of 50 gallons with an adequate grit sedimentation volume.

Figure 4.5. - Loading Docks with an Overhang to Prevent Material Contact with Rainwater.



Figure 4.6. - Door Skirts to Enclose the Trailer End of a Truck to Prevent Material Contact with Rainwater.



A2.2 Fueling at Dedicated Stations

Description of Pollutant Sources: A fueling station is a facility dedicated to the transfer of fuels from a stationary pumping station to mobile vehicles or equipment. It includes above or underground fuel storage facilities. In addition to general service gas stations, fueling may also occur at 24hour convenience stores, construction sites, warehouses, car washes, manufacturing establishments, port facilities, and businesses with fleet vehicles. Typical causes of stormwater contamination at fueling stations include leaks/spills of fuels, lube oils, radiator coolants, and vehicle washwater.

Pollutant Control Approach: New or substantially remodeled fueling stations must be constructed on an impervious concrete pad under a roof to keep out rainfall and stormwater runon. Substantial remodeling includes replacing the canopy or relocating or adding one or more fuel dispensers in such a way that the Portland cement concrete (or equivalent) paving in the fueling area is modified. The facility must use a treatment BMP for contaminated stormwater and wastewaters in the fueling containment area.

Required BMPs

For New or Substantially Remodeled Fueling Stations:

- Prepare an emergency spill response and cleanup plan (per BMP A7.15 Spills of Oil and Hazardous Substances) and have designated trained person(s) available either on site or on call at all times to promptly and properly implement that plan and immediately cleanup all spills. Keep suitable cleanup materials, such as dry adsorbent materials, on site to allow prompt cleanup of a spill.
- Train employees on the proper use of fuel dispensers. Post signs in accordance with the International Fire Code. Post “No Topping Off” signs (topping off gas tanks causes spillage and vents gas fumes to the air). Make sure that the automatic shut off on the fuel nozzle is functioning properly.
- The person conducting the fuel transfer must be present at the fueling pump during fuel transfer, particularly at unattended or self-serve stations.
- Keep drained oil filters in a suitable container or drum.
- Design the fueling island to control spills (dead-end sump or spill control separator in compliance with the International Fire Code) and to treat collected stormwater and/or wastewater to required levels (see also Volume I, Appendix I-A for dead-end sump maintenance guidelines). Slope the concrete containment pad around the fueling island toward drains: trench drains, catch basins, and/or a dead-end sump. The slope of the drains shall not be less than 1 percent (Section 5703.6.8 of the International Fire Code). Drains to treatment facilities must have a normally closed shutoff valve. The spill control sump must be sized in compliance with International Fire Code.

  OR

- Design the fueling island as a spill containment pad with a sill or berm raised to a minimum of 4-inches (compliant with International Fire Code) to prevent the runoff of spilled liquids and to prevent runon of stormwater from the surrounding area. Raised sills are not required at the open-grate trenches that connect to an approved drainage-control system.
- The fueling pad must be paved with Portland cement concrete, or equivalent. Asphalt is not

considered an equivalent material.

- The fueling island must have a roof or canopy to prevent the direct entry of precipitation onto the spill containment pad (Figure 4.7). The roof or canopy should, at a minimum, cover the spill containment pad (within the grade break or fuel dispensing area) and preferably extend several additional feet to reduce the introduction of windblown rain. Convey all roof drains to storm drains outside the fueling containment area.

Figure 4.7. - Roof at Fueling Island to Prevent Stormwater Runon.



(Photo courtesy of Austin Mowhawk and Company, Inc.)

- Convey stormwater collected on the fuel island containment pad to a sanitary sewer system, if approved by Pierce County, Industrial Pretreatment Program at (253) 7983013; or to an approved treatment system such as an oil/water separator and a basic treatment BMP (basic treatment BMPs are listed in Volume V and include media filters and biofilters). Discharges from treatment systems to storm drains or surface water or to the ground must not display ongoing or recurring visible sheen and must not contain oil or grease.
- Alternatively, collect stormwater from the fuel island containment pad and hold for proper offsite disposal.
- Approval from Pierce County is required for conveyance of any fuel-contaminated stormwater to a sanitary sewer and must comply with pretreatment regulations (WAC 173216060). These regulations prohibit discharges that could “cause fire or explosion.” State and federal pretreatment regulations define an explosive or flammable mixture based on a flash point determination of the mixture. Stormwater could be conveyed to a sanitary sewer system if it is determined not to be explosive. Contact the Industrial Pretreatment Program at (253) 798-3013.
- Transfer the fuel from the delivery tank trucks to the fuel storage tank in impervious contained areas and ensure that appropriate overflow protection is used. Alternatively, cover nearby storm drains during the filling process and use drip pans under all hose connections.

Additional BMP for Vehicles 10 Feet in Height or Greater:

A roof or canopy may not be practicable at fueling stations that regularly fuel vehicles that are 10 feet in height or greater, particularly at industrial or WSDOT sites. At those types of fueling facilities, the following BMPs apply, as well as all of the other required BMPs and fire prevention International Fire Code requirements.

- If a roof or canopy is impractical, the concrete fueling pad must be equipped with emergency spill control, including a shutoff valve for drainage from the fueling area. Maintain the valve in the closed position in the event of a spill. An electronically actuated valve is preferred to minimize the time lapse between spill and containment. Clean up spills and dispose of materials off site in accordance with BMP A7.14 Spills of Oil and Hazardous Substances.
- The valve may be opened to convey contaminated stormwater to a sanitary sewer, if approved by Pierce County (Industrial Pretreatment Program at (253) 7983013), or to oil removal treatment such as an American Petroleum Institute (API) or coalescent plate oil/water separator, or equivalent treatment, and then to a basic treatment BMP. See Volume V for more information. Discharges from treatment systems to storm drains or surface water or to the ground must not display ongoing or recurring visible sheen and must not contain greater than a significant amount of oil and grease.

A2.3 Engine Repair and Maintenance

Description of Pollutant Sources: This activity applies to businesses and public agencies where fuel filters, engine oil, and other fluids such as battery acid, coolants, and transmission and brake fluids are removed and replaced in vehicles and equipment. It also applies to mobile vehicle maintenance operations, such as at construction sites. Related vehicle maintenance activities are covered under the following activity headings in this volume, and other BMPs provided in this volume:

- A1.3 Washing, Pressure Washing, and Steam Cleaning of Vehicles/Equipment/Building Structures
- A2.1 Loading and Unloading Areas for Liquid or Solid Material
- A2.2 Fueling at Dedicated Stations
- A3.7 Painting, Finishing, and Coating of Vehicles, Products, and Equipment
- A4.1 Storage or Transfer (Outside) of Solid Raw Materials, By-Products, or Finished Products
- A4.7 Storage of Liquid, Food Waste, or Dangerous Waste Containers
- A4.8 Storage of Liquids in Permanent Aboveground Tanks
- A4.9 Parking and Storage for Vehicle and Equipment
- A7.15 Spills of Oil and Hazardous Substances

Pollutants of concern include toxic hydrocarbons, toxic organic compounds, oils and greases, pH, and heavy metals.

Pollutant Control Approach: Control of leaks and spills of fluids using good housekeeping and cover and containment BMPs.

Required BMPs

The following BMPs or equivalent measures are required of all businesses and agencies engaged in engine and vehicle repair:

- Employees must be educated about the need for careful handling of automotive fluids. Employees at businesses or agencies who routinely change or handle these fluids must be trained in spill response and cleanup procedures. Inspect all incoming vehicles, parts, and equipment stored temporarily outside for leaks.
- Remove batteries and liquids from vehicles and equipment in designated areas designed to prevent stormwater contamination. Store cracked batteries in a covered non-leaking secondary containment system.
- Empty fuel filters before disposal.
- Spill cleanup materials, such as rags and absorbent materials, must always be kept close at hand when changing oil and other fluids. You can comply more easily with sewer and stormwater requirements by running a 'dry shop', thereby reducing your consumption/ discharge of liquids. Soiled rags and other cleanup material must be properly disposed of or cleaned and reused. Contact Pierce County Planning and Public Works Sustainable Resources (253) 7982179, online at: <https://www.piercecountywa.org/1507/Recycle-Reduce-Waste >, or your local solid waste hauler for proper disposal options.
- No drains inside maintenance buildings may connect to the sanitary sewer without prior written approval by the county, contact the Industrial Pretreatment Program at (253) 7983013. Interior drains will not be allowed to be connected to the stormwater drainage system.
- Do not hose down the maintenance/repair area. Instead, sweep the area weekly to collect dirt, and wipe up spills with rags and other absorbent materials.
- If the work is done at a mobile location, such as a construction site, a tarpaulin, ground cloth, or drip pans must be used beneath the vehicle or equipment to capture all spills and drips (Figure 4.8). The collected drips and spills must be recycled or disposed of properly. See BMP S.2 in Chapter 5 for disposal options.

Figure 4.8. - Drip Pan for Use at Mobile Sites.



- If this activity occurs at a stationary business location, the activity area must be moved indoors. An exception to this requirement would be equipment that is too large to fit under a roofed area. In this case, the outdoor area must be paved, provided with a sump drain, and provision made for stormwater runon prevention. See BMP S.6 and S.7 in Chapter 5 for more on paving, sump drains and holding tanks, and runon prevention. Contact Industrial Pretreatment Program at (253) 798-3013 for information on requirements for disposal to sewer. If you are on a septic tank, sump contents will need to be pumped and disposed of by an oil recycler or hazardous waste company.
- Recycle oil, antifreeze, batteries, and air conditioning coolant.
- Contaminated stormwater runoff from vehicle staging and maintenance areas must be conveyed to an API or coalescent plate oil and water separator followed by a basic treatment BMP (see Volume V), applicable filter, or other equivalent oil treatment system.

Suggested BMPs

- Drain all fluids from wrecked vehicles and 'parts' cars/equipment upon arrival. Recover air conditioning gases.
- Use reusable cloth rags to cleanup drips and small spills instead of disposables: these can be professionally laundered and reused. Do not attempt to launder these at home or at a coin-op laundry.
- Use absorbent pillows or booms in or around storm drains and catch basins to absorb oil and fuel.

A2.4 Mobile Fueling of Vehicles and Heavy Equipment

Description of Pollutant Sources: Mobile fueling, also known as fleet fueling, wet fueling, or wet hosing, is the practice of filling fuel tanks of vehicles by tank trucks that are driven to the yards or sites where the vehicles to be fueled are located.

Historically organizations conducted mobile fueling for off-road vehicles operated for extended periods in remote areas. This includes construction sites, logging operations, and farms. Some organizations conduct mobile fueling of on-road vehicles commercially in the State of Washington.

Note that some local fire departments may have restrictions on mobile fueling.

Pollutant Control Approach: Operators typically need proper training of the fueling operations, and the use of spill/drip control and reliable fuel transfer equipment with backup shutoff valving.

Required BMPs

Organizations and individuals conducting mobile fueling operations must implement the BMPs listed below. The operating procedures for the driver/operator should be simple, clear, effective and their implementation verified by the organization that will potentially be liable for environmental and third party damage.

- Ensure that the Pierce County Fire District approves of all mobile fueling operations. Comply with county and Washington State fire codes.
- In fueling locations that are in close proximity to sensitive aquifers, designated wetlands, wetland buffers, or other waters of the state, approval by Pierce County is necessary to ensure compliance with additional local requirements.
- Ensure compliance with all 49 CFR 178 requirements for DOT 406 cargo tanker. Documentation from a U.S. Department of Transportation Registered Inspector provides proof of compliance.
- Ensure the presence and the constant observation/monitoring of the driver/operator at the fuel transfer location at all times during fuel transfer and implementation of the following procedures at the fuel transfer locations:
    - Locate the point of fueling at least 25-feet from the nearest storm drain or inside an impervious containment with a volumetric holding capacity equal to or greater than 110 percent of the fueling tank volume, or covering the storm drain to ensure no inflow of spilled or leaked fuel. Covers are not required for storm drains that convey the inflow to a spill control separator approved by Pierce County, including the Pierce County Fire District. Potential spill/leak conveyance surfaces must be impervious and in good repair.
    - Place a drip pan or an absorbent pad under each fueling location prior to and during all dispensing operations. The pan (must be liquid tight) and the absorbent pad must have a capacity of at least 5 gallons. There is no need to report spills retained in the drip pan or the pad.
    - Manage the handling and operating of fuel transfer hoses and nozzle, drip pan(s), and absorbent pads as needed to prevent spills/leaks of fuel from reaching the ground, storm drains, and receiving waters.
    - Avoid extending the fueling hoses across a traffic lane without fluorescent traffic cones, or equivalent devices, conspicuously placed so that all traffic is blocked from

crossing the fuel hose.

- Remove the fill nozzle and cease filling the tank when the automatic shut-off valve engages. Do not lock automatic shutoff fueling nozzles in the open position.
- Do not "top off" the fuel receiving equipment.

- Provide the driver/operator of the fueling vehicle with:
  - Adequate flashlights or other mobile lighting to view fuel fill openings with poor accessibility. Consult with the Pierce County Fire District for additional lighting requirements.
  - Two-way communication with his/her home base.
- Train the driver/operator annually in spill prevention and cleanup measures and emergency procedures. Make all employees aware of the significant liability associated with fuel spills.
- The responsible manager shall properly sign and date the fueling operating procedures. Distribute procedures to the operators, retain them in the organization files, and make them available in the event an authorized government agency requests a review.
- Immediately notify the Pierce County Fire District (911) and the Ecology Southwest Regional Office in the event of any spill entering surface or groundwater. Establish a "call down list" to ensure the rapid and proper notification of management and government officials should any significant amount of product be lost off site. Keep the list in a protected but readily accessible location in the mobile fueling truck. The "call down list" should also pre-identify spill response contractors available in the area to ensure the rapid removal of significant product spillage into the environment.
- Maintain a minimum of the following spill cleanup materials in all fueling vehicles, that are readily available for use:
  - Non-water absorbents capable of absorbing at least 15 gallons of diesel fuel
  - A storm drain plug or cover kit
  - A non-water absorbent containment boom of a minimum 10 feet in length with a 12gallon absorbent capacity (Figure 4.9)
  - A non-spark generating shovel (a steel shovel could generate a spark and cause an explosion in the right environment around a spill)
  - Two, 5gallon buckets with lids.

Figure 4.9. - Spill Containment Boom.



- Use automatic shutoff nozzles for dispensing the fuel. Replace automatic shut-off nozzles as recommended by the manufacturer.
- Maintain and replace equipment on fueling vehicles, particularly hoses and nozzles, at established intervals to prevent failures.
- Include the following fuel transfer site components:
  - Automatic fuel transfer shut-off nozzles
  - An adequate lighting system at the filling point.

A2.5 In-Water and Over-Water Fueling

Description of Pollutant Sources: BMPs in this section apply to businesses and public agencies that operate a facility used for the transfer of fuels from a stationary pumping station to vehicles or equipment in water. This type of fueling station includes aboveground or underground fuel storage facilities, which may be permanent or temporary. Fueling stations include facilities such as, but not limited to, commercial gasoline stations, port facilities, marinas, private fleet fueling stations, and boatyards.

Typically, stormwater contamination at fueling stations is caused by leaks or spills of fuels, lubrication oils, and fuel additives. These materials contain organic compounds, oil and greases, and metals that can be harmful to humans and aquatic life.

Most fuel dock spills are small and result from overfilling boat fuel tanks, burps from air vent lines, and drips from the pump nozzle as it is being returned to the pump.

Pollutant Control Approach: Provide employees with proper training and use spill control devices to prevent the discharge of pollutants in the receiving water or the drainage system.

Required BMPs for Fuel Docks

General

- Facilities and procedures for the loading or unloading of petroleum products must comply with U.S. Coast Guard requirements. Refer to specifications in Coast Guard Requirements for Marine Transfer of Petroleum Products.

Training and Fueling Dock Supervision

- Train staff on proper fueling procedures. Document training and maintain records.
- Have a trained employee supervise the fuel dock during fueling activities.
- Do not allow self-service on a marina dock without some means of controlling the dock activity. According to NFPA 30A: Code for Motor Fuel Dispensing Facilities and Repair Garages, each facility must have an attendant on duty to supervise, observe, and "control" the operation when open for business. This can be done via camera, intercom, and shutoff abilities in the office. However, this can lead to complacency and nothing can replace having an attendant on the dock to attend to emergencies when they occur.(NFPA, 2012)

Fueling Dock Setup, Maintenance, and Inspection

- Install a tank and leak detection monitoring system that shuts off the pump and fuel line when a leak is sensed.
- Install personal watercraft floats at fuel docks to stabilize personal watercraft/jet skis while refueling.
- Provide a spill containment equipment storage area where materials are easily accessible and clearly marked.
- Use automatic shut-off nozzles and promote the use of "whistles" and fuel/air separators on air vents or tank stems of inboard fuel tanks to reduce the amount of fuel spilled into receiving waters during fueling of boats.
- Post readable refueling directions, BMPs, and emergency protocols.
- Always have a "Spills Aren't Slick" sign with emergency spill reporting numbers clearly

visible. Marinas on land leased from the Washington Department of Natural Resources (DNR) are required to post these signs.

- Display "No Smoking" signs on fuel docks.
- Create a regular inspection, maintenance, and replacement schedule for fuel hoses, pipes, and tanks. Have staff walk the dock fuel lines from dispenser to tank to look for signs of leakage at joints and determine hose condition from end to end.

Fueling Practices

- Discourage operators from "topping off" (no more than 90% capacity). Fuel expands and can slosh out of the vent when temperatures rise or waters become choppy.
- When handing over the nozzle, wrap an absorbent pad around the nozzle end or plug inside the nozzle end to prevent fuel in the nozzle from spilling.
- Have the boat operator place an absorbent pad or suction cup bottle under the vent(s) to capture fuel spurts from the vent.
- Never block open the fuel nozzle trigger and always disable hands-free clips to ensure the boater remains with the nozzle to prevent overfilling. Hands-free clips are not allowed in Washington, per WAC 296-24-33015.
- Always keep the nozzle tip pointing up and hang the nozzle vertically when not in use.
- During fueling operations, visually monitor the liquid level indicator to prevent the tank from being overfilled.
- The maximum amount of product received must not exceed 90 percent capacity of the receiving tank.

Spill cleanup

- Refer to Activity A7.15 for Spills of Oil and Hazardous Substances.
- Manage petroleum-contaminated booms, pads, and absorbents in a designated collection container and properly dispose of these materials (refer to Activity A4.7 for Storage of Liquid, Food Waste, or Dangerous Waste Containers).
- Ensure customers do not use soaps in the event of a spill. Use oil absorbent booms or pads instead.

Required BMPs for Fueling by Portable Container

- Have boats fuel on shore or at a fuel dock rather than transport fuel from an upland facility to the boats. Only use hand-held fueling containers or "jerry cans" when necessary or when on shore or at dock fueling is not practical.
- Always refill portable fuel containers on the pavement or dock to ensure a good electrical ground. While the deck of the boat may seem stable, static electricity can build up and cause a spark.
- On the dock, put an absorbent pad under the container and wrap an absorbent pad around the fuel fill — this can easily be done by putting a hole in the pad.
- Ensure the nozzle stays in contact with the tank opening.
- When transferring fuel from a portable can, use a fuel siphon with a shut-off feature. If a

siphon is not available, a nozzle/spout with a shut off is a good alternative.

- Since fueling boats with a portable container can take time, make sure the container is comfortable to carry, hold, and balance.
- Use a high flow funnel. Funnels can help prevent spills by making a larger opening for fueling.
- Place a plug of absorbent pad or paper towel in the nozzle when not in use to capture any extra drops that accumulate.
- Fuel slowly and pour deliberately, and watch the container (especially the nozzle mechanism) for signs of wear.
- Store portable fuel tanks out of direct sunlight and keep in a cool, dry place to minimize condensation.

Section A3 Production and Application Activities

A3.1 Concrete and Asphalt Mixing and Production at Stationary Sites

Description of Pollutant Sources: This activity applies to businesses and agencies that mix raw materials on site to produce concrete or asphalt. It also applies to subsequent uses such as pouring concrete structures and making other concrete or asphalt products. Mobile concrete pouring and asphalt application are covered under Activity A3.2 in this section. Requirements for stockpiling of raw materials are covered under Activity A4.1 Storage or Transfer (Outside) of Solid Raw Materials, By-products or Finished Products.

Pollutants of concern include toxic hydrocarbons, toxic organic compounds, oils and greases, heavy metals, and pH.

Pollutant Control Approach: Cover and contain processes where possible and prevent stormwater runon and contamination, where feasible.

Any facility categorized under SIC Code 2951 (asphalt paving mixtures and blocks) or SIC Code 3273 (ready-mix concrete) may need to comply with Ecology's NPDES Sand and Gravel General Permit. Contact Ecology at (360) 4076400 for additional information.

Required BMPs

The following BMPs or equivalent measures are required of all businesses and public agencies active in concrete and asphalt mixing and production:

- Eliminate all illicit connections to the stormwater drainage system. See BMP S.1 in Chapter 5 for a detailed discussion on identifying and eliminating these connections.
- All process water from production, pouring, and equipment cleaning must be discharged to a dead-end sump, process water treatment system, or sanitary sewer (subject to approval by Industrial Pretreatment Program; call (253) 7983013), or recycled (see also Volume I, Appendix I-A for dead-end sump maintenance guidelines). Never wash fresh concrete or concrete mixer washout into streets, stormwater drainage systems, streams, other water bodies, or to groundwater.
- A BMP maintenance schedule must be established, and employees educated about the need to prevent stormwater contamination through the use and proper maintenance of BMPs.

Suggested BMPs

- The production and pouring area should be swept at the end of each workday to collect loose chunks of aggregate and raw materials for recycling or proper disposal. See BMP S.2 in Chapter 5 for disposal options.
- Sweep all driveways and gutters that show accumulation of materials to minimize the amount that could be carried off site by rain and enter the stormwater drainage system.
- Asphalt plants should use an oil/water separator to treat stormwater runoff. See Volume V of this manual, Runoff Treatment BMPs for more information.
- Production and pouring areas should be protected from stormwater runon. See BMP S.7 in Chapter 5 for methods of runon protection.
- Use absorbent materials in and around storm drains and catch basins to filter out contaminants. See Volume V of this manual, Runoff Treatment BMPs, for more information.

- Pave the mixing, production, and pouring areas. A sump drain in these areas is probably not advisable due to potential clogging problems, but could be used in a curing area. Sweep these areas to remove loose aggregate and recycle or dispose of properly.
- Use storm drain covers or similarly effective containment devices to prevent runoff from entering the stormwater drainage system. Accumulations of dirty runoff must be disposed of properly.

Contact Pierce County Surface Water Management (253) 798-2725 for information about water quality treatment BMPs for these types of operations. Visit Ecology's website for accepted water quality treatment at: https://ecology.wa.gov/Water-Shorelines/Water-quality/Runoff-pollution/Stormwater.

The use of any treatment BMP must not result in the violation of groundwater or surface water quality standards.

A3.2 Concrete Pouring, Concrete Cutting, and Asphalt Application at Temporary Sites

Description of Pollutant Sources: This activity applies to businesses and public agencies that apply asphalt or pour or cut concrete for building construction and remodeling, road construction, sidewalk, curb and gutter repairs and construction, sealing of driveways and roofs, and other applications. These activities are typically done on a temporary site-to-site basis where permanent BMP measures do not apply. Concrete pouring activities can not only severely alter the pH of receiving waters, but slurry from aggregate washing can harden in storm pipes, thus reducing capacity and creating flooding problems.

Pollutants of concern include toxic hydrocarbons, toxic organic compounds, oils and greases, heavy metals, suspended solids, and pH.

Pollutant Control Approach: Train employees on proper procedures, sweep or shovel aggregate chunks, collect accumulated runoff and solids, and wash equipment in designated areas.

Required BMPs

The following BMPs or equivalent measures are required of all businesses and agencies doing concrete pouring and asphalt application at temporary sites:

- Employees must be educated on the pollution hazards of concrete and asphalt application and cutting.
- Loose aggregate chunks and dust must be swept or shoveled and collected (not hosed down a storm drain) for recycling or proper disposal at the end of each workday, especially at work sites such as streets, driveways, parking lots, sidewalks, curbs, and gutters where rain can readily pick up the loose material and carry it to the nearest stormwater conveyance. Small amounts of excess concrete, grout, and mortar can be disposed of in the trash.
- Storm drain covers or similarly effective containment devices must be placed over all nearby drains at the beginning of each day. Shovel or vacuum slurry and remove from the site. All accumulated runoff and solids must be collected and properly disposed of (see BMP S.2 in Chapter 5 for disposal options) at the end of each workday, or more often if necessary.
- Exposed aggregate washing, where the top layer of unhardened concrete is hosed or scraped off to leave a rough finish, must be done with a mechanism for containment and collection of the discarded concrete slurry.
- Cleaning of concrete application and mixing equipment or concrete vehicles must be done in a designated area where the rinse water is controlled and properly disposed. See Volume II, Section 3.1, BMP C154 for more information.

The use of any treatment BMP must not result in the violation of groundwater or surface water quality standards.

Suggested BMPs

- Avoid the activity when rain is occurring or expected.
- If possible, portable asphalt mixing equipment should be covered by an awning, a lean-to, or another simple structure to avoid contact with rain. See BMP S.4 in Chapter 5 for further

details on cover structures.

- Recycle broken concrete and asphalt. Look under Recycling Services in the Yellow Pages of the phone book to find the recycler nearest you.

A3.3 Manufacturing and Postprocessing of Metal Products

Description of Pollutant Sources: This activity applies to businesses such as mills, foundries, and fabricators that manufacture or postprocess metal products. A variety of activities such as machining, grinding, soldering, cutting, welding, quenching, etching, bending, coating, cooling, and rinsing may take place. These businesses may be required to obtain a NPDES permit from Ecology. See Chapter 6 for a discussion of NPDES requirements. Note: Painting, finishing and coating of metal products is covered under A3.7 Painting, Finishing, and Coating of Vehicles, Boats, Buildings, and Equipment.

Pollutants of concern include toxic organic compounds, heavy metals, oils and greases, pH, suspended solids, and chemical oxygen demand (COD).

Pollutant Control Approach: Cover and contain operations and apply good housekeeping and preventive maintenance practices to prevent the contamination of stormwater.

Required BMPs

The following BMPs or equivalent measures are required of all businesses engaged in metals manufacturing or postprocessing:

- Eliminate illicit connections to the stormwater drainage system. See BMP S.1 in Chapter 5 for detailed information on identifying and eliminating illicit connections.
- Process wastewater (including contact cooling water, filter backwash, cooling tower blow down, etc.) from processing or production, and stormwater runoff from activity areas, must discharge to the sanitary sewer, holding tank, or process treatment system need an Ecology NPDES permit for discharge to surface water or storm drain. Contact Industrial Pretreatment Program at (253) 7983013 to obtain permits for discharge to the sewer. See BMP S.3 in Chapter 5 for detailed requirements.
- Employees must be educated in proper handling to control their work with metal products to minimize pollution.
- The activity area must be swept at the end of each workday to collect and dispose of metal fragments and product residues properly. See BMP S.2 in Chapter 5 for disposal alternatives. Do not allow metal fragments, residues, or dust to accumulate in areas exposed to stormwater.

Suggested BMPs

- Limit the amount of water used in quenching and rinsing. Recycle used water where possible.
- Cover the activity area to prevent rain from contacting the process and reduce the amount of runoff that has to be detained or treated. See BMP A3.9.
- Refer to the BMPs under sections A2 Transfer of Liquid or Solid Materials and A4 Storage and Stockpiling Activities, and utilize those BMPs which are applicable for materials storage and maintenance activities in your shop.

A3.4 Wood Treatment Areas

Description of Pollutant Sources: Wood treatment includes both anti-staining and wood preserving using pressure processes or by dipping or spraying. Wood preservatives include creosote, creosote/coal tar, pentachlorophenol, copper naphthenate, arsenic trioxide, malathion, or inorganic arsenicals such as chromated copper arsenate, acid copper chromate, chromate zinc chloride, and fluor-chrome-arsenate-phenol. Anti-staining chemical additives include iodo-prophenyl-butyl carbamate, dimethyl sulfoxide, didecyl dimethyl ammonium chloride, sodium azide, 8quinolinol, copper (II) chelate, sodium ortho-phenylphenate, 2(thiocyanomethylthio)-benzothiazole (TCMTB) and methylene bis- (thiocyanate), and zinc naphthenate.

Pollutant sources include drips of condensate or preservative after pressurized treatment, product washwater (in the treatment or storage areas), spills and leaks from process equipment and preservative tanks, fugitive emissions from vapors in the process, blowouts and emergency pressure releases, and kick-back from lumber (phenomenon where preservative leaks as it returns to normal pressure). Potential pollutants typically include the wood treating chemicals, BOD, suspended solids, oil and grease, benzene, toluene, ethylbenzene, phenol, chlorophenols, nitrophenols, heavy metals, and PAH, depending on the chemical additive used.

Pollutant Control Approach: Cover and contain all wood treating areas and prevent all leaching of and stormwater contamination by wood treating chemicals. Wood treating facilities may be covered by the Industrial Stormwater General Permit or by an individual permit. Individual permits covering wood treatment areas include applicable source control BMPs or require the development of BMPs or a SWPPP. Facilities covered under the Industrial Stormwater General Permit must prepare and implement a SWPPP. When developing a SWPPP or BMPs, wood treating facilities should include the applicable source control BMPs listed below.

Required BMPs

- Use dedicated equipment for treatment activities to prevent the tracking of treatment chemicals to other areas on the site.
- Eliminate non-process traffic on the drip pad. Scrub down non-dedicated lift trucks on the drip pad.
- Immediately remove and properly dispose of soils with visible surface contamination (green soil) to prevent the spread of chemicals to groundwater and/or surface water via stormwater runoff.
- If any treated wood is observed to be contributing chemicals to the environment in the treated wood storage area, relocate it on a concrete chemical containment structure until the surface is clean and until it is drip free and surface dry.
- Cover and/or enclose, and contain with impervious surfaces, all wood treatment areas. Slope and drain areas around dip tanks, spray booths, retorts, and any other process equipment in a manner that allows return of treatment chemicals to the wood treatment process.
- Cover storage areas for freshly treated wood to prevent contact of treated wood products with stormwater. Segregate clean stormwater from process water. Convey all process water to an approved treatment system.
- Seal any holes or cracks in the asphalt areas that are subject to wood treatment chemical contamination.

- Elevate stored, treated wood products to prevent contact with stormwater runon and runoff.
- Place dipped lumber over the dip tank or on an inclined ramp for a minimum of 30 minutes to allow excess chemical to drip back to the dip tank.
- Place treated lumber from dip tanks or retorts in a covered paved storage area for at least 24 hours before placement in outside storage. Use a longer storage period during cold weather unless the temporary storage building is heated. Prior to moving wood outside, ensure that the wood is drip free and surface dry.

Suggested BMP

- Consider using preservative chemicals that do not adversely impact receiving surface water and groundwater.

A3.5 Commercial Composting

Description of Pollutant Sources: Commercial compost facilities, operating outside without cover, require large areas to decompose wastes and other feedstocks. Design these facilities to separate stormwater from leachate (i.e., industrial wastewater) to the greatest extent possible. When stormwater contacts any active composting areas, including waste receiving and processing areas, it becomes leachate. Pollutants in leachate include nutrients, biochemical oxygen demand (BOD), organics, coliform bacteria, acidic pH, and suspended solids. Stormwater at a compost facility consists of runoff from areas at the facility that are not associated with active processing and curing, such as product storage areas, vehicle maintenance areas, and access roads.

NPDES and State Solid Waste Permit Requirements: Composting facilities are regulated under WAC 173-350-220. Solid Waste Regulations require the collection and containment of all leachate produced from activities at commercial composting facilities. Composting facilities that propose to discharge to surface water, municipal sewer system, or groundwater must obtain the appropriate permits. Zero discharge is possible by containing all leachate from the facility (in tanks or ponds) for use early in the composting process or preventing production of leachate (by composting under a roof or in an enclosed building).

The Tacoma-Pierce County Health Department regulates solid waste facilities in accordance with WAC 173304. The Tacoma-Pierce County Health Department should be contacted at (253) 798-6047 to obtain permits and requirements for composting and recycling facilities.

Pollutant Control Approach: Consider zero leachate discharge.

Required BMPs

- See WAC 173-350-220, Composting Facilities
- View this Ecology publication for common sense actions that a facility can adopt to help run a successful program: Siting and operating Composting Facilities in Washington State Good Management Practices. This document is available at: <fortress.wa.gov/ecy/publications/publications/1107005.pdf>.
- See Ecology's Organic Materials Management Rule and Law page for the most up-to-date information: <https://ecology.wa.gov/Waste-Toxics/Reducing-recycling-waste/Organic-materials>. >.
- Contact other federal, state, and Pierce County agencies with environmental or zoning authority for applicable permit and regulatory information. The Tacoma-Pierce County Health Department is responsible for issuing solid waste handling permits for commercial compost facilities.
- Apply for coverage under the Industrial Stormwater General Permit if the facility discharges stormwater to surface water or a municipal stormwater system. If all stormwater from the facility properly infiltrates to groundwater, the Industrial Stormwater General Permit is not required.
- There are some cases where an Individual State Waste discharge Permit is required. Check with the Ecology Southwest Regional Office and health department to discuss your permitting options.

A3.6 Landscaping and Lawn/Vegetation Management

Description of Pollutant Sources: Landscaping can include grading, soil transfer, vegetation removal, pesticide and fertilizer application, and watering. Stormwater contaminants include toxic organic compounds, heavy metals, oils, total suspended solids, coliform bacteria, fertilizers, and pesticides.

Lawn and vegetation management can include control of objectionable weeds, insects, mold, bacteria, and other pests with pesticides. Pesticides include herbicides, rodenticides, insecticides, fungicides, etc. Examples of pesticide uses include:

- Weed control on golf course lawns, access roads, and utility corridors and during landscaping;
- Sap stain and insect control on lumber and logs;
- Rooftop moss removal;
- Killing nuisance rodents;
- Fungicide application to patio decks;
- Residential lawn/plant care.

It is possible to release toxic pesticides such as pentachlorophenol, carbamates, and organometallics to the environment by leaching and dripping from treated parts, container leaks, product misuse, and outside storage of pesticide contaminated materials and equipment. Poor management of the vegetation and poor application of pesticides or fertilizers can cause appreciable stormwater contamination.

Irrigation consists of discharges from irrigation water lines, landscape irrigation, and lawn or garden watering. Excessive watering can lead to discharges of chlorinated potable water runoff into drainage systems; it can also cause erosion; and negatively affect plant health. Improper irrigation can encourage pest problems, leach nutrients, and make a lawn completely dependent on artificial watering. Mosquito breeding habitats may form through excessive watering.

Pollutant Control Approach: Control of fertilizer and pesticide applications, soil erosion, and site debris to prevent contamination of stormwater.

Develop and implement an Integrated Pest Management Plan and use pesticides only as a last resort. Refer to Appendix IVB Example of an Integrated Pest Management Program for more information. Carefully apply pesticides/herbicides in accordance with label instructions. Maintain appropriate vegetation, with proper fertilizer application where practicable, to control erosion and the discharge of stormwater pollutants. Where practicable, grow plant species appropriate for the site, or adjust the soil properties of the subject site to grow desired plant species.

Limit the amount and location of watering to prevent runoff and discharge to drainage systems.

Required BMPs for Landscaping

- Do not dispose of collected vegetation into waterways or stormwater drainage systems.
- Use mulch or other erosion control measures when soils are exposed for more than 1 week during the dry season or 2 days during the rainy season.
- If oil or other chemicals are handled, store and maintain appropriate oil and chemical spill cleanup materials in readily accessible locations. Ensure that employees are familiar with

proper spill cleanup procedures.

Suggested BMPs for Landscaping

- Conduct mulch-mowing whenever practicable.
- Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.
- Dispose of grass clippings, leaves, sticks, or other collected vegetation by composting, if feasible.
- Till fertilizers into the soil rather than dumping or broadcasting onto the surface. Determine the proper fertilizer application rate for the types of soil and vegetation encountered.
- Till a topsoil mix or composted organic material into the soil to create a well-mixed transition layer that encourages deeper root systems and drought-resistant plants.
- Use manual and/or mechanical methods of vegetation removal rather than applying herbicides, where practical.

Required BMPs for the Use of Pesticides

- Train employees on proper application of pesticides and disposal practices.
- Follow manufacturer's application guidelines and label requirements.
- Develop and implement an Integrated Pest Management Program if pests are present. (see section on Integrated Pest Management below)
- Remove weeds/vegetation in stormwater ditches, stormwater facilities, and drainage systems by hand or other mechanical means and use pesticides only as a last resort.
- Implement a pesticide-use plan and include at a minimum:
    - A list of selected pesticides and their specific uses;
    - Brands, formulations, application methods, and quantities to be used;
    - Equipment use and maintenance procedures;
    - Safety, storage, and disposal methods; and
    - Monitoring, record keeping, and public notice procedures. All procedures shall conform to the requirements of Chapter 17.21 Revised Code of Washington (RCW) and Chapter 16228 WAC.
- Choose the least toxic pesticide available that is capable of reducing the infestation to acceptable levels. The pesticide should readily degrade in the environment and/or have properties that strongly bind it to the soil. Conduct any pest control activity at the life stage when the pest is most vulnerable. For example, if it is necessary to use a Bacillus thuringiensis application to control tent caterpillars, apply it before the caterpillars cocoon or it will be ineffective. Any method used should be site-specific and not used wholesale over a wide area.
- Do not apply pesticides in quantities that exceed the limits on the product the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) label. Avoid excessive application of chemical.
- Mix the pesticides and clean the application equipment in an area where accidental spills

will not enter surface or groundwater, and will not contaminate the soil.

- Store pesticides in enclosed areas or in covered impervious containment. Do not discharge pesticide contaminated stormwater or spills/leaks of pesticides to storm drains. Do not hose down paved areas to a storm drain or conveyance ditch. Store and maintain appropriate spill cleanup materials in a location known to all near the storage area.
- Cleanup any spilled pesticides. Keep pesticide contaminated waste materials in designated covered and contained areas.
- The pesticide application equipment must be capable of immediate shutoff in the event of an emergency.
- Spraying pesticides within 100 feet of open waters including wetlands, ponds, rivers, streams, creeks, sloughs, and any drainage ditch or channel that leads to open water, may have additional regulatory requirements beyond just following the pesticide label. Additional requirements may include:
  - Obtaining a discharge permit from Ecology
  - Obtaining approval from PPW per PCC Title 18E
  - Using an aquatic labeled pesticide.
- Flag all sensitive areas including wells, creeks, and wetlands prior to spraying.
- Post notices and delineate the spray area prior to the application, as required by Pierce County or by Ecology.
- Conduct spray applications during weather conditions as specified in the label direction and applicable local and state regulations. Do not apply during rain or immediately before expected rain.

Suggested BMPs for the Use of Pesticides

- Consider alternatives to the use of pesticides such as covering or harvesting weeds, substitute vegetative growth, and manual weed control/moss removal.
- Choose pesticides categorized by EPA as reduced risk. For example, the herbicide imazamox.
- When possible, apply pesticides during the dry season so that the pesticide residue is degraded prior to the next rain event.
- Use manual pest control strategies such as physically scraping moss from rooftops, high-pressure sprayers to remove moss, and rodent traps.
- Consider the use of soil amendments, such as compost, that are known to control some common diseases in plants, such as Pythium root rot, ashy stem blight, and parasitic nematodes. The following are three possible mechanisms for disease control by compost addition (USEPA publication 530F9044):
  - Successful competition for nutrients by antibiotic production
  - Successful predation against pathogens by beneficial microorganism; and
  - Activation of disease-resistant genes in plants by composts.

Installing an amended soil/landscape system can preserve both the plant system and the soil

system more effectively. This type of approach provides a soil/landscape system with adequate depth, permeability, and organic matter to sustain itself and continue working as an effective stormwater infiltration system and a sustainable nutrient cycle.

- Once a pesticide is applied, evaluate its effectiveness for possible improvement. Records should be kept showing the effectiveness of the pesticides considered.
- Develop an annual evaluation procedure including a review of the effectiveness of pesticide applications, impact on buffers and sensitive areas (including potable wells), public concerns, and recent toxicological information on pesticides used/proposed for use. If individual or public potable wells are located in the proximity of commercial pesticide applications, contact the regional Ecology hydrogeologist to determine if additional pesticide application control measures are necessary.
- Follow the FIFRA label requirements for disposal. If the FIFRA label does not have disposal requirements the rinsate from equipment cleaning and/or triple-rinsing of pesticide containers should be used as product or recycled into product.

  For more information, contact the Washington State University (WSU) Extension Home-Assist Program at (253) 798-7180; Pesticide Information Center Online (PICOL) Databases at http:// cru66.cahe.wsu.edu/LabelTolerance.html; Bio-Integral Resource Center (BIRC), P.O. Box 7414, Berkeley, CA 94707; or U.S. EPA to obtain a publication entitled "Suspended, Canceled and Restricted Pesticides" which lists all restricted pesticides and the specific uses that are allowed.

  Washington pesticide law requires most businesses that commercially apply pesticides to the property of another to be licensed as a Commercial Applicator from the Washington State Department of Agriculture.

Required BMPs for Integrated Pest Management

Develop and implement an Integrated Pest Management (IPM) program if pests are present. The IPM program shall consist of the following steps:

- Step 1 Correctly identify problem pests and understand their life cycle.
- Step 2 Establish tolerance thresholds for pests.
- Step 3 Monitor to detect and prevent pest problems.
- Step 4 Modify the maintenance program to promote healthy plants and discourage pests.
- Step 5 Use cultural, physical, mechanical, or biological controls first if pests exceed the tolerance thresholds.
- Step 6 Evaluate and record the effectiveness of the control and modify maintenance practices to support lawn or landscape recovery and prevent recurrence.

For an elaboration of these steps refer to Appendix IV-B, Example of an Integrated Pest Management Program.

Suggested BMPs for Vegetation Management

- Use at least an 8inch "topsoil" layer with at least 8 percent organic matter to provide a sufficient vegetation-growing medium (see soil preservation and amendment in Volume III, Section 3.1 for soil mix and installation guidance). Amending existing landscapes and turf systems can substantially improve the permeability of the soil, improve the disease and

drought resistance of the vegetation, and reduce fertilizer demand. Return natural plant debris and mulch to the soil to continue recycling nutrients indefinitely.

- Select the appropriate turfgrass mixture for the climate and soil type. Certain tall fescues and rye grasses resist insect attack because the symbiotic endophytic fungi found naturally in their tissues repel or kill common leaf and stem-eating lawn insects. However, they do not repel root-feeding lawn pests such as Crane Fly larvae, and are toxic to ruminants such as cattle and sheep. The fungus causes no known adverse effects to the host plant or to humans. Endophytic grasses are commercially available; use them in areas such as parks or golf courses where grazing does not occur. Local agricultural or gardening resources such as Washington State University Extension office can offer advice on which types of grass are best suited to the area and soil type.
- Use the following seeding and planting BMPs, or equivalent BMPs, to obtain information on grass mixtures, temporary and permanent seeding procedures, maintenance of a recently planted area, and fertilizer application rates: Temporary and Permanent Seeding, Mulching; Plastic Covering; and Sodding as described in Volume II.
- Adjusting the soil properties of the subject site can assist in selection of desired plant species. For example, design a constructed wetland to resist the invasion of reed canary grass by layering specific strata of organic matters (e.g., composted forest product residuals) and creating a mildly acidic pH and carbon-rich soil medium. Consult a soil restoration specialist for site-specific conditions.
- Aerate lawns regularly in areas of heavy use, where the soil tends to become compacted. Conduct aeration while the grasses in the lawn are growing most vigorously. Remove layers of thatch greater than 0.75-inches deep.
- Mowing is a stress-creating activity for turfgrass. Grass decreases its productivity when mown too short and there is less growth of roots and rhizomes. The turf becomes less tolerant of environmental stresses, more disease prone, and more reliant on outside means such as pesticides, fertilizers, and irrigation to remain healthy. Set the mowing height at the highest acceptable level and mow at times and intervals designed to minimize stress on the turf. Generally, mowing only one-third of the grass blade height will prevent stressing the turf.

Required BMPs for Irrigation

- Irrigate with the minimum amount of water needed. Never water at rates that exceed the infiltration rate of the soil.
- Maintain all irrigation systems so that irrigation water is applied evenly and where it is needed.
- Ensure sprinkler systems do not overspray vegetated areas resulting in excess water discharging into the drainage system.
- Inspect irrigated areas for excess watering. Adjust watering times and schedules to ensure that the appropriate amount of water is being used to minimize runoff. Consider factors such as soil structure, grade, time of year, and type of plant material in determining the proper amounts of water for a specific area.
- Inspect irrigated areas regularly for signs of erosion and/or discharge.
- Place sprinkler systems appropriately so that water is not being sprayed on impervious

surfaces instead of vegetation.

- Repair broken or leaking sprinkler nozzles as soon as possible.
- Appropriately irrigate lawns based on the species planted, the available water holding capacity of the soil, and the efficiency of the irrigation system.
- The depth from which a plant normally extracts water depends on the rooting depth of the plant. Appropriately irrigated lawn grasses normally root in the top 6-to-12 inches of soil; lawns irrigated on a daily basis often root only in the top 1-inch of soil.
- Do not irrigate plants during or immediately after fertilizer application. The longer the period between fertilizer application and irrigation, the less fertilizer runoff occurs.
- Do not irrigate plants during or immediately after pesticide application (unless the pesticide label directs such timing).
- Reduce frequency and/or intensity of watering as appropriate for the wet season (October 1 to April 30).
- Place irrigation system to ensure that plants receive water where they need it. For example, do not place irrigation systems downgradient of plant's root zones on hillsides.

Suggested BMPs for Irrigation

- Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present.
- Water deeply, but infrequently, so that the top 6- to 12-inches of the root zone is moist.
- Use soaker hoses or spot water with a shower type wand when an irrigation system is not present.
    - Pulse water to enhance soil absorption, when feasible.
    - Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method, each pass increases soil absorption and allows more water to infiltrate prior to runoff.
- Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear.
- Water during drought conditions or more often if necessary to maintain plant cover.
- Adjust irrigation frequency/intensity as appropriate after plant establishment.
- Annually inspect irrigation systems to ensure:
    - That there are no blockages of sprayer nozzles.
    - Sprayer nozzles are rotating as appropriate.
    - Sprayer systems are still aligned with the plant locations and root zones.
- Consult with the Tacoma Water, the Pierce Conservation District, or the Pierce County Cooperative Extension office to help determine optimum irrigation practices.
- Do not use chemigation and fertigation in irrigation systems. This will help avoid over application of pesticides and fertilizers.

Required BMPs for Fertilizer Management

- Apply the minimum amount of slow-release fertilizer necessary to achieve successful plant establishment.
- Never apply fertilizers if it is raining or about to rain.
- Determine the proper fertilizer application for the types of soil and vegetation involved.
- Follow manufacturers' recommendations and label directions.
- Train employees on the proper use and application of fertilizers.
- Keep fertilizer granules off impervious surfaces. Clean up spills immediately. Do not hose down to a storm drain, conveyance ditch, or water body.
- If possible, do not fertilize areas within 100 feet of water bodies including wetlands, ponds, and streams.
- Avoid fertilizer applications in stormwater ditches, stormwater facilities, and drainage systems.
- Apply fertilizers in amounts appropriate for the target vegetation and at the time of year that minimizes losses to surface and groundwater.
- Do not fertilize when the soil is dry or during a drought.
- Do not apply fertilizers within 3 days prior to predicted rainfall. The longer the period between fertilizer application and either rainfall or irrigation, the less fertilizer runoff occurs.
- Use slow release fertilizers such as methylene urea, IDBU, or resin coated fertilizers when appropriate, generally in the spring. Use of slow release fertilizers is especially important in areas with sandy or gravelly soils.
- Time the fertilizer application to periods of maximum plant uptake. Ecology generally recommends application in the fall and spring, although Washington State University turf specialists recommend four fertilizer applications per year.
- Apply no fertilizer at commercial and industrial facilities to grass swales, filter strips, or buffer areas that drain to sensitive water bodies unless approved by the county.
- Do not use turf fertilizers containing phosphorous unless a soil sample analysis taken within the past 36 months indicates the soil of the established lawn is deficient in phosphorus. For more information about restrictions on turf fertilizers containing phosphorus, see the following website: https://agr.wa.gov/departments/pesticides-and-fertilizers/fertilizers/fertilizers-containing-phosphorus.

Suggested BMPs for Fertilizer Management

Test Soils to determine the correct fertilizer application rates.

- Evaluation of soil nutrient levels through regular testing ensures the best possible efficiency and economy of fertilization.
- Fertilization needs vary by site depending on plant, soil, and climatic conditions.
- Choose organic fertilizers when possible.
- For details on soil testing, contact the Pierce Conservation District, a soils testing professional, or Washington State University Extension office.

A3.7 Painting, Finishing, and Coating of Vehicles, Boats, Buildings, and Equipment

Description of Pollutant Sources: Surface preparation and the application of paints, finishes, and/or coatings to vehicles, boats, buildings, and/or equipment outdoors can be sources of pollutants. Potential pollutants include organic compounds, oils and greases, heavy metals, and suspended solids.

Pollutant Control Approach: Cover and contain painting and sanding operations and apply good housekeeping and preventive maintenance practices to prevent the contamination of stormwater with painting over sprays and grit from sanding.

Required BMPs

- Train employees in the careful application of paints, finishes, and coatings to reduce misuse and overspray. Use ground or drop cloths underneath outdoor painting, scraping, sandblasting work, and properly clean and temporarily store collected debris daily.
- Do not conduct spraying, blasting, or sanding activities over open water or where wind may blow paint or waste into water.
- Wipe up spills with rags and other absorbent materials immediately. Do not hose down the area to a storm drain, conveyance ditch, or receiving water.
- On marine dock areas, sweep rather than hose down debris. Collect any hose water generated and convey to appropriate treatment and disposal.
- Use an effective runoff control device if dust, grit, washwater, or other pollutants may escape the work area and enter a catch basin. The containment device(s) must be in place at the beginning of the workday. Collect contaminated runoff and solids and properly dispose of such wastes before removing the containment device(s) at the end of the workday.
- Use a ground cloth, pail, drum, drip pan, tarpaulin, or other protective device for activities such as outdoor paint mixing and tool cleaning, or where spills can contaminate stormwater.
- Properly dispose of all wastes and prevent all uncontrolled releases to the air, ground, or water.
- Clean brushes and tools covered with non-water-based paints, finishes, or other materials in a manner that allows collection of used solvents (e.g., paint thinner, turpentine, xylol) for recycling or proper disposal.
- Store toxic materials under cover (tarpaulin, etc.) during precipitation events and when not in use to prevent contact with stormwater.
- Enclose and/or contain all work while using a spray gun or conducting sand blasting and in compliance with applicable Puget Sound Air Pollution Control Agency Air Quality (PSAPCA), Occupational Safety and Health Administration (OSHA), and Washington Industrial Safety and Health Act (WISHA) requirements. Do not conduct outside spraying, grit blasting, or sanding activities during windy conditions that render containment ineffective.

Suggested BMPs

- Incidental cleaning of paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers. Dump pollutants collected in portable containers into a sanitary sewer drain, NOT a stormwater drain.

- Recycle paint, paint thinner, solvents, pressure washwater, and any other recyclable materials.
- Use efficient spray equipment such as electrostatic, air-atomized, high volume/low pressure, or gravity feed spray equipment.
- Purchase recycled paints, paint thinner, solvents, and other products if feasible.

A3.8 Commercial Printing Operations

Description of Pollutant Sources: Materials used in the printing process include inorganic and organic acids, resins, solvents, polyester film, developers, alcohol, vinyl lacquer, dyes, acetates, and polymers. Waste products may include waste inks and ink sludge, resins, photographic chemicals, solvents, acid and alkaline solutions, chlorides, chromium, zinc, lead, spent formaldehyde, silver, plasticizers, and used lubricating oils. With indoor printing operations, the only likely points of potential contact with stormwater are the outside temporary waste material storage area and area where chemicals are offloaded at external unloading bays. Pollutants can include total suspended solids, pH, heavy metals, oil and grease, and COD.

Pollutant Control Approach: Ensure appropriate disposal and NPDES permitting of process wastes. Cover and contain stored raw and waste materials.

Required BMPs

- Discharge process wastewaters to a sanitary sewer (if approved by Pierce County Industrial Pretreatment Program at (253) 7983013) or to an approved process wastewater treatment system.
- Do not discharge process wastes or wastewaters into storm drains or surface water.
- Determine whether any of these wastes qualify for regulation as dangerous wastes and dispose of them accordingly.
- Store raw materials or waste materials that could contaminate stormwater in covered and contained areas.

Suggested BMPs

- Train all employees in pollution prevention, spill response, and environmentally acceptable materials handling procedures.
- Store materials in proper, appropriately labeled containers. Identify and label all chemical substances.
- Regularly inspect all stormwater management devices and maintain as necessary.
- Try to use press washes without listed solvents, and with the lowest VOC content possible. Do not evaporate ink cleanup trays to the outside atmosphere.
- Place cleanup sludges into a container with a tight lid and dispose of as dangerous waste. Do not dispose of cleanup sludges in the garbage or in containers of soiled towels.

For additional information on pollution prevention the following Ecology publications are recommended: *A Guide for Screen Printers, publication No. 94137 and A Guide for Lithographic Printers, publication No. 94139.*

A3.9 Manufacturing Operations (Outside)

Description of Pollutant Sources: Manufacturing pollutant sources include outside process areas, stack emissions, and areas where manufacturing activity has taken place in the past and significant pollutant materials remain.

Pollution Control Approach: Cover and contain outside manufacturing and prevent stormwater runon and contamination, where feasible.

Required BMPs

- Sweep paved areas regularly, as needed, to prevent contamination of stormwater.
- Eliminate or minimize the contamination of stormwater by altering the activity.
- Enclose the activity (Figure 4.10). If possible, enclose the manufacturing activity in a building.

Figure 4.10. - Commercially Available Bermed Workspace.



(Photo courtesy of Mark Dilley, Interstate Products, Inc.)

- Cover the activity and connect floor drains to a sanitary sewer (Figure 4.11), if approved by Pierce County Industrial Pretreatment Program (253) 7983013. Berm or slope the floor as needed to prevent drainage of pollutants to outside areas.
- Isolate and segregate pollutants, as feasible. Convey the segregated pollutants to a sanitary sewer, process treatment, or dead-end sump, depending on available methods and applicable permit requirements (see also Volume I, Appendix I-A for dead-end sump maintenance guidelines).

Figure 4.11. - Structure Used to Cover Manufacturing Operations.



(Photo courtesy of Seattle Public Utilities)

A3.10 Agricultural Crop Production

This activity applies to farming of crops on a commercial scale. Crop farming practices can cause a large variety of pollution problems in receiving waters. Many of these practices can be altered without adversely affecting the farmers' ability to produce the same crops.

One of the most effective BMPs for stormwater pollution prevention the farmer can pursue is to contact the Pierce County Conservation District at (253) 8459770. They will help develop a farm plan that covers all aspects of the farming operation, with particular care and attention to soil conservation and water resource protection. They also have access to grants to pay for conservation plantings and stream corridor fencing.

Pollutants of Concern: Toxic organic compounds, oils, heavy metals, nutrients, Biochemical oxygen demand (BOD), suspended solids (e.g., sediments), fecal bacteria.

Crop farms should implement agricultural practices proven to limit erosion. Several farming techniques aimed at reducing erosion have been proven successful. Individual farms should implement the combination of the following BMPs that best suits conditions present:

Suggested BMPs

- Maintain ground cover. Cover bare areas with material such as mulch or green manure during times when land is not in production.
- Practice conservation tillage. Implement tillage or planting systems in which at least 30 percent of the soil surface is covered by plant residue after planting.
- Practice conservation cover. Establish and maintain perennial vegetation cover to protect soil and water resources on land retired from agricultural production.
- Utilize contour farming. Plow, prepare, plant and cultivate land on contours perpendicular to the slope of the land in a terrace-like fashion, so that runoff cannot proceed directly along a row but rather is impeded by rows in its path, thus allowing for more infiltration.
- Plant critical areas. Plant vegetation such as trees, shrubs, vines, grasses, and legumes on highly erodible or critical areas to stabilize the soil.
- Plant and maintain vegetated buffers and filter strips. Maintain a strip of permanent vegetation downslope of crop fields so that sediments and associated pollutants in surface water runoff can be filtered out. These filter strips are especially important along stream banks, shorelines, and drainage ditches. Contact the Pierce County Conservation District at (253) 8459770 and the Natural Resources Conservation Service at (253) 8459272 for more information. In some instances, these organizations may be able to provide plant materials for such work free or for a low cost.
- Practice conservation irrigation. Replace flood irrigation systems with sprinkler head or drip irrigation systems that use less water. These irrigation methods reduce the amount of crop field runoff and thereby reduce erosion and pollutant transport.

Some other suggested BMPs to consider for your farm include the following:

- Use an Integrated PestManagement (IPM) Plan and reduce reliance on pesticides. Information on IPM is available from the Washington State University/Pierce County Cooperative Extension Service. BMP S.8 in Chapter 5 provides some details on IPM and in Appendix IVB for an example. See Activity 3.6 for information on BMPs for pesticide and fertilizer use.

- If possible, crops should be planted as far as possible from surface drainages. This will help keep nutrients from fertilizers out of water bodies.
- Contact the Natural Resources Conservation Service (formerly the Soil Conservation Service) at (253) 845-9272 for information on developing specific fertilization schedules. Applying fertilizers at the right time and in the right quantity can help minimize pollution.
- If possible, crop cultivation should be avoided on steep slopes.

A3.11 Application of Pesticides, Herbicides, Fungicides, and Rodenticides for Purposes Other than Landscaping

This activity applies to businesses and government agencies using pesticides, herbicides, fungicides and rodenticides for purposes such as removing moss from rooftops or decks, killing nuisance rodents and some insects (such as termites and carpenter ants) that live outdoors but can invade the home if left unchecked. Businesses and government agencies involved in these activities must comply with Tacoma-Pierce County Health Department regulations and Washington State Department of Agriculture pesticide regulations. See Chapter 6 for more information on these regulations. The BMPs listed are intended to complement other regulations. Application of pesticides for landscaping purposes must follow the BMPs discussed under **A3.6 Landscaping and Lawn/Vegetation Management.**

Pollutants of Concern: Toxic organic compounds, oils, heavy metals, Chemical oxygen demand (COD)

Required BMPs

The following BMPs or equivalent measures are required of all businesses and agencies applying pesticides, herbicides, fungicides and rodenticides for non-landscaping purposes:

- Proper application practices must be used to avoid excessive application. Follow the manufacturers' guidelines and directions carefully.
- Never apply pesticides, herbicides, fungicides or rodenticides when rain is expected, or during rain events.
- Do not apply chemicals when it is windy. Early morning is typically the calmest time of day.
- Employees must be educated regarding the pollution potential of misusing the chemicals they are working with.
- Manage residues properly. Triple rinse or pressure rinse empty containers and mixing and application equipment. Collect all rinse water, and use it for diluting the next batch.

Suggested BMPs

- Use manual pest control measures, such as scraping or using high-pressure sprayers to remove moss from roofs and decks, before resorting to chemicals. Rodent traps can also be highly effective, without endangering pets and children as chemical baits can.
- Integrated Pest Management (IPM)is a comprehensive approach to the use of pesticides. IPM minimizes pesticide application and stresses selection of proper products and tailored application rates. It is a sensible long-term strategy rather than a hit-and-run operation, and as such is probably the most effective BMP measure that can be utilized under this activity. See BMP S.8 in Chapter 5 for more details on IPM and in Appendix IVB for an example.

A3.12 Nurseries and Greenhouses

Description of Pollutant Sources: These BMPs are for use by commercial container plant, greenhouse grown, and cut foliage production operations. Common practices at nurseries and greenhouses can cause elevated levels of phosphorus, nitrogen, sediment, bacteria, and organic material which can contribute to the degradation of water quality.

Pollutant Control Approach: Minimize the pollutants that leave the site by controlling the placement of materials, stabilizing the site, and managing irrigation water.

Required BMPs

- Establish nursery composting areas, soil storage, and mixing areas at least 100 feet away from any stream or other surface water body and as far away as possible from drainage systems.
- Do not dispose of collected vegetation into waterways or storm drain systems.
- Do not blow, sweep, or otherwise allow vegetation or other debris into the drainage system.
- Regularly clean up spilled potting soil to prevent its movement, especially if fertilizers and pesticides are incorporated. (Haver, 2014)
- Use soil mixing and layering techniques with composted organic material to reduce herbicide use and watering.
- Utilize soil incorporated with fertilizers and/or pesticides immediately; do not store for extended periods. (Haver, 2014)
- Cover soil storage and compost storage piles. Refer to Activity A4.1 for Storage or Transfer of Solid Raw Materials, Byproducts, or Finished Products.
- Dispose of pathogen-laced potting substrate and diseased plants appropriately.
- Place plants on gravel, geotextile, or weed cloth to allow infiltration and minimize erosion, including inside greenhouse structures. (Haver, 2014)
- Properly reuse, recycle, or dispose of used polyfilm, containers, and other plastic-based products so that they do not collect stormwater. (FDACS, 2014)
- Evaluate and manage irrigation to reduce runoff, sediment transport, and erosion:
    - Place irrigation inputs to keep moisture primarily in the plant's root zone. This will significantly reduce nutrient related impacts from fertilizers. (FDACS, 2014)
    - Avoid over-irrigating. This may exceed the soil's water-holding capacity and lead to runoff or leaching. (FDACS, 2014)
    - Consider and adjust as needed the uniformity of application, the amount of water retained within the potting substrate, and the amount of water that enters containers compared to that which exits the containers and/or falls between containers. (FDACS, 2014)
    - Consolidate containers and turn off irrigation in areas not in production. This may require individual on/off valves at each sprinkler head. (Haver, 2014)
    - Based on the stage of plant growth, space containers and flats as close as possible to minimize the amount of irrigation water that falls between containers. (FDACS, 2014)

  - Group plants of similar irrigation needs together. (FDACS, 2014)
  - Consider minimizing water losses by using cyclic irrigation (multiple applications of small amounts). (FDACS, 2014)
  - Consider using sub-irrigation systems (e.g., capillary mat, ebb-and-flow benches, and trays or benches with liners); these systems can conserve water and reduce nutrient loss, particularly when nutrients are supplied in irrigation water that is reused. (FDACS, 2014)
  - Refer to Activity A3.6 for Landscaping and Lawn/Vegetation Management for additional irrigation BMP considerations.
- Refer to Activity A3.6 for Landscaping and Lawn/Vegetation Management for irrigation, for fertilizer application, and for pesticides information and Appendix IV-B for an Example of an Integrated Pest Management Program.
- Use windbreaks or other means (e.g., pot in pot) to minimize plant blowover. (FDACS, 2014)
- Cover potting areas with a permanent structure to minimize movement of loose soil. Use a temporary structure if a permanent structure is not feasible. (Haver, 2014)
- Control runoff from central potting locations that have a watering station used to irrigate plants immediately after potting. Either:
  - Collect runoff in a small basin and reuse the runoff.
  - Or, route runoff through an onsite vegetative treatment area.
  - Or, use a graveled area and allow runoff to infiltrate.
- Surround soil storage and compost storage areas with a berm or wattles.
- Utilize a synthetic (geotextile) groundcover material to stabilize disturbed areas and prevent erosion in areas where vegetative cover is not an option. (FDACS, 2014)
- In areas with a large amount of foot traffic, use appropriate aggregate such as rock and gravel for stabilization. (FDACS, 2014)
- Store potting substrate that contains fertilizer in a dedicated area with an impermeable base. If the storage area is not under a roof to protect it from rainfall, manage runoff by directing it to a stormwater treatment area. (FDACS, 2014)

References:

(Haver, 2014) Darren Haver, Best Management Practices: A Water Quality Field Guide for Nurseries, Southern California Edition, The Regents of the University of California, 2014. (viii)

(FDACS, 2014) Florida Department of Agriculture and Consumer Services (FDACS), Water Quality/Quantity Best Management Practices for Florida Nurseries, DACS-P-1267, April 2014. [v(D)]

Section A4 Storage and Stockpiling Activities

A4.1 Storage or Transfer (Outside) of Solid Raw Materials, Byproducts, or Finished Products

Description of Pollutant Sources: Some pollutant sources stored outside in large piles, stacks, etc. at commercial or industrial establishments include:

- Solid raw materials
- By-products
- Gravel
- Sand
- Salts
- Topsoil
- Compost
- Logs
- Sawdust
- Wood chips
- Lumber and other building materials
- Concrete
- Metal products

Contact between bulk materials stored outside and stormwater can cause leachate and erosion of the stored materials. Contaminants include total suspended solids, oxygen demanding substances (i.e., BOD and COD), organics, and dissolved salts (sodium, calcium, magnesium chloride, etc.).

Pollutant Control Approach: Provide impervious containment with berms, dikes, etc. and/or cover to prevent runon and discharge of leachate pollutant(s) and total suspended solids.

Required BMPs

- Do not hose down the contained stockpile area to a storm drain or a conveyance to a storm drain or receiving water.
- The source control BMP options listed below are applicable to stockpiles greater than 5 cubic yards of erodible or water soluble materials such as:
    - Soil
    - Road de-icing salts
    - Compost
    - Unwashed sand and gravel
    - Sawdust
    - Outside storage areas for solid materials such as
    - Logs
    - Bark

- Lumber
- Metal products

Choose one or more of the following Source Controls:

- Store in a building or paved and bermed covered area as shown in Figure 4.12.

Figure 4.12. - Covered and Secured Storage Area for Bulk Solids.



- Place temporary plastic sheeting (polyethylene, polypropylene, hypalon, or equivalent) over the material (Figure 4.13); or
- Pave the area and install a stormwater drainage system. Place curbs or berms along the perimeter of the area to prevent the runon of uncontaminated stormwater and to collect and convey runoff to treatment. Slope the paved area in a manner that minimizes the contact between stormwater (e.g., pooling) and leachable materials in compost, logs, bark, wood chips, etc.
- For large uncovered stockpiles, implement containment practices at the perimeter of the site and at any catch basins as needed to prevent erosion and discharge of the stockpiled material offsite or to a storm drain. Ensure that no direct discharge of contaminated stormwater to catch basins exists without conveying runoff through an appropriate treatment BMP.

Figure 4.13. - Temporary Plastic Sheeting Anchored over Raw Materials Stored Outdoors.



- Convey contaminated stormwater from the stockpile area to a wet pond, wet vault, settling basin, media filter, or other appropriate treatment system, depending on the contamination.

Suggested BMPs

- Maintain drainage areas in and around storage of solid materials with a minimum slope of 1.5 percent to prevent pooling and minimize leachate formation. Areas should be sloped to drain stormwater to the perimeter for collection, or to internal drainage "alleyways" where no stockpiled material exists.
- Sweep paved storage areas regularly for collection and disposal of loose solid materials.
- If and when feasible, collect and recycle water-soluble materials (leachates).
- Stock cleanup materials such as brooms, dustpans, and vacuum sweepers near the storage area.

A4.2 Storage and Treatment of Contaminated Soils

Description of Pollutant Sources: This activity applies to businesses and agencies that store and treat soils contaminated with toxic organic compounds, petroleum products, or heavy metals. Such contamination typically comes to light when an environmental audit is done or old underground tanks are removed. The soils are usually excavated and taken off site for treatment via aeration and perhaps chemical stabilization. Stormwater runoff that comes in contact with contaminated soil can carry those contaminants along with loose dirt into receiving waters.

Pollutants of concern include toxic organic compounds, oils and greases, and heavy metals.

Pollutant Control Approach: The Tacoma-Pierce County Health Department Waste Management Section at (235) 7986047 regulates and permits businesses treating contaminated soil. In addition, a permit from the Puget Sound Clean Air Agency is required if the treatment method for removing soil contaminants involves forcing air through, or extracting air from, the soil. Contact these agencies for additional information regarding the appropriate pollutant control approach.

The use of any treatment BMP must not result in the violation of groundwater or surface water quality standards.

A4.3 Temporary Storage or Processing of Fruits or Vegetables

Description of Pollutant Sources: This activity applies to businesses that temporarily store fruits and vegetables outdoors prior to processing or sale, or that crush, cut, or shred fruits or vegetables for wines, frozen juices, and other food and beverage products.

Activities involving the storage or processing of fruits, vegetables, and grains can potentially result in the delivery of pollutants to stormwater. Potentialpollutants of concern from all fruits and vegetable storage and processing activities include nutrients, suspended solids, substances that increase biological oxygen demand (BOD) and color. These pollutants must not be discharged to the drainage system or directly into receiving waters.

Pollutant Control Approach: Store and process fruits and vegetables indoors or under cover whenever possible. Educate employees about proper procedures. Eliminate illicit connections to the stormwater drainage system. Cover and contain operations and apply good housekeeping and preventive maintenance practices to prevent the contamination of stormwater.

Required BMPs

The following BMPs or equivalent measures are required of all businesses engaged in storage of fruits or vegetables:

- Employees must be educated on benefits of keeping a clean storage area.
- Keep fruits, vegetables, and grains stored outside for longer than a day in plastic bins or in bins lined with plastic. The edge of the plastic liner should be higher than the amount of fruit stored or should drape over the side of the bin.
- Dispose of rotten fruit, vegetables, and grains in a timely manner (typically, within a week).
- Make sure all outside materials that have the potential to leach or spill to the drainage system are covered, contained, or moved to an indoor location. For fruits, vegetables, and grains stored outside for a week or more, cover with a tarp or other waterproof material. Make sure coverings are secured from wind.

  Eliminate illicit connections to the stormwater drainage system. See BMP S.1 in Chapter 5 for details on detecting and eliminating these connections.

  No untreated water used to clean produce can enter the stormwater drainage system. Minimize the use of water when cleaning produce to avoid excess runoff.
- The storage areas must be swept or shoveled daily to collect dirt and fruit and vegetable fragments for proper disposal. Keep hosing to a minimum.

  Cleanup materials, such as brooms and dustpans, must be kept near the storage area.

  Gutters, storm drains, and catch basins on the property must be cleaned as needed. See BMP S.9 in Chapter 5 for details on catch basin cleaning requirements.
- If a holding tank is used for the storage of wastewater, pump out the contents before the tank is full and dispose of wastewater to a sanitary sewer or approved wastewater treatment system.

The following BMPs or equivalent measures are required of all businesses that process fruits or vegetables:

- Eliminate illicit connections to the stormwater drainage system. See BMP S.1 in Chapter 5 for details on detecting and eliminating these connections.
- Employees must be educated on benefits of keeping a clean processing area.
- Cleanup materials, such as brooms, dustpans, and shovels, must be kept near the storage area.
- The processing area must be swept or shoveled daily to collect dirt and fruit and vegetable fragments for proper disposal.
- The processing area must be enclosed in a building or shed, or covered with provisions for stormwater runon prevention. See BMPs S.4, S.5, and S.7 in Chapter 5 for more on covering and runon prevention.

  OR

- The processing area must be paved and sloped to a sanitary sewer drain, holding tank, or process treatment system collection drain, and stormwater runon prevention must be provided for the processing area. Call Pierce County Industrial Pretreatment Program (253) 7983013 for information on discharging to the sanitary sewer. See BMPs S.6 and S.3 in Chapter 5 for details on paving and drainage.

Suggested BMPs

The following BMPs are not required but can provide additional pollution protection:

- Cover storage areas for fruits and vegetables. See BMPs S.4 and S.5 in Chapter 5 for more details on coverings.
- A containment curb, dike, or berm can be used to prevent offsite runoff from storage or processing areas and also to prevent stormwater runon. See BMP S.7 in Chapter 5 for more information. Note that runon prevention is required for processing areas, but not for storage areas.
- Use an approved or equivalent treatment BMPs for any runoff (see Volume V).

A4.4 Storage of Solid Wastes and Food Wastes

Description of Pollutant Sources: This activity applies to businesses and public agencies that store solid wastes and food wastes outdoors. This includes ordinary garbage. If improperly stored in our climate, these wastes can contribute a variety of different pollutants to stormwater. Requirements for handling and storing solid waste may include a permit from the Tacoma-Pierce County Health Department. For more information, call the Waste Management Section at (253) 7986047.

NOTE: Dangerous solid wastes must be stored and handled under special guidelines. Businesses and agencies that store dangerous wastes must follow specific regulations outlined by Ecology and, in some cases, the Tacoma-Pierce County Health Department. Ecology regulations are outlined in Chapter 6. Please contact Ecology at (360) 407-6300 and the Tacoma-Pierce County Health Department at (253) 798-6047 for the specific requirements and permitting information.

Pollutants of concern include toxic organic compounds, oils and greases, heavy metals, nutrients, suspended solids, and oxygen demanding substances (i.e., BOD and COD).

Pollutant Control Approach: Store wastes in suitable containers with leak-proof lids. Sweep or shovel loose solids. Educate employees about the need to check for and replace leaking containers.

Required BMPs

The following BMPs are required of all businesses and public agencies engaged in storage of non-dangerous solid wastes or food wastes:

- All solid and food wastes must be stored in suitable containers. Piling of wastes without any cover is not acceptable.
- Storage containers must be checked for leaks and replaced if they are leaking, corroded, or otherwise deteriorating.
- Storage containers must have leak-proof lids or be covered by some other means (Figure 4.14). Lids must be kept closed at all times. This is especially important for dumpsters, as birds can pick out garbage and drop it, promoting rodent, health, and stormwater problems.

  OR

- If lids cannot be provided for the waste containers, or they cannot otherwise be covered, there is another option: a designated waste storage area must be provided with a containment berm, dike, or curb, and the designated area must drain to a sanitary sewer (contact Industrial Pretreatment Program at (253) 798-3013 prior to any connections) or holding tank for further treatment. See BMP S.7 and S.3 in Chapter 5 for more information.

Figure 4.14. - Solid Waste Dumpsters with Properly Sealed Lids.



- Employees must be trained to frequently check storage containers for leaks and to ensure that the lids are on tightly.
- The waste storage area must be swept or otherwise cleaned frequently to collect all loose solids for proper disposal in a storage container. Do not hose the area to collect or clean solids.
- If you clean your containers, all rinse water from cleaning must be disposed of in a sanitary sewer or septic system.
- Clean out catch basins on your property that receive drainage from your waste storage area. See BMP S.9 in Chapter 5 for details on catch basin cleaning.

Suggested BMPs

- If the amount of waste accumulated appears to frequently exceed the capacity of the storage container, then another storage container should be obtained and utilized.
- Store containers such that wind will not be able to knock them over.
- Designate a storage area, pave the area, and slope the drainage to a holding tank to prevent stormwater runon or runoff. If a holding tank is used, the contents must be pumped out before the tank is full and properly disposed of. See BMP S.2 in Chapter 5 for more information on disposal options.
- Compost appropriate wastes. Contact Pierce County Planning and Public Works Sustainable Resources at (253) 798-2179 for more information on composting.
- Recycle your solid wastes. The Industrial Materials Exchange program facilitates the transfer of excess materials and wastes to those who can use them. Industrial Materials Exchange can be reached at (206) 296-4899, toll free 1-888-TRY-IMEX or at https://www.hazwastehelp.org/IMEX.

A4.5 Recyclers and Scrap Yards

Description of Pollutant Sources: This activity applies to businesses and public agencies that salvage and store scrap metal, scrap equipment, junk appliances and vehicles, empty metal drums, and recyclable items such as cans, bottles, paper products, construction materials, metals, and beverage containers. This does not apply to businesses and agencies that store these items for less than 2 weeks. Businesses engaged in these activities may be required to obtain an NPDES permit for stormwater discharges from Ecology. See the discussion of NPDES requirements in Chapter 6 for more information. For these permit holders, the BMPs listed below should be used to complement NPDES requirements.

Potential sources of pollutants include paper, plastic, metal scrap debris, engines, transmissions, radiators, batteries, and other materials contaminated or that contain fluids. Other pollutant sources include leachate from metal components, contaminated soil, and the erosion of soil. Activities that can generate pollutants include the transfer, dismantling, and crushing of vehicles and scrap metal; the transfer and removal of fluids; maintenance and cleaning of vehicles, parts, and equipment; and storage of fluids, parts for resale, solid wastes, scrap parts, and materials, equipment and vehicles that contain fluids, generally in uncovered areas.

Potential pollutants typically found at these facilities include: toxic hydrocarbons, polychlorinated biphenyls (PCBs), other toxic organic compounds, heavy metals, oils and greases, suspended solids, oxygen demanding substances (i.e., BOD and COD), ethylene and propylene glycol, and acidic pH.

Required BMPs

- For facilities subject to Ecology's industrial stormwater general permit refer to BMP Guidance Document No. 94146 "Vehicle Recyclers: A Guide for Implementing the Industrial Stormwater General National Pollutant Discharge Elimination System (NPDES) Permit Requirements," Ecology, March 2011, Website: <https://fortress.wa.gov/ecy/publications/documents/94146.pdf>.
- For facilities not subject to Ecology's industrial stormwater general permit, apply the BMPs in BMP Guidance Document No. 94146 (see above), as well as the following required BMPs where applicable, depending on the pollutant sources existing at those facilities:
    - Gasoline, engine fluids, freon, and other contaminated liquids must be drained from scrapped items in a designated area and disposed of or recycled properly before the items are placed in the scrap storage area. See BMP S.2 in Chapter 5 for acceptable disposal options. The designated fluid draining area must be covered and paved, or if not covered, must be paved and sloped to a drain and holding tank. See BMP S.3 in Chapter 5 for drainage alternatives. Batteries must also be removed and recycled properly prior to storage.
    - Employees must be educated about the need for stormwater pollution protection, and proper maintenance of BMPs. They also must have training in spill cleanup procedures, and appropriate cleanup materials must be stocked near the fluid draining area.
    - Catch basins on the property must be cleaned as needed. See BMP S.9 in Chapter 5 for more details.
    - If the storage area is small, the scrap or recycling materials must be covered. See BMPs S.4 and S.5 in Chapter 5 for further details on coverings.

OR

- If the storage area cannot be covered, a stormwater treatment system consisting of a wet pond/vault, infiltration basin with underdrains, filtration system, or vegetated biofilter preceded by an oil/water separator must be provided to treat runoff from the entire material storage area. See Volume V for detailed information on these treatment methods.

Suggested BMPs

- The material storage area can be paved and sloped to a drain and holding tank. See BMP S.6 in Chapter 5 for details on this drainage strategy.
- Use of a containment dike, curb, or berm can help prevent contaminated runoff from leaving the site, and can function to direct runoff to one of the treatment methods mentioned under the Required BMPs. See BMP S.7 in Chapter 5 for more details.
- Chemical addition can be used to enhance settling or adjust pH in a wet pond/vault or filtration system. See Volume II, Section 3.2, BMP C252 for details on pH adjustment.
- Recycle, reuse, or let others use your scrap materials.

A4.6 Treatment, Storage, or Disposal of Dangerous Wastes

This activity applies to businesses and public agencies that are permitted by Ecology to treat, store, or dispose of dangerous wastes. Ecology regulates these facilities with specific requirements, which include the need for a NPDES permit. Detailed BMPs are not included in this volume since site requirements for these facilities are well beyond the level of typical BMP applications. See Chapter 6 for reference information.

The Tacoma-Pierce County Health Department also administers some aspects of dangerous waste treatment, storage, and disposal. Call (253) 649-1420 for more information.

A4.7 Storage of Liquid or Dangerous Waste Containers

Description of Pollutant Sources: Steel and plastic drums with volumetric capacities of 55 gallons or less are typically used at industrial facilities for container storage of liquids and powders. The BMPs specified below apply to container(s) located outside a building. Use these BMPs when temporarily storing accumulated food wastes, vegetable or animal grease, used oil, liquid feedstock or cleaning chemicals, or Dangerous Wastes (liquid or solid), unless the business is permitted by Ecology to store the wastes. Leaks and spills of pollutant materials during handling and storage are the primary sources of pollutants. Oil and grease, acid/alkali pH, oxygen demanding substances (i.e., BOD and COD) are potential pollutant constituents.

Pollutant Control Approach: Store containers in impervious containment under a roof or other appropriate cover, or in a building. For storage areas on site for less than 30 days, consider using a portable temporary secondary system in lieu of a permanent system as described above.

Required BMPs

- Place tight-fitting lids on all containers.
- Place drip pans beneath all mounted container taps and at all potential drip and spill locations during filling and unloading of containers.
- Inspect container storage areas regularly for corrosion, structural failure, spills, leaks, overfills, and failure of piping systems. Check containers daily for leaks/spills. Replace containers, and replace and tighten bungs in drums, as needed.
- Businesses accumulating Dangerous Wastes that do not contain free liquids need only to store these wastes in a sloped designated area with the containers elevated or otherwise protected from stormwater runon.
- Secure drums when stored in an area where unauthorized persons may gain access in a manner that prevents accidental spillage, pilferage, or any unauthorized use (Figure 4.15).
- If the material is a Dangerous Waste, the business owner must comply with any additional Ecology requirements as specified in Chapter 6, Section 6.2, R.2.
- Storage of reactive, ignitable, or flammable liquids must comply with the International Fire Code.
- Cover dumpsters or keep them under cover, such as a lean-to, to prevent the entry of stormwater. Replace or repair leaking garbage dumpsters.
- Drain dumpsters and/or dumpster pads to sanitary sewer. Dumpster drains must not discharge to stormwater systems. Keep dumpster lids closed. Install waterproof liners.

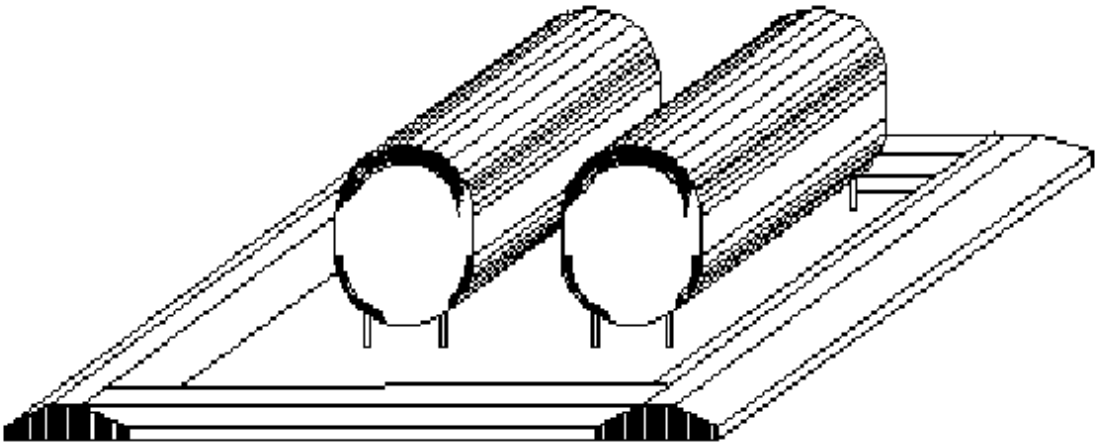
Figure 4.15. - Outdoor Drum Storage Unit with Locking Doors.



(Photo courtesy of Mark Dilley, Interstate Products, Inc.)

- Keep containers with Dangerous Waste, food waste, or other potential pollutant liquids inside a building unless this is impracticable due to site constraints or International Fire Code requirements.
- Store containers in a designated area that is covered, bermed, or diked; paved; and impervious in order to contain leaks and spills. Slope the secondary containment to drain into a dead-end sump for the collection of leaks and small spills (see also Volume I, Appendix I-A for dead-end sump maintenance guidelines).
- For liquid wastes, surround the containers with a dike as illustrated in Figure 4.16. The dike must be of sufficient height to provide a volume of either 10 percent of the total enclosed container volume or 110 percent of the volume contained in the largest container, whichever is greater.

Figure 4.16. - Containment Berm Used to Control Liquid-Material Leaks or Spills.



- Where material is temporarily stored in drums, use a containment system, as illustrated, in lieu of the above system (Figure 4.17).

Figure 4.17. - Temporary Secondary Containment.



(Photo courtesy of Seattle Public Utilities)

- Place containers mounted for direct removal of a liquid chemical for use by employees inside a containment area as described above. Use a drip pan during liquid transfer (Figure 4.18).

Figure 4.18. - Mounted Containers with Drip Pans.



- For contaminated stormwater in the containment area, connect the sump outlet to a sanitary sewer, if approved by Pierce County Industrial Pretreatment Program at (253) 798-3013, or to appropriate treatment such as an API or coalescent plate oil/water separator, or other appropriate system (see Volume V). Equip the sump outlet with a normally closed valve to prevent the release of spilled or leaked liquids, especially flammables (in compliance with International Fire Codes), and dangerous liquids. Open this valve only for the conveyance of contaminated stormwater to treatment.
- Another option for discharge of contaminated stormwater is to pump it from a dead-end sump or catchment to a tank truck or other appropriate vehicle for offsite treatment and/or disposal.

A4.8 Storage of Liquids in Permanent Aboveground Tanks

Description of Pollutant Sources: Aboveground tanks containing liquids (excluding uncontaminated water) may be equipped with a valved drain, vent, pump, and bottom hose connection. Aboveground tanks may be heated with steam heat exchangers equipped with steam traps. Leaks and spills can occur at connections and during liquid transfer. Oil and grease, organics, acids, alkalis, and heavy metals in tank water and condensate drainage can also cause stormwater contamination at storage tanks.

Pollutant Control Approach: Install secondary containment or a double-walled tank. Slope the containment area to a drain with a sump. Operators may need to discharge stormwater collected in the containment area to treatment such as an API or coalescent plate oil/water separator, or equivalent BMP. Add safeguards against accidental releases including protective guards around tanks to protect against vehicle or forklift damage, and tag valves to reduce human error. Tank water and condensate discharges are process wastewater that may need an NPDES permit.

Required BMPs

- Inspect the tank containment areas regularly for leaks/spills, cracks, corrosion, etc. to identify problem components such as fittings, pipe connections, and valves.
- Place adequately sized drip pans beneath all mounted taps and drip/spill locations during filling/unloading of tanks. Operators may need valved drain tubing in mounted drip pans.
- Vacuum sweep and clean the tank storage area regularly, if paved.
- Replace or repair tanks that are leaking, corroded, or otherwise deteriorating.
- All installations shall comply with the International Fire Code and the National Electric Code.
- Locate permanent tanks in impervious (Portland cement concrete or equivalent) secondary containment surrounded by dikes as illustrated in Figure 4.19, or use Underwriters Laboratory approved double-walled tanks. The dike must be of sufficient height to provide a containment volume of either 10 percent of the total enclosed tank volume or 110 percent of the volume contained in the largest tank, whichever is greater.
- Slope the secondary containment to drain to a dead-end sump, or equivalent, for the collection of small spills (see also Volume I, Appendix I-A for dead-end sump maintenance guidelines).
- Include a tank overfill protection system to minimize the risk of spillage during loading.

Figure 4.19. - Aboveground Storage Tanks with Secondary Containment.



(Photo courtesy of Seattle Public Utilities)

- For an uncovered tank containment area, equip the outlet from the spill-containment sump with a shutoff valve. The shutoff valve is normally closed and operators may open it manually or automatically, only to convey contaminated stormwater to approved treatment or disposal or convey uncontaminated stormwater to a storm drain. Evidence of contamination can include the presence of visible sheen, color, or turbidity in the runoff, or existing or historical operational problems at the facility. Use simple pH tests with litmus or pH paper for areas subject to acid or alkaline contamination.
- At petroleum tank farms, convey stormwater contaminated with floating oil or debris in the contained area through an API or coalescent plate type oil/water separator (Volume V) or other approved treatment prior to discharge to storm drain or surface water.

A4.9 Parking and Storage for Vehicles and Equipment

Description of Pollutant Sources: Parked vehicles at public and commercial parking lots, such as retail store, fleet vehicle (including rent-a-car lots and car dealerships), equipment sale and rental parking lots, and parking lot driveways, can be sources of toxic hydrocarbons and other organic compounds, oils and greases, metals, and suspended solids.

Required BMPs

- An oil removal system such as an API or coalescent plate oil and water separator, or equivalent BMP (see Volume V), approved by Pierce County, is applicable for parking lots meeting the threshold vehicle traffic intensity level of a high-use site. For more information on high-use sites, refer to Volume V, Section 2.1, Step 3.
- If washing a parking lot, discharge the washwater to a sanitary sewer (if allowed by Pierce County Industrial Pretreatment Program at (253) 7983013) or other approved wastewater treatment system, or collect washwater for offsite disposal.
- Do not hose down the area to a storm drain or receiving water. Vacuum sweep parking lots, storage areas, and driveways regularly to collect dirt, waste, and debris.

A4.10 Storage of Pesticides, Fertilizers, or Other Products That Can Leach Pollutants

This activity applies to businesses, public agencies and farms that store non-liquid pesticides, fertilizers, or a variety of other products, such as treated lumber, metal building materials, and metal tools, that have the potential to leach pollutants into underlying soil or stormwater runoff. The main problem with the potential pollutants from these sources is their solubility, which means they are difficult or impossible to filter out of runoff. If there is any question as to whether materials on your site have the potential to leach pollutants into stormwater runoff or underlying soil, call Pierce County Planning and Public Works Surface Water Management at (253) 798-2725 or Tacoma Stormwater Source Control Unit at (253) 591-5588 and ask to speak to a water quality person. Note that the storage of liquid pesticides is covered under activity A4.7 Storage of liquid chemicals, waste oils, solvents or petroleum products in portable containers.

Pollutants of Concern: Toxic organic compounds, oils, heavy metals, nutrients, fecal bacteria, oxygen demanding substances (i.e., BOD and COD), Biochemical oxygen demand (BOD), suspended solids.

Required BMPs

The following BMPs or equivalent measures are required of all businesses, public agencies and farms engaged in storage of pesticides, fertilizers or finished products that can leach pollutants:

- Employees must be trained on the proper storage, handling, application and disposal of fertilizers and pesticides, from keeping bags intact to storing in a covered or contained area.
- Store pesticides and fertilizers in enclosed impervious containment areas that prevent precipitation or unauthorized personnel from coming into contact with the materials.
- Outdated or banned pesticides must be disposed of at an approved hazardous waste facility.
- Sweep paved storage areas as needed. Collect and dispose of spilled materials. Do not hose storage areas to a storm drain or conveyance ditch.
- Do not discharge pesticide contaminated stormwater or spills/leaks of pesticides to storm drain or to the sanitary sewer. Contaminated stormwater must be collected and disposed of properly. Unused or spilled/leaked pesticides must be disposed of according to the label.

For fertilizers or pesticides:

- Containers and bags must be covered, intact, and off the ground.
- Store all material so that it cannot come into contact with water.
- Immediately clean up any spilled fertilizer or pesticides.
- Keep pesticide and fertilizer contaminated waste materials in designated covered and contained areas, and dispose of properly.
- Store and maintain spill cleanup materials near the storage area.
- Comply with WAC 16-228-1220 and Chapter 16-229 WAC.

Suggested BMPs

Contained storage areas should drain to a sump or a holding tank. Note that this only applies to

finished products other than treated lumber. The sump should have an outlet pipe for discharges to the stormwater drainage system. The sump must be cleaned at least once per year, and solid materials and residues collected in the bottom of the sump must be properly disposed of. See BMP S.2 in Chapter 5 for information on disposal options.

See BMPs S.4 and S.5 in Chapter 5 for further information on coverings of pesticides, fertilzers, and finished products that can leach pollutants. Stormwater runon prevention must be provided for the covered area, or the stored materials must be raised off the ground. See BMP S.7 in Chapter 5 for more information on runon prevention options.

Storage areas for treated lumber should be paved, and either covered or sloped to drain to a dead-end sump or treatment system (see also Volume I, Appendix I-A for dead-end sump maintenance guidelines). Material collected from the sump must be disposed of as a hazardous waste (it may be economical to install an evaporation system for the uncovered area). Stormwater runon must be prevented from entering the covered area if the lumber is not elevated off the ground. See BMPs S.4 and S.7 in Chapter 5 for more information on roof covers and runon prevention.

- Paved storage areas for finished products should be swept weekly and collected materials disposed of properly. Small amounts of fertilizers can be disposed of in the regular garbage after double wrapping in plastic.
- Use less pesticide or fertilizer, or store less finished product, so that the size of the designated storage areas can be smaller and stormwater contamination potential is reduced.
- If it is not feasible to use the source-control BMPs listed above, one or more of the following stormwater treatment BMPs should be used (see Volume V for more information on each BMP):
    - Infiltration with underdrains to prevent groundwater contamination
    - Filtration
    - Wet pond with nutrient control, for fertilizer storage only
    - Constructed wetland
    - Vegetated biofilter.

Section A5 Construction and Demolition Activities

A5.1 Construction Demolition

Description of Pollutant Sources: This activity applies to removal of existing buildings and other structures by controlled explosions, wrecking balls, or manual methods, and subsequent clearing of the rubble. The loose debris can contaminate stormwater. Demolitions will also need to verify if asbestos is present and my require additional permits to remove.

Pollutants of concern include toxic organic compounds, hazardous wastes, high pH, heavy metals, and suspended solids.

Pollutant Control Approach: Do not expose hazardous materials to stormwater. Regularly cleanup debris that can contaminate stormwater. Protect the stormwater drainage system from dirty runoff and loose particles. Sweep paved surfaces daily. Educate employees about the need to control site activities.

Required BMPs

The following BMPs or equivalent measures are required of all businesses and public agencies engaged in building demolition:

- Identify, remove, and properly dispose of hazardous substances from the building before beginning construction demolition activities that could expose them to stormwater. Such substances could include PCBs, asbestos, lead paint, mercury switches, and electronic waste.
- Educate employees about the need to control site activities to prevent stormwater pollution, and also train them in spill cleanup procedures.
- Keep debris containers, dumpsters, and debris piles covered.
- Storm drain covers or a similarly effective containment device must be placed on all nearby drains to prevent dirty runoff and loose particles from entering the stormwater drainage system (Figure 4.20). Covers shall be placed at the beginning of the workday and the accumulated materials collected and disposed of before removing the covers at the end of the workday. If storm drains are not present, dikes, berms, or other methods must be used to protect overland discharge paths from runoff. See BMPs S.2 and S.7 in Chapter 5 for more information on runoff control and disposal options.

Figure 4.20. - Commercially Available Gutter Guard Being Replaced.



(Photo courtesy of Mark Dilley, Interstate Products, Inc.)

- Sweep gutters, sidewalks, driveways, and other paved surfaces in the immediate area of the demolition must be swept at the end of each workday to collect and properly dispose of loose debris and garbage.
- Lightly spray water (such as from a hydrant or water truck) throughout the site to help control windblown fine materials such as soil, concrete dust, and paint chips. Control the amount of dust control water so that runoff from the site does not occur, yet dust control is achieved. Do not use oils for dust control.

Check with Pierce County Planning and Public Works (253) 798-3739 and Puget Sound Clean Air Agency to obtain required permits. Additional information is available at:

- piercecountywa.gov/applyforapermit
- pscleanair.gov

Suggested BMPs

- If possible, a wall or screen should be constructed to prevent stray building materials and dust from escaping the area during demolition. Size and orient the wall or screen to capture wind-blown materials and contain them onsite.
- Schedule demolition to take place at a dry time of the year to prevent stormwater runoff from the demolition site.

A5.2 Building Repair, Remodeling, Painting, and Construction

Description of Pollutant Sources: This activity refers to activities associated with construction of buildings and other structures, remodeling of existing buildings and houses, and general exterior building repair work. Concrete pouring is covered under A3.2 Concrete Pouring and Asphalt Application at Temporary Sites.

Pollutants of concern include toxic hydrocarbons, toxic organics, suspended solids, heavy metals, pH, oils, and greases.

Pollutant Control Approach: Employees must be educated about the need to control site activities. Control leaks, spills, and loose material. Utilize good housekeeping practices.

Required BMPs

The following BMPs or equivalent measures are required of all businesses engaged in building repair, remodeling, painting, or construction:

- Identify, remove and properly dispose of hazardous substances from the building before beginning repairing or remodeling activities that could expose them to stormwater. Such substances could include PCBs, asbestos, lead paint, mercury switches, and electronic waste.
- Employees must be educated about the need to control site activities to prevent stormwater pollution, and also trained in spill cleanup procedures.
- Spill cleanup materials, appropriate to the chemicals being used on site, must be available at the work site at all times.
- The work site must be cleaned up at the end of each workday, with materials such as solvents put away indoors or covered and secured so that vandals will not have access to them.
- The area must be swept daily to collect loose litter, paint chips, grit, and dirt.
- Absolutely no substance can be dumped on pavement, on the ground, or in or toward storm drains, regardless of its content, unless it is clean water only.
- For wood treating activities drop cloths must be placed where space and access permit before the work begins. Additional drip pans must be used in areas where drips are likely to occur that cannot be protected with a drop cloth.
- Ground or drop cloths must be used underneath scraping, sandblasting work. Ground cloths, buckets, or tubs must also be used anywhere that work materials are laid down.
- Incidental cleaning of paint brushes and other tools that are covered with water-based paints must be cleaned in sinks connected to sanitary sewers or in portable containers that can subsequently be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based finishes or other materials must be cleaned in a manner that enables collection of used solvents for recycling or proper disposal and cannot be discharged to the sanitary sewer. See BMP S.2 in Chapter 5 for disposal options.
- Storm drain covers or similarly effective devices must be used if dust, grit, washwater, or other pollutants may escape the work area. This is particularly necessary on rainy days. The cover or containment device shall be placed over the storm drain at the beginning of the workday, and accumulated dirty runoff and solids must be collected and disposed of before

removing the cover at the end of the day.

- Refer to Activity A1.3 Washing and Steam Cleaning Vehicles/Equipment/Building Structures for best management practices associated with power washing buildings.

Suggested BMPs

The following BMPs are not required, but can provide additional pollution protection:

- Recycle materials whenever possible.
- Light spraying of water on the work site can control some of the dust and grit that can blow away. Oils must never be used for dust control. Never spray to the point of runoff from the site.
- Activities such as tool cleaning should occur over a ground cloth or within a containment device such as a tub.
- Consider using filtered vacuuming to collect waste that may be hard to sweep, such as dust on a drop cloth.
- If conducting work in wet weather conditions, consider setting up temporary cover when scraping or pressure-washing lead based paint.

Section A6 Dust Control and Soil and Sediment Control

A6.1 Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots

Description of Pollutant Sources: Dust can cause air and water pollution problems particularly at demolition sites, disturbed land areas, and unpaved roadways and parking lots.

Pollutant Control Approach: Minimize dust generation and apply environmentally friendly and government approved dust suppressant chemicals, if necessary.

Required BMPs

- Sprinkle or wet down soil or dust with water as long as it does not result in a wastewater discharge (Figure 4.21).

Figure 4.21. - Dust Suppression by Water Spray.



- Use in the recommended manner, only local and/or state government approved dust suppressant chemicals such as those listed in Ecology publication No. 96433, "Techniques for Dust Prevention and Suppression." See BMP C126, Polyacrylamide for Soil Erosion Protection, in Volume II of this manual.
- Avoid excessive and repeated applications of dust suppressant chemicals. Time the application of dust suppressants to avoid or minimize their wash-off by rainfall or human activity such as irrigation.
- Apply stormwater containment to prevent the conveyance of sediments and/or dust suppressant chemicals into storm drains or receiving waters.
- The use of motor oil for dust control is prohibited. Take care when using lignin derivatives and other high BOD chemicals in areas susceptible to contaminating surface water or groundwater.
- Consult with the Ecology Southwest Regional Office and the Pierce County Planning and Public Works department on discharge permit requirements if the dust suppression process results in a wastewater discharge to the ground, groundwater, storm drain, or surface water.

Suggested BMPs for Roadways and Other Trafficked Areas

- Consider limiting use of off-road recreational vehicles on dust generating land.
- Consider graveling or paving unpaved permanent roads and other trafficked areas at municipal, commercial, and industrial areas.
- Consider paving or stabilizing shoulders of paved roads with gravel, vegetation, or Pierce County approved chemicals.
- Encourage use of alternate paved routes, if available.
- Vacuum sweep fine dirt and skid control materials from paved roads soon after winter weather ends or when needed.
- Consider using pre-washed traction sand to reduce dust emissions.

Suggested BMPs for Dust Generating Areas

- Prepare a dust control plan. Helpful references include: Control of Open Fugitive Dust Sources (EPA450/388088) and Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (EPA450/292004).
- Limit exposure of soil (dust source) as much as feasible.
- Stabilize dust-generating soil by growing and maintaining vegetation, mulching, topsoiling, and/or applying stone, sand, or gravel.
- Apply windbreaks in the soil such as trees, board fences, tarpaulin curtains, bales of hay, etc.

Additional information on dust control can be found in Volume II of this manual.

A6.2 Dust Control at Manufacturing Sites

Description of Pollutant Sources: Industrial material handling activities can generate considerable amounts of dust that is typically removed using exhaust systems. Dusts can be generated at cement and concrete product mixing facilities, and wherever powdered materials are handled. Particulate materials that are of concern to air pollution control agencies include grain dust, sawdust, coal, gravel, crushed rock, cement, and boiler fly ash. Air emissions can contaminate stormwater. The objective of this BMP is to reduce the stormwater pollutants caused by dust generation and control.

Pollutant Control Approach: Prevent dust generation and emissions where feasible, regularly cleanup dust that can contaminate stormwater, and convey dust contaminated stormwater to proper treatment.

Required BMPs

- Clean powder material handling equipment and vehicles.
- Regularly sweep dust accumulation areas that can contaminate stormwater. Conduct sweeping using vacuum filter equipment to minimize dust generation and to ensure optimal dust removal.
- Use in the recommended manner, approved dust suppressants such as those listed in Ecology publication “Techniques for Dust Prevention and Suppression,” No. 96433 (Ecology 1996). Application of some products may not be appropriate in close proximity to receiving

waters or conveyances close to receiving waters. For more information, check with the Ecology Southwest Regional Office or Pierce County.

Suggested BMPs

- In manufacturing operations, train employees to handle powders carefully to prevent generation of dust.
- Use dust filtration/collection systems such as bag house filters, cyclone separators, etc. to control vented dust emissions that could contaminate stormwater. Control of zinc dusts in rubber production is one example.
- Use water spray to flush dust accumulations to sanitary sewers where allowed by Pierce County or to other appropriate treatment system. Contact Industrial Pretreatment Program at (253) 798-3013 for details.
- Install sedimentation basins, wet ponds, wet vaults, vegetated filter strips, or equivalent sediment removal BMPs. Refer to Volume V for more information about these BMPs.

Additional information on dust control can be found in Volume II of this manual.

A6.3 Soil Erosion and Sediment Control at Industrial Sites

Description of Pollutant Sources: Industrial activities on soil areas, exposed and disturbed soils, steep grades, etc. can be sources of sediments that can contaminate stormwater runoff.

Pollutant Control Approach: Limit the exposure of erodible soil, stabilize or cover erodible soil where necessary to prevent erosion, and/or provide treatment for stormwater contaminated with total suspended solids caused by eroded soil.

Required BMPs

- Apply one or more of the following cover practices:
  - Vegetative cover such as grass, trees, or shrubs on erodible soil areas
  - Covering with mats such as clear plastic, jute, or synthetic fiber
  - Preservation of natural vegetation including grass, trees, shrubs, and vines
- Apply one or more of the following structural practices:
  - Vegetated swale
  - Dike
  - Silt fence
  - Check dam
  - Sedimentation basin
  - Properly grading

For design information, refer to Volume II, Standards and Specifications for BMPs.

Section A7 Other Activities

A7.1 Commercial Animal Handling Areas

Description of Pollutant Sources: Animals at racetracks, kennels, fenced pens, veterinarians, and businesses that provide boarding services for horses, dogs, cats, etc. can generate pollutants from the following activities: manure deposits, animal washing, grazing, and any other animal handling activity that could contaminate stormwater. Pollutants can include coliform bacteria, nutrients, and total suspended solids. Individual Stormwater Permits covering commercial animal handling facilities include additional applicable source controls.

Pollutant Control Approach: To prevent, to the maximum extent practicable, the discharge of contaminated stormwater from animal handling and keeping areas.

Required BMPs

- Regularly sweep and clean animal keeping areas to collect and properly dispose of droppings, uneaten food, and other potential stormwater contaminants.
- Do not hose down areas that contain potential stormwater contaminants where they drain to storm drains or to receiving waters.
- Do not discharge any washwater to storm drains or to receiving waters without proper treatment.
- If the operator keeps animals in unpaved and uncovered areas, the ground must have either vegetative cover or some other type of ground cover, such as mulch.
- Surround the area where animals are kept with a fence or other means to prevent animals from moving away from the controlled area where BMPs are used.

A7.2 Keeping Livestock in Stables, Pens, Pastures, or Fields

This activity applies to management of all types of livestock. Manure from livestock can pollute stormwater and local water bodies. Animals that are not fenced off from creeks and streams can also cause severe erosion of stream banks, which in turn can silt up fish spawning areas. Certain areas of Pierce County require the filing of a livestock management plan. Contact the Pierce County Conservation District at (253) 845-9770 for more information and assistance in preparing such a plan. Pierce County/WSU Cooperative Extension at (253) 7987180 also has literature to help you more effectively manage your pastures and livestock.

Pollutants of Concern: Nutrients, suspended solids, oxygen demanding substances (i.e., BOD and COD), fecal bacteria.

Required BMPs

The following BMPs or equivalent measures are required of all businesses and citizens keeping livestock in stables, pens, pastures, or fields:

- Restrict animal access to creeks and streams, preferably by fencing. There are ways to fence and still allow animals drinking access to the stream, without allowing bank trampling and minimizing fecal inputs into the stream. Contact the Pierce County Conservation District for more information on fencing, including possible financing to provide such fencing. They can also help you with replanting stream banks to prevent further erosion. A minimum setback of 20-feet from the center of the streambed will be required on each side. Major tributaries and large farm ditches should be fenced as well.
- Dispose of manure from stables and pens properly. Do not pile it where rain will wash nutrients into constructed or natural stormwater drainage systems that leave your land. Place it within a bermed area to contain runoff, or cover it with a tarpaulin. It may also be placed in a grassy area as far from watercourses as possible, so that any seepage has a chance to be filtered and absorbed by the grasses before reaching a creek or stream.

Suggested BMPs

- On fields where animals are pastured, a rotational grazing system should be developed. This would mean that a field would need to be divided into a minimum of four equal units, and the stock rotated from one unit to another. The stock should not be allowed onto the pastures until the grass reaches a minimum height of 6 inches. They should be moved to the second field when the grass height is down to approximately 3-inches. Each field should be allowed to recover for a period of 21 to 28 days prior to regrazing.
- Monitor grazing carefully. If 90 percent of the plants' leaves are removed, the roots will stop growing for at least 18 days. If only 40 percent or less of the leaves are removed, the roots will continue to grow. Not only will overgrazing or overstocking limit pasture production, but the pastures become vulnerable to the invasion of unpalatable or poisonous weed species such as tussock, moss, buttercup, tansy ragwort, and thistle.
- Grazing should be discontinued starting in early October. Neither the animals nor the fields benefit from grazing during the winter. Since the plants are basically dormant, the protein content is extremely low. The fields become compacted and rutted, thus reducing soil tilth, which in turn reduces summer grass yields. Fence off a small portion of your pasture to sacrifice during winter, and feed hay and grain instead of grazing.
- Proper pasture management should also include the practices of clipping and harrowing the

fields after the stock has been removed. This is done to assure uniform growth and to avoid excessive damage to the stand and a consequent reduction in yields. This would also be the optimum time to apply fertilizer, such as manure, to the fields.

- Weed control is very important for maintaining highly productive pastures. If you follow the practices described above, you will go a long way toward effective weed control. You may occasionally need to apply herbicides, but do so judiciously. Remember that it is much easier to take care of a few thistles early on than it is to get rid of a field full.

A7.3 Log Sorting and Handling

Description of Pollutant Sources: Log yards are paved or unpaved areas where logs are transferred, sorted, debarked, cut, and stored to prepare them for shipment or for the production of dimensional lumber, plywood, chips, poles, or other products. Log yards are generally maintained at sawmills, shipping ports, and pulp mills. Typical pollutants include oil and grease, oxygen demanding substances (i.e., BOD and COD), settleable solids, total suspended solids (including soil), high and low pH, heavy metals, pesticides, wood-based debris, and leachate.

The following are pollutant sources:

1. Log storage, rollout, sorting, scaling, and cutting areas
2. Log and liquid loading areas
3. Log sprinkling
4. Debarking, bark bin, and conveyor areas
5. Bark, ash, sawdust and wood debris piles, and solid wastes
6. Metal salvage areas
7. Truck, rail, ship, stacker, and loader access areas
8. Log trucks, stackers, loaders, forklifts, and other heavy equipment
9. Maintenance shops and parking areas
10. Cleaning areas for vehicles, parts, and equipment
11. Storage and handling areas for hydraulic oils, lubricants, fuels, paints, liquid wastes, and other liquid materials
12. Pesticide usage for log preservation and surface protection
13. Application of herbicides for weed control
14. Contaminated soil resulting from leaks or spills of fluids.

Ecology's Baseline General Permit Requirements

Industries with log yards are required to obtain coverage under the Industrial Stormwater General Permit for discharges of stormwater associated with industrial activities. The permit requires preparation and onsite retention of an Industrial Stormwater Pollution Prevention Plan (SWPPP). Required and Suggested operational, source control, and treatment BMPs are presented in detail in Ecology's Guidance Document: *Industrial Stormwater General Permit Implementation Manual for Log Yards, publication No. 0410031*. It is recommended that all log yard facilities obtain a copy of this document.

A7.4 Boat Building, Mooring, Maintenance, and Repair

Description of Pollutant Sources: Sources of pollutants at boat and ship building, repair, and maintenance facilities at boatyards, shipyards, ports, and marinas include pressure washing, surface preparation, paint removal, sanding, painting, engine maintenance and repairs, and material handling and storage, if conducted outdoors.

Potential pollutants include spent abrasive grits, solvents, oils, ethylene glycol, washwater, paint over-spray, cleaners/detergents, anti-corrosive compounds, paint chips, scrap metal, welding rods, resins, glass fibers, dust, and miscellaneous trash. Pollutant constituents include total suspended solids, oil and grease, organics, copper, lead, tin, and zinc. Related activities are covered under the following activity headings in this volume, and other BMPs provided in this volume:

- A1.3 Washing, Pressure Washing, and Steam Cleaning of Vehicles/Equipment/ Building Structures
- A2.2 Fueling at Dedicated Stations
- A7.15 Spills of Oil and Hazardous Substances

Pollutant Control Approach: Apply good housekeeping, preventive maintenance, and cover and contain BMPs in and around work areas.

Required BMPs

The following BMPs or equivalent measures are required of all businesses, public agencies, and private boat owners engaged in boat building, mooring, maintenance and repair that are not covered by Ecology's NPDES Boatyard General Permit:

- Maintenance and repair activities that can be moved onshore must be moved accordingly. This action reduces some of the potential for direct pollution impact on water bodies.
- Blasting and spray painting activities must be sheltered by hanging tarps to block the wind and prevent dust and overspray from escaping. Move the activity indoors if possible. See Chapter 6 for details on Puget Sound Clean Air Agency limitations.
- Ground cloths must be used for collection of drips and spills in painting and finishing operations, and paint chips and used blasting sand from sand blasting (Figure 4.22).
- Collect spent abrasives regularly and store under cover to await proper disposal.
- Dispose of greasy rags, oil filters, air filters, batteries, spent coolant, and degreasers properly.

Figure 4.22. - Drop Cloth Used During Hull Sanding.



- Drain oil filters before disposal or recycling.
- Bilge water must be collected for proper disposal rather than discharged on land or water. See BMP S.2 in Chapter 5 for detail on disposal options. Several companies are available for bilge pumpout services. The problem can be avoided if oil-absorbent pads are used to capture the oil in the bilge water before or during pumping. If pads are used, they must be recycled or properly disposed of.
- Ballast water that has an oily sheen on the surface must be collected for proper disposal rather than discharged on land or water. See BMP S.2 in Chapter 5 for details on disposal options.
- Maintenance yard areas must be swept and cleaned, without hosing down the area, at least once per week or as needed. This prevents sandblasting materials, scrapings, paint chips, oils, and other loose debris from being carried away with stormwater. The collected materials must be disposed of properly. See BMP S.2 in Chapter 5 for disposal options.
- Docks and boat ramps must be swept at least once per week or as needed, and the collected materials must be disposed of properly. Dry docks must be swept before flooding.
- Paint and solvent mixing, fuel mixing and similar handling of liquids shall be performed on

shore, or such that no spillage can occur directly into surface water bodies.

- Routine cleanup materials such as oil-absorbent pads, brooms, dustpans, mops, buckets, and sponges must be stocked near docks.
- When washing, no pollutants, including soaps, may enter the stormwater drainage system or receiving water.
- Comply with BMP A2.3 and A4.2 if engine repair and maintenance are conducted.
- In the event of an accidental discharge of oil or hazardous material into waters of the state or onto land with a potential for entry into state waters, immediately notify the yard, port, or marina owner or manager, Ecology, and the National Response Center at 1-800-424-8802 (24hour). If the spill can reach or has reached marine waters, contact the U.S. Coast Guard at (206) 217-6232.

Suggested BMPs

- Boat construction and structural repair activities should be covered.
- Avoid the use of soaps, detergents, and other chemicals that need to be rinsed or hosed off in the water. If necessary, consider applying sparingly so that a sponge, towel, or rag can be used to remove residuals. Consider instead washing the boat in a suitable controlled area (see BMP A1.3 Washing, Pressure Washing, and Steam Cleaning of Vehicles/Equipment/ Building Structures) while it is out of the water.
- Materials such as paints, tools, and ground cloths should be stored indoors or in a covered area when not in use.
- Select the least toxic anti-fouling paint available.
- Boat interiors should be routinely cleaned, with proper disposal of collected materials, so that accumulations of water drained from them are not contaminated.
- Use sanders that have dust containment bags and avoid sanding in windy conditions.
- All used oil should be recycled if feasible. Most marinas now offer used oil recycling services. To dispose of filters, let drain 24 hours, then double wrap in plastic and dispose of in the regular garbage, or take them to the Tacoma Landfill Household Hazardous Waste facility for recycling. Pending state legislation may make disposal in the garbage illegal, so call the Hazardous Waste Line at 1-800-287-6429 for current information.
- Citizens for a Healthy Bay, a local environmental group, provides “Clean Bay Boating Kits.” Call them at (253) 383-2429 to obtain a free kit.
- Use one of the following treatment BMPs when paint chips or blasting grit are prevalent in the work area:
    - Infiltration basin
    - Wet pond or vault
    - Constructed wetland
    - Vegetated biofilter
    - Filtration with media designed for the pollutants that are present
    - Equivalent BMP (see Volume V).

A7.5 Logging

Description of Pollutant Sources: This activity covers logging activities that fall under the Washington State Forest Practices Act category of Class IV general forest practices. These are situations where timber harvesting is done in the process of converting forest lands into other land uses, such as home and business construction. Stormwater runoff from bare ground can be loaded with dirt and other pollutants. This material can clog ditches and stream channels, thus reducing carrying capacity and increasing flooding, as well as smothering spawning beds for fish. Simply controlling runoff and not allowing it to leave the site will prevent these harmful effects. Clearing and grading activities are covered in detail in Volume II of this manual.

Coverage under Ecology's Construction Stormwater General Permit is required for construction sites that result in the disturbance of 1 acre or more of land. Compliance with the Construction Stormwater Pollution Prevention requirements in Ecology's manual is required, as applicable. Virtually all logging operations will require a permit from the Washington State Department of Natural Resources (WDNR). Sensitive/critical areas and wetlands ordinances for Pierce County also contain requirements for logging activities in the vicinity of water bodies.

Pollutants of concern include suspended solids, oils and greases, oxygen demanding substances (i.e., BOD and COD), nutrients, toxic organic compounds, and heavy metals.

Pollutant Control Approach: Maintain required buffers adjacent to critical areas, including streams and wetlands. Keep sediments out of water bodies and off paved areas.

Required BMPs

- Vegetation along stream corridors, and adjacent to other water bodies and wetlands, must be preserved. Maintenance of a vegetated buffer enables filtration of most of the pollutants of concern for this activity. The above-mentioned ordinances contain specific requirements for buffer setbacks.
- Logging access roads must have a crushed rock or spall apron construction entrance where they join the pavement to prevent sediments from being tracked onto the pavement.
- Onsite fueling and maintenance operations must follow the required BMPs as outlined in A2.4 Mobile Fueling of Vehicles and Heavy Equipment; A2.3 Engine Repair and Maintenance; and A.4.7 Storage of Liquid Chemicals, Waste Oils, Solvents, or Petroleum Products in Portable Containers.

Suggested BMPs

- Erosion potential can be reduced by avoiding logging on steep slopes.
- If access roads are constructed for logging, they should be provided with drainage ditches that divert runoff into vegetated areas or stormwater treatment systems.
- Plant vegetated buffers in areas where they are already lost downslope of proposed logging areas, with sufficient lead time to allow for effective growth.

A7.6 Mining and Quarrying of Sand, Gravel, Rock, Minerals, Peat, Clay, and Other Materials

Description of Pollutant Sources: This activity applies to surface excavation and onsite storage of sand, gravel, and other materials that are mined. All mining operations that have stormwater runoff from the site are required to apply for a NPDES permit with Ecology. Ecology has specific BMPs required by the permit. Some additional BMPs to help meet Ecology's discharge performance standards are listed below.

Pollutants of concern are suspended solids, nutrients, pH, and metals.

Pollutant Control Approach: Provide containment and or cover for any onsite storage areas to prevent runon and discharge of suspended solids and other pollutants.

Suggested BMPs

- If the material is appropriate, use excavated spoil material to form compacted berms along downslope sides of the site to contain runoff. Berms should be seeded to promote growth of grass or other vegetation to limit erosion from the berms. Safety considerations must be examined to prevent flooding due to berm failure.
- Semi-permanent stockpiles should be seeded to promote vegetation growth to limit erosion from the stockpiles.
- Use detention ponds to promote settling of suspended solids, or infiltration basins to filter suspended solids, to cleanup runoff before it leaves the site. See Volume V for a further discussion of treatment BMPs.
- Use anchored tarps to cover stockpiles at small-scale mining operations if there is a potential for contaminated stormwater to leave the site.

A7.7 Swimming Pool and Spa Cleaning and Maintenance

Description of Pollutant Sources: This activity applies to all municipal and commercial swimming pools and spas, including Tacoma-Pierce County Health Department regulated facilities. Pools and spas at hotels, motels, and apartment and condominium complexes are covered here. Pools at single-family residences are covered in Chapter 3 of this volume. Commercial pool and spa cleaning services must follow these required BMPs for all pools they service.

Pollutants of concern include nutrients, suspended solids, chlorine, pH, and chemical oxygen demand (COD).

Discharge from pools, spas, hot tubs, and fountains can degrade ambient water quality. The waters from these sources typically contain bacteria that contaminate the receiving waters. Chemicals lethal to aquatic life such as chlorine, bromine and algaecides can be found in pools, spas, hot tubs, and fountains. These waters may be at an elevated temperature and can have negative effects on receiving waters and to aquatic life. Diatomaceous earth backwash from swimming pool filters can clog gills and suffocate fish.

Routine maintenance activities generate a variety of wastes. Chlorinated water, backwash residues, algaecides, and acid washes are a few examples. Direct disposal of these waters to stormwater drainage systems and waters of the State is not permitted without prior treatment and approval.

The quality of any discharge to the ground after proper treatment must comply with Ecology's Ground Water Quality Standards, Chapter 173-200 WAC.

The Washington State Department of Health and local health authorities regulate Water Recreation facilities which include pools, spas, and hot tubs. Owners and operators of those facilities must comply with those regulations, policies and procedures. Following the guidelines here does not exempt or supersede any requirements of the regulatory authorities.

Pollutant Control Approach: Many manufacturers do not recommend draining pools, spas, hot tubs or fountains; refer to the facility's operation and maintenance manual. Dispose of pool, spa and hot tub water to the sanitary sewer after getting preapproval from the Industrial Pretreatment Program at (253) 798-3013.

Required BMPs

- The preferred method of pool, spa or hot tub water disposal is to the sanitary sewer. If a sanitary sewer is available, all Tacoma-Pierce County Health Department regulated facilities are required to connect for draining and backwash. Contact Industrial Pretreatment Program at (253) 798-3013 for specific instructions on allowable flow rates and timing before starting to drain the pool. Never discharge pool water to a septic system, as it will cause the system to fail.
- If discharge to the sanitary sewer is not possible, pool and spa water may be discharged to a ditch or stormwater drainage system if the discharge water is:
    - Dechlorinated to a concentration of 0.1 ppm or less (some guidance on dechlorination is provided in the Department of Health's Water System Design Manual, Revised 12/09, DOH Publication 331-123. The Department of Health manual further references AWWA. 1999b. C651 – AWWA Standard for Disinfecting Water Mains. American Water Works Association, Denver, CO. and AWWA. 2002. C652 – AWWA Standard for Disinfecting

Water Storage Facilities. American Water Works Association, Denver, CO. for more details.) Contact a pool chemical supplier to obtain the neutralizing chemicals needed.

  - pH-adjusted if necessary.
  - Reoxygenated.
  - Volumetrically and velocity controlled to prevent resuspension of sediments.
  - Free of any filter media.
  - Free of acid cleaning wastes.
  - At a temperature that will prevent an increase in temperature in the receiving water. Cool heated water prior to discharge.
  - Released at a rate that can be accommodated by the receiving body (i.e. can infiltrate or be safely conveyed).

- Swimming pool cleaning wastewater and filter backwash shall not be discharged to the Pierce County stormwater system. You are required to contact Pierce County Surface Water Management at (253) 7982725 prior to discharge for instructions on allowable flow rates for the system or ditch that is being discharged to. Neutralizing chemicals are available for dechlorinating water. Letting the pool, spa or hot tub "sit" may also reduce chlorine levels. Use a test kit to determine if the concentration has reached zero.
- State law may allow discharges of pool water to the ground. However, the water must not cross property lines or impact neighboring properties, and a satisfactory means for distributing the water to the ground must be used so there is no runoff. Check with Ecology prior to release.
- Diatomaceous earth used in pool filters cannot be discharged to surface waters, stormwater drainage systems, or septic systems, or on the ground.
- Ensure that the pool/spa/hot tub/fountain system is free of leaks and operates within the design parameters.
- Do not provide any permanent links to stormwater drainage systems. All connections should be visible and carefully controlled.
- If the dechlorination or cooling process selected requires the water to be stored for a time, it should be contained within the pool or appropriate temporary storage container.

Suggested BMPs

- Hire a professional pool-draining service to collect all pool water for offsite disposal.
- Clean the pool, spa, hot tub, or fountain regularly, maintain proper chlorine levels and maintain water filtration and circulation. Doing so will limit the need to drain the facility.
- Manage pH and water hardness to reduce copper pipe corrosion that can stain the facility and pollute receiving waters.
- Before using copper algaecides, try less toxic alternatives. Only use copper algaecides if the others alternative do not work. Ask a pool/spa/hot tub/fountain maintenance service or store for help resolving persistent algae problems without using copper algaecides.
- Develop and regularly update a facility maintenance plan that follows all discharge requirements.

- Dispose of unwanted chemicals properly. Many of them are hazardous wastes when discarded.

A7.8 De-icing and Anti-icing Operations for Airports and Streets

Description of Pollutant Sources: De-icing and/or anti-icing compounds are used on highways, streets, airport runways, and on aircraft to control ice and snow. Typically ethylene glycol and propylene glycol are de-icing chemicals used on aircraft. De-icing chemicals commonly used on highways and streets include calcium magnesium acetate (CMA), calcium chloride, magnesium chloride, sodium chloride, urea, and potassium acetate. The de-icing and anti-icing compounds become pollutants when they are conveyed to storm drains or to surface water after application. Leaks and spills of these chemicals can also occur during their handling and storage.

BMPs for Airport De/anti-icing Operations

Pollutant Control Approach for Aircraft: Spent glycol discharges in aircraft application areas are regulated process wastewaters under Ecology's Industrial Stormwater General Permit. BMPs for aircraft anti-icing chemicals must be consistent with aviation safety and the operational needs of the aircraft operator.

Refer to 40 CFR Part 449 for EPA effluent limitations guidelines and new source performance standards to control discharges of pollutants from airport deicing operations.

Required BMPs for Aircraft:

- Conduct aircraft de-icing or anti-icing applications in impervious containment areas. Collect aircraft de-icing spent chemicals, such as glycol, draining from aircraft in de-icing or anti-icing application areas and convey to a sanitary sewer, treatment, or other approved disposal or recovery method. Contact the Industrial Pretreatment Program at (253) 7983013 to obtain permit for discharges to sanitary sewer. Divert de-icing runoff from paved gate areas to appropriate collection areas or conveyances for proper treatment or disposal.
- Do not discharge spent de-icing chemicals or stormwater contaminated with aircraft de-icing chemicals from application areas including gate areas, into storm drains. No discharge to surface water or groundwater, directly or indirectly, should occur.
- Transfer de-icing and anti-icing chemicals on an impervious containment pad, or equivalent spill/leak containment area, and store in secondary containment areas (see Storage of Liquids in Aboveground Tanks).

Suggested BMPs for Aircraft:

Establish a centralized aircraft de/anti-icing facility, if feasible and practicable, or in designated areas of the tarmac equipped with separate collection drains for the spent de-icing liquids.

- Consider installing an aircraft de/anti-icing chemical recovery system, or contract with a chemical recycler, if practicable.

Note: the applicable containment BMP of aircraft de/anti-icing applications, and applicable treatment BMPs for anti-icing spent chemicals such as glycols.

Required BMPs for Airport Runways/Taxiways:

- Avoid excessive application of all de/anti-icing chemicals, which could contaminate stormwater.
- Store and transfer de/anti-icing materials on an impervious containment pad or an equivalent containment area and/or under cover in accordance with BMP Storage or Transfer (Outside) of Solid Raw Materials, By-Products, or Finished Products in this volume.

Consider other material storage and transfer approaches only if the anti-icing material cannot reach surface or groundwater.

Suggested BMPs for Airport Runways/Taxiways:

- Include limits on toxic materials and phosphorous in the specifications for de/anti-icing chemicals, where applicable.
- Consider using anti-icing materials rather than de-icing if it will result in less adverse environmental impact.
- Select cost-effective de/anti-icing chemicals that cause the least adverse environmental impact.

BMPs for Streets/Highways

Required BMPs for Streets/Highways:

- Select de/ anti-icing chemicals that cause the least adverse environmental impact. Apply only as needed using minimum quantities.
- Where practicable, use roadway de-icing, such as calcium magnesium acetate, potassium acetate, or similar materials that cause less adverse environmental impact than urea and sodium chloride.
- Store and transfer de/anti-icing materials on an impervious containment pad in accordance with BMP Storage or Transfer (Outside) of Solid Raw Materials, By-Products, or Finished Products in this volume.
- Sweep/cleanup accumulated de/and anti-icing materials and grit from roads as soon as possible after the road surface clears.

Suggested BMPs for Streets/Highways:

- Intensify roadway cleaning in early spring to help remove particulates from road surfaces.
- Include limits on toxic metals in the specifications for anti-icing chemicals.

A7.9 Roof Vents and Building Drains at Manufacturing and Commercial Buildings

Description of Pollutant Sources: Stormwater runoff from roofs and sides of manufacturing and commercial buildings can be sources of pollutants caused by leaching of roofing materials, vent emissions to the roof and/or the accumulation of pollutants on roofs, and other air emission sources. Processes of special concern are stone cutting, metal grinding, spray painting, painting stripping, galvanizing and electroplating. Pollutants from these processes may build up on roofs and may pollute stormwater roof runoff.

Vapors and entrained liquid and solid droplets/particles have been identified as potential pollutants in roof/building runoff. Metals, solvents, acidic/alkaline pH, oxygen demanding substances (i.e., BOD and COD), and organics are some of the pollutant constituents identified.

Ecology has performed a study on zinc in industrial stormwater. The study is presented in Ecology Publication 08-10-025 Suggested Practices to reduce Zinc Concentrations in Industrial Stormwater Discharges at fortress.wa.gov/ecy/publications/publications/0810025.pdf. The user should refer to this document for more details on addressing zinc in stormwater.

Pollutant Control Approach: Evaluate the potential sources of stormwater pollutants and apply source control BMPs where feasible.

Required BMPs

- Identify processes that are vented and may contribute pollutants to the roof. Pollutants of concern include and are not limited to:
  - Metal dust
  - Grease from food preparation
  - Solvents
  - Hydrocarbons
  - Fines
  - Stone dust
- Look for chemical deposition around vents, pipes, and other surfaces.
- Install and maintain appropriate source control measures such as air pollution control equipment (filters, scrubbers, and other treatment).
  - Check that your scrubber solution is appropriate for the chemistry of the fumes.
  - Install vent covers and drip pans where there are none.
  - Prevent leaks in pipefittings and containment vessels with routine maintenance.
- Consider instituting operational or process changes to reduce pollution.
- If proper installation and maintenance of air pollution control equipment does not prevent pollutant fallout on your roof, additional treatment of the roof runoff may be necessary.
  - Install/provide appropriate devices for roof runoff before it is discharged off site. This may include approved water quality treatment BMPs or structural stormwater treatment systems.

- Maintain air filters and pollution control equipment on a regular basis to ensure they are working properly. (The smell of odors from outside the building indicates that the pollution control equipment may need maintenance or evaluation.)
- When cleaning accumulated emissions from roof tops, collect the washwater and loose materials using a sump pump, wet vacuum or similar device. The collected runoff may be discharge to the sanitary sewer, subject to approval by the Pierce County Industrial Pretreatment Program at (253) 798-3013 or have a waste disposal company remove it.
- If leachates and/or emissions from buildings are suspected sources of stormwater pollutants, then sample and analyze the stormwater draining from the building.
- Sweep the area routinely to remove any zinc residuals.
- If a roof/building stormwater pollutant source is identified, implement appropriate source control measures such as air pollution control equipment, selection of materials, operational changes, material recycle, process changes, etc.
- Bare galvanized metal shall not be used for materials that convey stormwater, such as roofs, canopies, siding, gutters, downspouts, roof drains, and pipes. Any galvanized materials shall have an inert, non-leachable finish, such as a baked enamel, fluorocarbon paint (such as Kynar or Hylar), factory-applied epoxy, pure aluminum, or asphalt coating. Acrylic paint, polyester paint, field-applied, and Galvalume coatings are not acceptable. Paint/coat the galvanized surfaces as described in Ecology Publication # 08-10-025.

A7.10 Urban Streets

Description of Pollutant Sources: Streets can be the sources of vegetative debris, paper, fine dust, vehicle liquids, tire wear residues, heavy metals (lead and zinc), soil particles, ice control salts, domestic wastes, lawn chemicals, and vehicle combustion products. Street surface contaminants have been found to contain significant concentrations of particle sizes less than 250 microns (Sartor and Boyd 1972).

Pollutant Control Approach: Conduct efficient street sweeping where and when appropriate to minimize the contamination of stormwater. Do not wash street debris into storm drains.

Suggested BMPs

- For maximum stormwater pollutant reductions on curbed streets and high volume parking lots, use efficient vacuum sweepers.

  Note: High-efficiency street sweepers utilize strong vacuums and the mechanical action of main and gutter brooms combined with an air filtration system that only returns clean air to the atmosphere (i.e., filters very fine particulates). They sweep dry and use no water since they do not emit any dust.

  High-efficiency vacuum sweepers have the capability of removing, 80 percent or more of the accumulated street dirt particles whose diameters are less than 250 microns (Sutherland 1998). This assumes pavements under good condition and reasonably expected accumulation conditions.

- For moderate stormwater pollutant reductions on curbed streets, use regenerative air sweepers or tandem sweeping operations.

  Note: A tandem sweeping operation involves a single pass of a mechanical sweeper followed immediately by a single pass of a vacuum sweeper or regenerative air sweeper.

  - A regenerative air sweeper blows air down on the pavement to entrain particles and uses a return vacuum to transport the material to the hopper.
  - These operations usually use water to control dust. This reduces their ability to pick up fine particulates.

  These types of sweepers have the capability of removing approximately 25 to 50 percent of the accumulated street dirt particles whose diameters are less than 250 microns (Sutherland 1998). This assumes pavements under good conditions and typical accumulation conditions.

- For minimal stormwater pollutant reductions on curbed streets, use mechanical sweepers.

  Note: The industry refers to mechanical sweepers as broom sweepers and uses the mechanical action of main and gutter brooms to throw material on a conveyor belt that transports it to the hopper.

  These sweepers usually use water to control dust. This reduces their ability to pick up fine particulates.

  Mechanical sweepers have the capability of removing only 10 to 20 percent of the accumulated street dirt particles whose diameters are less than 250 microns (Sutherland 1998). This assumes pavements under good condition and the most favorable accumulation conditions.

- Conduct vacuum sweeping at optimal frequencies. Optimal frequencies are those scheduled sweeping intervals that produce the most cost-effective annual reduction of pollutants normally found in stormwater and can vary depending on land use, traffic volume, and rainfall patterns.
- Train operators in those factors that result in optimal pollutant removal. These factors include sweeper speed, brush adjustment and rotation rate, sweeping pattern, maneuvering around parked vehicles, and interim storage and disposal methods.
- Consider the use of periodic parking restrictions in low to medium density single-family residential areas to ensure the sweeper's ability to sweep along the curb.
- Establish programs for prompt vacuum sweeping, removal, and disposal of debris from special events that will generate higher than normal loadings.
- Disposal of street sweeping solids must comply with "Recommendations for Management of Street Wastes" described in Appendix IVC of this volume.
- Inform citizens about the importance of eliminating yard debris, oil, and other wastes in street gutters in order to reduce street pollutant sources.

A7.11 Railroad Yards

Description of Pollutant Sources: Pollutant sources can include:

- Drips/leaks of vehicle fluids onto the railroad bed
- Human waste disposal
- Litter
- Locomotive/railcar/equipment cleaning
- Fueling
- Outside material storage
- The erosion and loss of soil particles from the railroad bed
- Maintenance and repair activities at railroad terminals, switching yards, and maintenance yards
- Herbicides used for vegetation management

Waste materials can include waste oil, solvents, degreasers, antifreeze solutions, radiator flush, acids, brake fluids, soiled rags, oil filters, sulfuric acid and battery sludges, machine chips with residual machining oil, and toxic fluids/solids lost during transit. Potential pollutants include oil and grease, total suspended solids, oxygen demanding substances (i.e., BOD and COD), organics, pesticides, and metals.

Pollutant Control Approach: Apply good housekeeping and preventive maintenance practices to control leaks and spills of liquids in railroad yard areas.

Required BMPs

- Implement the applicable BMPs in this chapter depending on the pollution generating activities/sources at a railroad yard facility.
- Do not allow discharge to outside areas from toilets while a train is in transit. Use pumpout facilities to service these units.
- Use drip pans at hose/pipe connections during liquid transfer and other leak-prone areas (BMP A2.1).
- During maintenance do not discard debris or waste liquids along the tracks or in railroad yards.

In areas subjected to leaks/spills of oils or other chemicals, convey stormwater to appropriate treatment such as a sanitary sewer (if approved by Pierce County Industrial Pretreatment Program at (253) 7983013), to an API or coalescent plate oil/water separator for floating oils, or other appropriate treatment BMP (as approved by Pierce County). See Volume V.

A7.12 Maintenance of Public and Utility Corridors and Facilities

Description of Pollutant Sources: Passageways and equipment at petroleum product, natural gas, and water pipelines and electrical power transmission corridors and rights-of-way can be sources of pollutants, such as herbicides used for vegetation management and eroded soil particles from unpaved access roads. At pump stations, waste materials generated during maintenance activities may be temporarily stored outside. Additional potential pollutant sources include the leaching of preservatives from wood utility poles, PCBs in older transformers, water that is removed from underground transformer vaults, and leaks/spills from petroleum pipelines. The following are potential pollutants: oil and grease, total suspended solids, oxygen demanding substances (i.e., BOD and COD), organics, PCB, pesticides, and heavy metals.

Pollutant Control Approach: Control of fertilizer and pesticide applications, soil erosion, and site debris that can contaminate stormwater.

Required BMPs

- Implement BMPs included in Chapter 4, Section 4.3, A3.6 Landscaping and Lawn/Vegetation Management and in Chapter 6, Section 6.2, R.6 Pesticide Regulations.
- When removing water or sediments from electric transformer vaults, determine the presence of contaminants before disposing of the water and sediments. This includes inspecting for the presence of oil or sheen, and determining from records or testing if the transformers contain PCBs. If records or tests indicate that the sediments or water are contaminated above applicable levels, manage these media in accordance with applicable federal and state regulations, including the federal PCB rules (40 CFR 761) and the state MTCA cleanup regulations (Chapter 173340 WAC). Water removed from the vaults can be discharged in accordance with the federal 40 CFR 761.79, and state regulations (Chapter 173201A WAC and Chapter 173200 WAC), or via the sanitary sewer if the requirements, including applicable permits, for such a discharge are met. (See also Chapter 6, Section 6.2R2).
- Within utility corridors, prepare maintenance procedures to minimize the erosion of soil. An implementation schedule may provide for vegetative, gravel, or equivalent cover that minimizes bare or thinly vegetated ground surfaces within the corridor.
- Provide maintenance practices to prevent stormwater from accumulating and draining across and/or onto roadways. Convey stormwater through roadside ditches and culverts. The road should be crowned, outsloped, water barred, or otherwise left in a condition not conducive to erosion. Appropriately maintaining grassy roadside ditches discharging to surface waters is an effective way of removing some pollutants associated with sediments carried by stormwater.
- Maintain ditches and culverts at an appropriate frequency to ensure that plugging and flooding across the roadbed, with resulting overflow erosion, does not occur.
- Apply the appropriate BMPs from Section A4 of this volume, Storage Activities, for the storage of waste materials that can contaminate stormwater.

Suggested BMPs

- When selecting utility poles for a specific location, consider the potential environmental effects of the pole or poles during storage, handling, and end-use, as well as its cost, safety, efficacy, and expected life. Use wood products treated with chemical preservatives

made in accordance with generally accepted industry standards such as the American Wood Preservers Association Standards. Consider alternative materials or technologies if placing poles in or near an environmentally sensitive area, such as a wetland or a drinking water well. Alternative technologies include poles constructed with material(s) other than wood, such as fiberglass composites, metal, or concrete. Consider other technologies and materials, such as sleeves or caissons for wood poles, when they are determined to be practicable and available.

- As soon as practicable, remove all litter from wire cutting/replacing operations.
- Implement temporary erosion and sediment control in areas cleared of trees and vegetation and during the construction of new roads.

A7.13 Maintenance of Roadside Ditches

Description of Pollutant Sources: Common road debris including eroded soil, oils, vegetative particles, and heavy metals can be sources of stormwater pollutants.

Pollutant Control Approach: Maintain roadside ditches to preserve the condition and capacity for which they were originally constructed, and to minimize bare or thinly vegetated ground surfaces. Maintenance practices should provide for ESC (refer to Activity A3.6 Landscaping and Lawn/ Vegetation Management).

Required BMPs

- Inspect roadside ditches regularly to identify sediment accumulations and localized erosion.
- Clean ditches on a regular basis, as needed. Keep ditches free of rubbish and debris.
- Vegetation in ditches often prevents erosion and cleanses runoff waters. Remove vegetation only when flow is blocked or excess sediments have accumulated. Conduct ditch maintenance (seeding, fertilizer application, harvesting) in late spring and/or early fall, where possible. This allows re-establishment of vegetative cover by the next wet season, thereby minimizing erosion of the ditch as well as making the ditch effective as a biofilter.
- In the area between the edge of the pavement and the bottom of the ditch, commonly known as the “bare earth zone,” use grass vegetation, wherever possible. Establish vegetation from the edge of the pavement, if possible, or at least from the top of the slope of the ditch.
- Maintain diversion ditches on top of cut slopes constructed to prevent slope erosion by intercepting surface drainage to retain their diversion shape and capability.
- Do not leave ditch cleanings on the roadway surfaces. Sweep, collect, and dispose of dirt and debris remaining on the pavement at the completion of ditch cleaning operations.
- Roadside ditch cleanings contaminated by spills or other releases known or suspected to contain dangerous waste must be handled following the Dangerous Waste Regulations (Chapter 173303 WAC). If testing determines materials are not dangerous waste but contaminants are present, consult with the Tacoma-Pierce County Health Department (253) 798-6047 for disposal options.
- Inspect culverts on a regular basis for scour or sedimentation at the inlet and outlet, and repair as necessary. Give priority to those culverts conveying perennial and/or salmon-bearing streams and culverts near streams in areas of high sediment load, such as those near subdivisions during construction.

Suggested BMPs

- Install biofiltration swales and filter strips to treat roadside runoff wherever practicable and use engineered topsoils wherever necessary to maintain adequate vegetation. These systems can improve infiltration and stormwater pollutant control upstream of roadside ditches. Refer to Volume V of this manual for additional information about biofiltration swales and filter strips.
- Consider screening roadside ditch cleanings not contaminated by spills or other releases and not associated with a stormwater treatment system such as a bioswale may be screened to remove litter. Separate screenings into soil and vegetative matter (leaves,

grass, needles, branches, etc.) categories. Compost or dispose of the vegetative matter in a municipal waste landfill. Consult the Tacoma-Pierce County Health Department (253) 7986047 to discuss use or disposal options for the soil portion. For more information, please see “Recommendations for Management of Street Wastes,” in Appendix IVC of this volume.

A7.14 Maintenance of Stormwater Drainage and Treatment Facilities

Description of Pollutant Sources: Facilities include roadside catch basins on arterials and within residential areas, conveyance systems, detention facilities such as ponds and vaults, oil and water separators, bioretention, biofilters, settling basins, infiltration systems, and all other types of stormwater treatment systems presented in Volume V. Oil and grease, hydrocarbons, debris, heavy metals, sediments, and contaminated water are found in catch basins, oil and water separators, settling basins, etc.

Pollutant Control Approach: Provide maintenance and cleaning of debris, sediments, and oil from stormwater collection, conveyance, and treatment systems to obtain proper operation.

Required BMPs

Maintain stormwater treatment facilities per the operations and maintenance (O&M) procedures presented in Volume I, Appendix IA, in addition to the following BMPs:

- Inspect and clean treatment BMPs, conveyance systems, and catch basins (Figure 4.23) as needed, and determine necessary O&M improvements.

Figure 4.23. - Catch Basin Cleaning with a Vacuum Truck.



- Promptly repair any deterioration threatening the structural integrity of stormwater facilities. These include replacement of clean-out gates, catch basin lids, and rock in emergency spillways.
- Ensure adequacy of storm drain capacities and prevent heavy sediment discharges to the sanitary sewer system.

- Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc. and truck to an appropriate local or state government approved disposal site.
- Clean catch basins in accordance with the information provided in Volume I, Appendix IA. Additional information is also included in Chapter 5 of this volume, BMP S.9 Cleaning Catch Basins.
- Clean woody debris in a catch basin as frequently as needed to ensure proper operation of the catch basin.
- Include notifications, e.g., "Only Rain Down the Drain/Puget Sound Starts Here," "Dump No Waste – Drains to Groundwater," "Streams," "Lakes." Emboss on or adjacent to all storm drain inlets *where practical* (Figure 4.24).

Figure 4.24. - "Dump No Waste" Storm Drain Stencil.



(Photo courtesy of Seattle Public Utilities)

- Disposal of sediments and liquids from catch basins must comply with "Recommendations for Management of Street Wastes" described in Appendix IVC of this volume.
- Select additional applicable BMPs from this chapter depending on the pollutant sources and activities conducted at the facility. Those BMPs include:
  - A4.7 – Storage of Liquid, Food Waste, or Dangerous Waste Containers
  - A6.3 – Soil ESC at Industrial Sites
  - A7.10 – Urban Streets
  - A7.15 – Spills of Oil and Hazardous Substances.
- Eliminate illicit connections to the stormwater drainage system. See BMP S.1 in Chapter 5 for details on detecting and eliminating these connections.

A7.15 Spills of Oil and Hazardous Substances

Description of Pollutant Sources: Federal law requires owners or operators of facilities engaged in drilling, producing, gathering, storing, processing, transferring, distributing, refining or consuming oil and/or oil products to have a Spill Prevention and Emergency Cleanup Plan (SPECP). The SPECP is required if the above ground storage capacity of the facility is 1,320 gallons or more of oil. Additionally, the SPECP is required if any single container with a capacity in excess of 660 gallons and which, due to their location, could reasonably be expected to discharge oil in harmful quantities, as defined in 40 CFR.

Part 110, into or upon the navigable waters of the United States or adjoining shorelines'

{40 CFR 112.1(b)}. Onshore and offshore facilities, which, due to their location, could not reasonably be expected to discharge oil into or upon the navigable waters of the United States or adjoining shorelines are exempt from these regulations {40 CFR 112.1(1)(i)}. State Law requires owners of businesses that produce dangerous wastes are also required by state law to have a SPECP. These businesses should refer to Chapter 6, Section 6.2, R2. The federal definition of oil is oil of any kind or any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil.

Pollutant Control Approach: Maintain, update, and implement a Spill Prevention and Emergency Cleanup Plan.

Required BMPs

- Prepare a Spill Prevention and Emergency Cleanup Plan (SPECP), which includes:
  - A description of the facility including the owner's name and address.
  - The nature of the activity at the facility.
  - The general types of chemicals used or stored at the facility.
  - A site plan showing the location of storage areas for chemicals, the locations of storm drains, the areas draining to them, and the location and description of any devices to stop spills from leaving the site such as positive control valves.
  - Cleanup procedures.
  - Notification procedures to be used in the event of a spill, such as notifying key personnel. Agencies such as Ecology, Pierce County Fire District, Washington State Patrol, Pierce County, U.S. Coast Guard, and the U.S. EPA shall be notified.
  - The name of the designated person with overall spill cleanup and notification responsibility.
- Train key personnel in the implementation of the SPECP. Prepare a summary of the plan and post it at appropriate points in the building, identifying the spill cleanup coordinators, location of cleanup kits, and phone numbers of regulatory agencies to contact in the event of a spill.
- Update the SPECP regularly.
- Immediately notify Ecology and Pierce County if a spill may reach sanitary sewer or storm drain, groundwater, or surface water, in accordance with federal and Ecology spill reporting requirements.

- Immediately cleanup spills. Do not use emulsifiers for cleanup unless there is an appropriate disposal method for the resulting oily wastewater. Do not wash absorbent material down a floor drain or into a storm drain.
- Locate emergency spill containment and cleanup kit(s) in high potential spill areas. The contents of the kit shall be appropriate for the type and quantities of chemical liquids stored at the facility (Figure 4.25).

Figure 4.25. - Example of Spill Kit Contents.



(Photo courtesy of Seattle Public Utilities)

Suggested BMP

- Spill kits should include appropriately lined drums, absorbent pads, and granular or powdered materials for neutralizing acids or alkaline liquids where applicable. In fueling areas: Package absorbent material in small bags for easy use and make available small drums for storage of absorbent and/or used absorbent. Deploy spill kits in a manner that allows rapid access and use by employees.

A7.16 Well, Utility, Directional and Geotechnical Drilling

Description of Pollutant Sources: This activity applies to drilling water wells and utilities, environmental protection and monitoring wells, and geotechnical borings that use machinery in the drilling. It does not apply to the use of devices such as hand augers, or for large structural drilling such as drilled shafts.

Drilling activities can expose soil and contaminated soil. These activities may cause the discharge of stormwater contaminated with sediments and other contaminates. This risk increases when drilling in areas with contaminated soils.

Pollutant Control Approach: Reduce sediment runoff from drilling operations.

Required BMPs:

- When drilling in areas of known or suspected soil contamination, test and characterize soil cuttings and accumulated sediment to determine proper management and disposal methods. If applicable, generator knowledge may be used to characterize the soil cuttings and accumulated sediment.
- Obtain permits for drilling activities and for clearing and grading the access routes and the work site.
- Protect environmentally sensitive areas (streams, wetlands, floodplains, floodways, erosion hazards, and landslide hazards) within the area of influence of the work site.
- Mitigate potential impacts to surrounding areas and/or the drainage system.
- For horizontal directional drilling, take measures to capture and contain drilling fluids and slurry.
- Equip the driller to quickly respond to unusual conditions that may arise.
- Locate and prepare access roadways to minimize the amount of excavation and the potential for erosion.
- Contain accumulated uncontaminated water and sediment on site and pump into a storage tank or direct through a geotextile filtration system (or equivalent system) before discharging to the surrounding ground surface. Contaminants may include, but are not limited to, hydraulic fluids, contaminants in the soil and/or groundwater, polymers, and other drilling fluid additives.
- Keep all sediment-laden water out of storm drains and surface waters. If sediment-laden water does escape from the immediate drilling location, block flow to any nearby waterways or catch basins using fabric, inlet protections, sandbags, erosion fences, or other similar methods. Immediately notify Pierce County Surface Water Management at (253) 798-2725 and/or Ecology at 1-800-424-8802 if sediment-laden water impacts the storm drain system or surface waters.
- Divert any concentrated flows of water into the site using sandbags or check dams up-slope from the site.
- Dispose of soil cuttings and accumulated sediment appropriately. If cuttings or other soils disturbed in the drilling process are to be temporarily stockpiled on site, they must be covered and surrounded by a berm or filter device. See Activity A4.1 for Storage or Transfer (Outside) of Solid Raw Materials, Byproducts, or Finished Products.

- Stabilize exposed soils at the end of the job using mulch or other erosion control measures. See Activity A6.3 for Soil Erosion and Sediment Control at Industrial Sites.
- Contain spent drilling slurry on site and allow it to dewater, or haul to an appropriate, approved disposal site.
- Restore disturbed areas with mulch (see BMP C121: Mulching) and seeding or hydroseeding (see BMP C120: Temporary and Permanent Seeding).

Chapter 5. Source Control Best Management Practices

In the previous chapter, different commercial activities were described and BMPs for pollution prevention were listed. This chapter provides the detailed descriptions of those source control BMPs.

Section 4.2, BMPs to Consider for All Activities, provides a list of general BMPs that each business should consider. Most of these are common sense, housekeeping types of activities, such as spill cleanup, moving activities indoors, and using the least toxic materials available. The implementation of these types of BMPs will help improve water quality.

5.1 Index of BMP Descriptions

BMP	Description Title
S.1	Eliminate Illicit Stormwater Drainage System Connections
S.2	Dispose of Collected Runoff and Waste Materials Properly
S.3	Connect Process Water Discharges to a Sanitary Sewer, Holding Tank, or Water Treatment System
S.4	Cover the Activity with a Roof or Awning
S.5	Cover the Activity with an Anchored Tarpaulin or Plastic Sheet
S.6	Pave the Activity Area and Slope to a Sump or Holding Tank
S.7	Surround the Activity Area with a Curb, Dike, or Berm or Elevate the Activity
S.8	Implement Integrated Pest Management Measures
S.9	Clean Catch Basin
S.10	Labeling Storm Drain Inlets on Your Property
S.11	Dock Washing
S.12	Potable Water Line Flushing, Water Tank Maintenance, and Hydrant Testing
S.13	Color Events
S.14	Goose Waste

5.2 Source Control BMPs

S.1 Eliminate Illicit Storm Drain Connections

A common problem with the stormwater drainage system for Pierce County is the existence of illegal hook-ups to the system. Many businesses and residences hooked internal building drains, sump overflows, process wastewater discharges, and even sanitary sewer and septic system pipes to the storm drain in the past as a matter of course. These connections allow a variety of pollutants to flow directly to receiving waters instead of to the sanitary sewer or septic system. Frequently, these connections are unknown to the current owner, and do not appear on any plans for the site. Because of the potential to pollute these connections represent, the Environmental Protection Agency, under the mandate of the NPDES stormwater permits, has made the elimination of such illicit connections a top priority.

All businesses and residences in Pierce County must examine their plumbing systems to identify any potential illicit connections. Start with an examination of the site plans. This will help the current owner understand what piping systems were installed initially, making piping that does not appear on the plan a priority for investigation. Any time it is found that toilets, sinks, appliances, showers and bathtubs, floor drains, industrial process waters, or other indoor activities are connected to the stormwater drainage system, these connections must be immediately rerouted to the sanitary or septic system, holding tanks, or process treatment system. Exceptions to this requirement would be those industries and businesses that have been issued an NPDES General Stormwater Permit by Ecology, and are allowed specific discharges under that permit. Please refer to R.4 in Chapter 6 to determine if your type of business is required to have a NPDES permit.

If it is found that sanitary facilities, such as toilets, are hooked to the stormwater drainage system, you must have permits from your local sewer utility (Pierce County Sewer Service Permits at (253) 7982737) to reroute them to the sanitary sewer. If sanitary service is not available, contact the Tacoma-Pierce County Health Department at (253) 798-6470 for septic permits.

Dye testing with a non-toxic dye is one way of helping to determine where a pipe or structure drains if it is not obvious by observations or on plans. The dye is put into the structure and flushed with some water. Observations are then made at ends-of-pipes, drainage ditches, catch basins, and manholes to look for the color coming through. Contact Pierce County Planning and Public Works Surface Water Management at (253) 798-2725 if you need assistance in locating structures adjacent to your property.

Smoke testing can also be used to detect illicit connections. It is typically best done by qualified personnel. All indoor discharges should be shut off before this test is conducted. A smoke bomb or other smoke-generating device is placed in a storm drain manhole, and air is forced in after it. Personnel should be stationed at each suspect drain location to observe if smoke is coming out. Smoking drains should be tagged for future rerouting.

Drains which are found to connect to the stormwater drainage system must either be permanently plugged or disconnected and rerouted as soon as possible. Drains that are no longer needed can be plugged with concrete or similarly effective permanent materials. If a drain pipe is to be rerouted and a sanitary sewer services the property, then the local sewer district must be contacted. Contact the number listed above for specific directions prior to rerouting. Restrictions on certain types of discharges, particularly industrial process waters, may require pretreatment of discharges before entering the sanitary sewer. It is the responsibility of the property owner or

business operator to follow through on rerouting illicit storm drainage connections to the sanitary sewer.

If the property is not served by a sanitary sewer, alternate measures will be necessary. If the discharge is simply domestic waste, a septic system may be feasible. If it is necessary to install a septic system, the proper permits will need to be obtained from the Tacoma-Pierce County Health Department at (253) 798-6470. If the discharge is anything other than domestic waste, then a holding tank or onsite treatment will be necessary. Contact Pierce County Industrial Pretreatment Program at (253) 798-3013 for specific directions for installation and disposal.

S.2 Dispose of Collected Runoff and Waste Materials Properly

Every business and residence in Pierce County must dispose of solid and liquid wastes and contaminated stormwater properly. There are generally four options for disposal depending on the type of materials. These options include:

- Sanitary sewer and septic systems
- Recycling facilities
- Municipal solid waste disposal facilities
- Hazardous waste treatment, storage, and disposal facilities.

Many liquid wastes and contaminated stormwater (depending on the pollutants and associated concentrations present) may be put into the sanitary sewer, subject to approval by the Pierce County Industrial Pretreatment Program at (253) 798-3013.

If wastes cannot be legally discharged to a sanitary sewer or septic system, one of the other three disposal options must be used. Sumps or holding tanks may be useful for storing liquid wastes temporarily. The contents must be disposed of in the sanitary sewer or at a dangerous waste facility depending on the nature of the waste.

Recycling facilities are a recommended option for many commercial and household items, including used oils, used batteries, old equipment, glass, some plastics, metal scrap materials, solvents, paints, wood and land clearing wastes, and various other solid wastes. Solid wastes that cannot be recycled and that are not hazardous must be disposed of at a licensed municipal solid waste disposal facility. The list in Chapter 7 of this volume has the phone numbers and addresses of these facilities in Pierce County.

Dangerous and hazardous wastes must be properly transported to an appropriate hazardous waste treatment, storage, and disposal facility. Included in Chapter 7 is a list of companies dealing in these activities.

Costs of disposal vary considerably from option to option. Especially in the case of dangerous wastes, different types of wastes should be kept segregated. Disposal costs are usually determined by the most hazardous or difficult to dispose of waste present, so you can keep your costs down by not mixing wastes. The Tacoma-Pierce County Health Department Hazardous Waste section at (253) 798-6047 can help you determine the best disposal options for your waste.

S.3 Connect Process Water Discharges to a Sanitary Sewer, Holding Tank, or Wastewater Treatment System

This BMP is a minimum requirement for all industrial and commercial activities that generate contaminated process wastewater, such as washing activities, composting activities, and production and processing activities. The water used in these activities cannot drain to surface waters or groundwater untreated. Process water must drain to a sanitary sewer, holding tank, or wastewater treatment system, or it can be recycled.

The first priority for these businesses is discharge of process water to a sanitary sewer via a new or existing plumbing connection. In order to connect to the sewer, you must contact Pierce County Water Industrial Pretreatment Program at (253) 798-3013 for information on permits for the connection. Pretreatment of industrial wastewaters will often be necessary before it is allowed to discharge to the sewer, and more information can be obtained by calling the number above.

If a sanitary sewer is not available, or if it is determined that a discharge connection is not allowed, the only remaining options are holding tanks or an onsite wastewater treatment facility. Consideration should be given to using a holding tank for used process water if the volume of process water generated by the activity is not excessive. The contents of the holding tank must be pumped out or drained before the tank is full and disposed of properly (see BMP S.2 in this chapter for information on disposal options). If a sanitary sewer connection cannot be made and a holding tank is not used, a wastewater treatment facility must be constructed on the site. This treatment facility must be designed to receive and effectively treat all discharges of process water from the business. Ecology must be contacted for approval of such a facility, since discharges from the treatment facility will enter surface waters or be spread on land. See Chapter 6 for Ecology's requirements for discharges of process waters.

For all types of process water discharges the following measures are required if the activity is to remain uncovered. Define a designated area for the activity and provide a mechanism for prevention of stormwater runon into the activity area. This can be a curb, dike, or berm (see BMP S.7 in this chapter for more information) or similar effective means to prevent runon. In this manner, only the precipitation that falls within the activity area is discharged and/or treated along with the activity process water. The designated area should be paved and sloped to a central collection drain. The collection drain must connect to the sanitary sewer (with pretreatment if required), the onsite holding tank, or the onsite treatment facility, whichever method is selected.

This process water BMP can be made more effective if the activity is covered, thus reducing the total amount of water to be treated.

S.4 Cover the Activity with a Roof or Awning

Not every activity can or needs to be located inside a building. In many cases, a simple roof or awning will protect the activity from coming into contact with stormwater, and usually at a lower cost than a complete building. If you do decide to build one of these structures, you will need to obtain permits from Pierce County Planning and Public Works (253) 798-3739. They will also be able to help you with fire code requirements and zoning code provisions.

The roof structure can be designed in several ways. One option is a lean-to type of structure, where sheets of corrugated steel, fiberglass, aluminum, or similar impermeable material are attached to the wall of a building and are supported by sturdy poles. Similarly, if there is no building to attach to, roofing materials can be sufficiently supported at all four corners as a standalone cap, or a waterproof tent canopy can be used.

The area of the roof cover should be sufficient to prevent any precipitation from reaching the covered materials. An example of this type of structure is provided in Figure 5.1.

Figure 5.1. - Structure Used to Cover Manufacturing Operations.



(Photo courtesy of Seattle Public Utilities)

Another option for covering an activity is to use an overhanging awning of sufficient size to prevent rain from reaching the materials. Many of the building permit, fire code, and zoning requirements will also apply to these structures. An example of an awning cover is shown in Figure 5.2.

Figure 5.2. - Loading Docks with an Overhang to Prevent Material Contact with Rainwater.



Activities such as fueling operations may be more conveniently covered by an island-type overhanging roof. This type of roof is supported by columns along the center of the structure rather than at the corners, enabling vehicles easy access underneath while still providing sufficient protection from rain. An example of this type of roof structure is shown in Figure 5.3.

Figure 5.3. - Roof at Fueling Island to Prevent Stormwater Runon.



(Photo courtesy of Austin Mohawk and Company, Inc.)

Note that floating fuel stations (such as some used for refueling boats) cannot be covered, according to the fire code.

The particular roof cover option used at a given site is subject to the site layout and available space, affordability, and limitations imposed by other regulations. Structural cover options other than those given above can be used if they perform the same function. This BMP should usually be implemented in conjunction with sump or sanitary sewer drains and provisions for prevention of stormwater runon into the covered area. BMPs S.6 and S.7 in this chapter present information on sump installation and runon prevention.

S.5 Cover the Activity with an Anchored Tarpaulin or Plastic Sheet

Some activities, such as stockpiling of raw materials, can be effectively covered with a sturdy tarpaulin or heavy plastic sheet made of impermeable material. Weights such as bricks, tires, or sandbags should be used to anchor the cover in place. Care should be taken to ensure that the tarpaulin or sheet covers the activity completely and that stormwater runon does not penetrate significantly under the cover. If several sheets are used to form a cover, the sheets should be tethered together or laid in an overlapping manner. If necessary, pins or stakes should be used to anchor the tarpaulin to the ground. The tarpaulin must be inspected daily to ensure that no holes or gaps are present in the tarpaulin coverage. An example of this type of cover is shown in Figure 5.4.

Figure 5.4. - Temporary Plastic Sheeting Anchored over Raw Materials Stored Outdoors.



The tarpaulin covering will be easier to keep in place and will last longer if some form of wind protection is possible. Attempts should be made to locate stockpiles adjacent to buildings where winds are reduced, but not in between buildings where a wind tunnel effect can occur.

Tarpaulins are an inexpensive and cost effective BMP for many activities. This BMP can be combined with runoff containment/runon prevention curbs, dikes, and berms for better effectiveness (see BMP S.7 for more information).

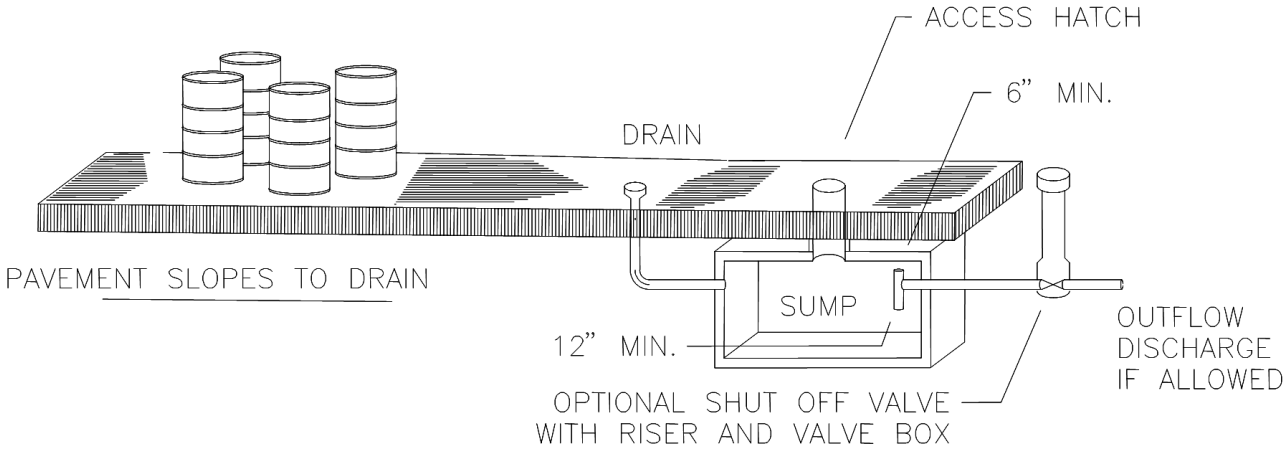
S.6 Pave the Activity Area and Slope to a Sump or Holding Tank

This BMP applies to several activities that cannot be covered effectively. It is particularly suited to activities with the potential for leaks and spills, but that otherwise do not generate excessive amounts of polluted runoff. Examples are storage of liquid chemicals, waste oils, and solvents in portable containers such as drums; loading and unloading of liquids from trucks; and painting, finishing, and coating activities. A sump or holding tank serves to provide spill containment until the liquids can be pumped out and properly disposed of. If the activity produces large amounts of runoff, this BMP will not be very effective because the stray contaminants will overflow the sump or pass through the sump before collection and disposal are possible. To prevent runon, the area should be enclosed with a berm, curb, or dike. The following implementation information is intended for situations where this BMP can be effective.

A designated activity area should be paved and sloped to drain to a central collection point. A sump, vault, or holding tank should be installed underneath this collection drain. Some materials, such as gasoline, can react with asphalt pavement and break it down, releasing additional pollutants. If the area is not yet paved and materials are present which may react with asphalt, the area must be paved with concrete. If the area is already paved with asphalt, an asphalt sealant can be applied which can aid in preventing pavement degradation. Whichever paving material is used, the paved surface must be free of gaps and cracks.

The sump or holding tank should have a capacity large enough to contain the entire volume of a potential spill. An example of a paved activity area with a sump drain is shown in Figure 5.5.

Figure 5.5. - Paved Area With Sump Drain.



Wash pads may frequently need to use a sump arrangement like this. To keep disposal costs down, a drain cover, plug, or shutoff valve upstream of the sump should be used at times when the activity is not occurring.

The cost of constructing a sump and the disposal of accumulated contents can be high, so businesses should consider whether other allowable alternative BMPs can be used.

Commercial services that pump sumps and holding tanks can be searched for using key words such as “Environmental” and “Ecological Services.”

BMPs S.4, S.5, and S.7 in this chapter present information on covering activities and runon prevention.

S.7 Surround the Activity Area with a Curb, Berm, or Dike, or Elevate the Activity

This set of BMP options can be an effective means for prevention of stormwater runon to an activity area. In addition, a curb, berm, or dike can be used for containment of spills in the activity area, or for containment of contaminated activity runoff. Generally, a containment BMP is most applicable to spill control situations; that is, sites where runoff is relatively clean, but occasional spills may occur. This BMP may be less expensive to implement than paving the activity area and providing proper drainage collection, but can also be more difficult to maintain if stormwater ponding occurs inside a containment dike.

If a curb, dike, or berm is used to prevent stormwater runon to a covered activity area, and the activity area is paved or otherwise impermeable, the berm should be placed underneath the covering so that rain will not pond inside it. Stormwater runon can also be prevented by elevating the activity with a platform or other type of pedestal.

Containment may be achieved with concrete curbing, an earthen berm, a tub such as a plastic wading pool, or some other dike material, depending on the activity, its size, and resources available. Activities that require more space and therefore cannot be contained with a tub may need to be surrounded by a curb, dike, or berm. Aboveground storage tanks of liquids, storage of chemicals or wastes in numerous drums, and stockpiling of fertilizer are examples of activities that can be contained effectively in this manner. As the activity area gets larger, containment with an earthen berm can probably be provided less expensively than concrete curbing.

If a curb, berm, or dike is used for runoff containment, and other containment sizing regulations (such as fire codes, Ecology or Tacoma-Pierce County Health Department restrictions) do not apply, it should function so that all stormwater runoff from rain events up to the 6month storm is contained in the immediate activity area until it infiltrates into the ground or is properly disposed of later. This approach is applicable for activities that involve liquid material storage, and that may consequently incur spills. It is also applicable to stockpile areas where runoff is typically polluted with suspended solids. If a stormwater treatment system is presently on site, a valve should be installed in the containment dike so that excess stormwater can be drained out of the activity area and directed to the treatment system. This valve should always be kept closed unless excess stormwater is being discharged, so that any spills that occur within the activity area can be effectively contained.

Difficulties in maintenance may arise with disposal of the captured water on sites without stormwater treatment capability. The collected rainwater may need to be treated before discharge. If the activity is located on impermeable ground, then potentially contaminated water will accumulate within the containment area. If contaminated, this accumulated water cannot simply be drained from the area; it must be collected and disposed of at a licensed disposal facility. During the wet season, this course of action can lead to frequent draining that may prove costly. In addition, some type of monitoring would be needed to determine if ponded water is contaminated. Depending on the monitoring requirements, this can also be very costly.

For storage of small items, the simplest containment device is a tub or wading pool. A plastic child's wading pool may be sufficient for some activities that do not require a lot of space, such as storing painting materials, and temporary storage of wastes in drums. An example of this is shown in Figure 5.6. Make sure the material you are using does not react with the plastic.

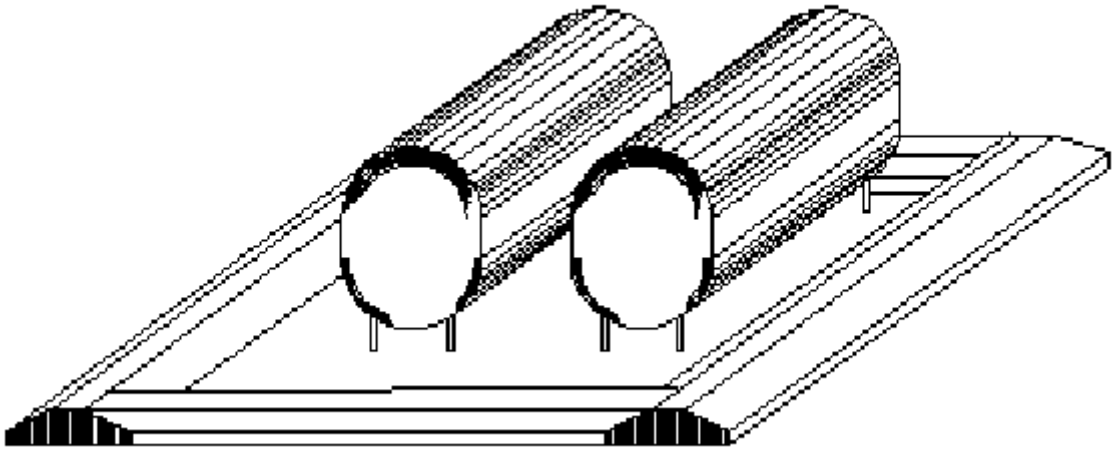
Figure 5.6. - Temporary Spill Containment.



(Photo courtesy of Mark Dilley, Interstate Products, Inc.)

For larger areas, a containment curb, dike, or berm may be necessary. If an earthen berm is used, it must be seeded with grass or other vegetation so that it does not erode. Sketches of a containment berm are shown in Figure 5.7.

Figure 5.7. - Containment Berm Used to Control Liquid-Material Leaks or Spills.



The volume of the containment area should be equal to 110 percent of the volume of the largest tank.

It should be noted that neglect and poor maintenance can render the containment useless. Other BMPs should be considered before containment is. Commercial products are available that are a combination containment box/elevated pedestal. These effective devices prevent stormwater runon by elevating containers off the ground, and allow for collection of spills and drips inside the pedestal box. Similar arrangements can be constructed by hand as well.

BMPs S.4, S.5, and S.6 in this chapter provide information on covering activities and sump installation.

S.8 Implement Integrated Pest Management Measures

Use of herbicides, fungicides, and rodenticides should always be done with extreme caution, not only because of the potential harm to humans and pets, but also because of the potential harm to fish, wildlife, and our water resources. In light of the toxic nature of these compounds, special attention should be given to pesticide usage in all applications. The discussion below applies more to large-scale pesticide users, but should be considered for backyard applications as well.

Commercial, agricultural, municipal, and other large scale pesticide users, such as golf courses and parks, should adhere to the principles of Integrated Pest Management, a decision-making process for pest management that strives for intelligent, environmentally sound control of pests. It is a systems approach to pest management that combines agronomic, biological, chemical, and genetic information for educated decisions on the type of control to use, the timing and extent of chemical application, and whether non-chemical means can attain an acceptable level of pest control.

Integrated Pest Management is a preventive measure aimed at knowing the exact pests being targeted for control, the locations and times when pests will pose problems, the level of pest-induced damage that can be tolerated without taking action, the most vulnerable life stage, and control actions that are least damaging to the environment. The major components of Integrated Pest Management are as follows:

- Monitoring and inventory of pest populations
- Determination of pest-induced injury and action levels
- Identification of priority pest problems
- Selection and timing of least toxic management tools
- Site-specific treatment with minimized chemical use
- Evaluation and adjustment of pesticide applications

Monitoring of pest populations is a key to successful Integrated Pest Management implementation. Pest problems are universally easier to control if the problem can be discovered early. With integrated pest management pesticides are used only as a last resort. Maximization of natural controls, including biological controls and removal of pests by hand, is always the first choice.

More information on integrated pest management is available from the Washington State Department of Agriculture and from the Washington State University Extension Service. Refer to Appendix IVB for an example of an Integrated Pest Management Program.

S.9 Cleaning Catch Basins

Cleaning catch basins regularly is one of the most important stormwater source control measures that a business can take (Figure 5.8).

Figure 5.8. - Catch Basin Cleaning with a Vacuum Truck.



Catch basins are typically located under low spots in parking lots, along curbs and road edges, and where storm drain pipes combine flows. Catch basins on the surface collect runoff for storm drains that are typically located directly underneath them. Most catch basins have some storage in the bottom that never drains to an outflow pipe. This permanent storage area is intended to trap sediments, debris, and other particles that can settle out of stormwater, thus preventing clogging of downstream pipes and washing of these solids into receiving waters.

Clean catch basins when the depth of deposits reaches 60 percent of the sump depth as measured from the bottom of basin to the invert of the lowest pipe into or out of the basin. However, in no case should there be less than 6-inches clearance from the debris surface to the invert of the lowest pipe. Some catch basins (for example, WSDOT Type 1L basins) may have as little as 12-inches sediment storage below the invert. These catch basins will need more frequent inspection and cleaning to prevent scouring. Where these catch basins are part of a stormwater collection and treatment system, the system owner/operator may choose to concentrate maintenance efforts on downstream control devices as part of a systems approach.

For additional information on the maintenance of catch basins, refer to Volume I, Appendix IA.

Several companies offer catch basin cleaning services. Pertinent equipment dealers and cleaning services can be found in the telephone Yellow Pages under headings like “Sewer Cleaning Equipment and Supplies” and “Sewer Contractors”. All of the solids and stagnant water collected from catch basin sumps must be disposed of properly. None of the sump contents can be flushed

into the catch basin outflow pipe. Depending on the nature of the pollutants in the sump, and the associated types of activities taking place on the site, the sump contents may need to be disposed of as hazardous waste. Contractors who perform catch basin cleanout services will be required to follow specified disposal requirements.

It should be apparent that use of other BMPs, such as frequent sweeping of activity areas, covering activity areas, reducing activity occurrence, and containing runoff from activity areas will help reduce catch basin cleaning frequency, thus saving time and money. All businesses and agencies should set up maintenance schedules for all of their BMPs so that coordinated BMP maintenance efforts result in reduced catch basin cleaning frequencies.

S.10 Labeling Storm Drain Inlets on Your Property

Description of Pollutant Sources: Waste materials dumped into storm drain inlets can have severe impacts on receiving waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Pollutant Control Approach: The stencil, affixed sign, or metal grate contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Required BMPs

- Label storm drain inlets in residential, commercial, industrial areas, and any other areas where contributions or dumping to storm drains is likely.
- Stencil or apply storm drain markers adjacent to storm drain inlets to help prevent the improper disposal of pollutants. Or, use a storm drain grate stamped with warnings against polluting.
- Place the marker in clear sight facing toward anyone approaching the inlet from either side.
- Use a brief statement and/or graphical icons to discourage illegal dumping. Examples include:
    - "No Dumping – Drains to Stream"
    - "No Pollutants – Drains to Puget Sound"
    - "Dump No Waste – Drains to Lake"
    - "No Dumping – Puget Sound Starts Here"
- Maintain the legibility of markers and signs. Signage on top of curbs tends to weather and fade. Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.
- When painting stencils or installing markers, temporarily block the storm drain inlet so that no pollutants are discharged from the labeling activities.

Optional Operational BMPs

- Use a stencil in addition to a storm drain marker or grate to increase visibility of the message.

Figure 5.9. - "Dump No Waste" Storm Drain Stencil.



S.11 Dock Washing

Description of Pollutant Sources: Washing docks (or wharves, piers, floats, and boat ramps) can result in the discharge dirt, bird feces, soaps, and detergents that can be toxic to aquatic life, especially after they take on contaminants while cleaning. The BMPs in this section do not address dry docks, graving docks, or marine railway cleaning operations.

Pollutant Control Approach: Use dry methods and equipment (scraping, sweeping, vacuuming) to remove debris and contaminants prior to cleaning with water to prevent these substances from entering surface water.

Required BMPs

Surface Preparation and Spot Cleaning:

- Scoop and collect debris and bird feces.
- Sweep, capture, and dispose of debris from the dock as solid waste. Sweep or vacuum docks to minimize the need for chemical cleaners.
- During cleaning activities, if debris, substances, or washwater could enter surface waters through drains, temporarily block the drains and collect the water for proper disposal.
- Hose down the area if necessary and collect water as feasible.
- Try spot cleaning with water and a coarse cloth before using soaps or detergents.
- If a cleaner is needed for spot cleaning:
    - Mix it in a bucket and use it to scrub down only the areas that need extra attention.
    - Start with vinegar and baking soda and move to other options as needed. Spot clean using a rag if harsher cleaning products are needed.
    - Avoid or minimize the use of petroleum distillates, chlorinated solvents, and ammoniated cleaning agents.
    - Use degreasers or absorbent material to remove residual grease by hand and do not allow this material to enter surface water.
    - Keep cleaners in sealed containers. Keep cleaner containers closed securely when transporting between the shore and docks.
    - Properly dispose of the dirty bucket water.
- Minimize the scour impact of washwater to any exposed soil at the landward end(s) of the dock or below the dock. Place a tarp over exposed soil, plant vegetation, or put berms to contain eroded soil.

Dock Washing and Disposal:

- To the extent practicable, collect any washwater generated from hosing down, pressure washing, or cleaning dock areas, and dispose of it properly.
- The following video, provided courtesy of the Port of Seattle, highlights the methods they have developed to collect washwater generated during dock washing.
- Video: Dock Scrubbing at Port of Seattle (YouTube Link): https://www.youtube.com/watch?v=7RBFdjC3K1Q.
- Try pressure washing using light pressure. This uses less water and decreases the need for

soap and scrubbing when washing the dock. Avoid using excessive pressure, which may damage the dock or send flakes of paint and other material into the water.

- Do not place any debris and substances resulting from cleaning activities in shoreline areas, riparian areas, or on adjacent land where these substances may erode into waters of the state.
- Where treated wood associated with the structure being washed are present, use non-abrasive methods and tools that, to the maximum extent practicable, minimize removal of the creosote or treated wood fibers when it removes marine growth from creosote or any other treated wood.
- Do not discharge removed marine growth to waters of the state where such marine growth would accumulate on the sea bed.
- Do not discharge emulsifiers, dispersants, solvents, or other toxic deleterious materials to waters of the state.

S.12 Potable Water Line Flushing, Water Tank Maintenance, and Hydrant Testing

Description of Pollutant Sources: Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in systems. Flushing done improperly can result in the discharge of solids to receiving waters. Hydrant testing may result in the discharge of rust particles. Chemicals used in line flushing and tank maintenance are highly toxic to aquatic organisms and can degrade receiving waters.

Pollutant Control Approach: Dechlorinate and pH adjust water used for flushing, tank maintenance, or hydrant testing. Dispose of the water to the sanitary sewer if possible.

Required BMPs

- Remove solids from associated curbs and gutters before flushing water. Use erosion and sediment control BMPs such as BMPs C235, C220, etc. to collect any solids resulting from flushing activities.
- If using super chlorination or chemical treatment as part of flushing, discharge water to the sanitary sewer. If sanitary sewer is not available, the water may be infiltrated to the ground as long as all of the following are met:
  - The water is dechlorinated to a total residual chlorine of 0.1 ppm or less.
  - Water quality standards are met.
  - A diffuser is used to prevent erosion.
  - The water does not cross property lines.
- Discharging water to a drainage system requires approval from Pierce County Surface Water Management at (253) 798-2725. They may require the water to be dechlorinated to a total residual chlorine concentration of 0.1 ppm or less and pH adjusted if necessary. Water must be volumetrically and velocity controlled to prevent resuspension of sediments or pollutants in the county municipal separated storm drain system (MS4). For discharges to the sanitary sewer, permits must be obtained from the County Industrial Pretreatment Program at (253) 798-3013.
- Do not over apply dechlorination agents. This can deplete the dissolved oxygen concentration and reduce the pH in discharge/receiving waters.

Suggested BMPs

- If possible, design flushing to convey accumulated material to strategic locations, such as to the sanitary sewer or to a treatment facility, thus preventing re-suspension and overflow of a portion of the solids during storm events. (For discharges to the sanitary sewer, permits must be obtained from the Pierce County Industrial Pretreatment Program at (253) 798-3013.)
- If possible, conduct flushing and tank maintenance activities on non-rainy days and during the time of year that poses the least risk to aquatic biota.

Suggested Treatment BMPs

- Treatment for dechlorinating can include an application of a stoichiometric quantity of:
  - Ascorbic Acid, Sodium Ascorbate (Vitamin C)
  - Calcium Thiosulfate
  - Sodium Sulfite tablets
  - Sodium Thiosulfate
  - Sodium Bisulfite
  - Alternate Dechlorination Solutions

S.13 Color Events

Description of Pollutant Sources: Color events are charity, religious, or commercial events that involve the use of powdered (typically cornstarch-based) and/or liquid dyes. Because they typically occur outside, there is a high likelihood of the color material entering drainage systems and surface water unless measures are taken to prevent these illicit discharges from occurring.

"Biodegradable" and "non-toxic" do NOT mean a substance can go into storm drains or water bodies. The dye material can harm aquatic organisms by altering water quality and chemistry. State and Federal environmental laws require the county to prohibit non-stormwater discharges to storm drains. Dye material and any washwater are prohibited discharges.

Pollutant Control Approach: Plan for the event. Control the application areas for the powder or liquid dyes. Block off storm drain inlets prior to the event. Clean up the areas immediately after the event.

Required BMPs

Pre-Event:

- Create a map of your event that includes the following:
  - Event route.
  - Nearby streams, lakes, and ponds.
  - Start and finish areas.
  - Color application stations/areas.
  - Storm drain inlets and open stormwater system features (e.g., ditches, swales, bioretention, rain gardens) at the color application, start and finish areas.
- Create a Pollution Plan that details:
  - Measures taken to ensure that NO dye material, either during or after the event, will enter the drainage system.
  - How all dye material will be removed and disposed of.
  - What will happen in the event of rain (including addressing localized flooding, runoff, and collection of the stormwater).
  - Emergency numbers for Pierce County Planning and Public Works Surface Water Management at (253) 798-2725 and Ecology's Spill Response at 1-800-424-8802 in case dye material does enter the storm drain or water body.
- Use handheld brooms to complete the initial cleanup of paved surfaces. Follow with use of a vacuum sweeper truck on roads.
- Contract with a commercial street sweeping firm to clean paved surfaces. Have a storm drain cleaning contractor on–call for discharges to storm drains or emergency cleanup if necessary.
- Ensure the commercial street sweeping firm has a plan in place for the proper disposal of sweepings from the event and associated air filters.
- Ensure all cleanup will be completed prior to the next forecasted rainfall, or no later than 24hours after the race event, and the contractor will have enough equipment and staff on

hand for the cleanup.

- Request a copy of the dye product's SDS (Safety Data Sheet) from the manufacturer or supplier. Review the SDS for potential safety and environmental hazards.
- Comply with Pierce County event permit requirements that contain stormwater pollution prevention BMPs. If no event permit is required, provide the following information to Pierce County Planning and Public Works Surface Water Management a minimum of two weeks prior to the scheduled event:
  - A copy of the map showing the location of the event
  - A copy of the Pollution Prevention Plan
  - A copy of the signed Commercial Cleaning Contract
  - Dye SDSs
  - Names and contact information of the event officials for both during and after the event.

Preventing Runoff from Entering Drainage Systems and Water Bodies:

- Protect storm drains by using berms, covering the drains, and using catch basin covers.
- Use care when removing berms, covers, and tarps to ensure no dye enters the storm drains.
- Prohibit participants from throwing dye within 100 feet of any stream or other surface water body.
- Prohibit participants from throwing dye within 100 feet of any open stormwater feature (e.g., ditch, swale, bioretention, rain garden, detention pond).
- Set up color stations at least 100 feet away from any surface water or open stormwater feature.
- The route, start, finish, and color application stations must be at least 100 feet away from any permeable pavement or the permeable pavement must be completely covered.
- If the event will be held on a small, contained area, cordon off the area and place enough covers on the ground to cover the entire site. If possible, contain the color application to grassy areas where ground covers are unnecessary.

Event Clean-Up:

- Dry off tarps and stained wet pavement with towels or absorbent pads.
- Use brooms or street sweepers to clean up paved areas. The fineness of the material may require sweepers with dust control systems.
- Do not use blowers to move dye material.
- Do not use hoses or pressure washers to rinse excess dye off of tarps, sidewalks, or paved areas. If it becomes necessary to use water to clean surfaces, all the water must be collected and disposed of to an onsite sewage disposal, or if approved by the Industrial Pretreatment Program (253) 798-3013, discharged to sanitary sewer.
- Call Pierce County Planning and Public Works Surface Water Management at (253) 798-2725 and/or Ecology's Spill Response at 1-800-424-8802 if any colored water enters a storm drain or water body.

- Dispose of the collected sweeping materials, cleaning materials, and air filters appropriately.
- All litter and debris must be picked up and properly disposed of.
- All cleanup must be done within 24 hours of the race event.

S.14 Goose Waste

Description of Pollutant Sources: Goose waste deposited near water or in water can contribute nutrients and algae growth. Goose feces may contain pathogens and contribute to the spread of diseases. Swimmers itch (schistosome or cercarial dermatitis) is caused by a parasite that can be spread by goose droppings but does not mature or reproduce in humans.

Pollutant Control Approach: To help decrease geese pollution to water sources, remove waste periodically and use deterrent management practices.

Required BMPs

This BMP is for areas of chronic accumulation of goose waste that impact stormwater systems.

- If possible, pick up goose waste using shovels, brooms, rakes, power sweepers, and trash cans. Properly dispose of goose waste in the garbage.
- Do not blow, sweep, or wash goose waste into waterways or storm drain systems.
- Regularly clean goose waste from areas of chronic deposition where deterrence measures are impractical.
- Do not feed wild geese or any other wild animals.
- In recreational areas, post signs discouraging the feeding of geese and other wild animals.

Suggested BMPs

- Change the habitat from goose-friendly to goose-resistant. Reduce lawn areas and increase the height of shoreline vegetation (tall grass, shrubs), as geese are reluctant to walk through tall vegetation.
- Create a natural geese barrier. 20- to 100-feet of herbaceous vegetation at least 3-feet in height to discourage geese . A narrow, winding path through the plantings will allow for beach access, while preventing geese from having a direct line of sight through the planted area.
- Make bank slopes steeper than 4:1 to discourage geese by preventing a clear view of the bank top and potential predators. Or, separate the beach from the grass with a few steep steps, which makes the ascent too difficult for most geese.
- Narrow ponds to limit takeoff and landing opportunities.
- Where space is limited, use one or two rows of shrub plantings combined with a fence. Fences can be made from woven wire, poultry netting, plastic netting, plastic snow fencing, monofilament line, or electrified wire. Fences should be at least 24-inches tall (3-feet may be better), firmly constructed, and installed to prevent the geese from walking around the ends. Lower openings should be no larger than 4-inches from the ground to prevent goslings from walking under or through the fence.
- Construct a grid of wire or line above the water's surface to prevent geese from flying into a pond that they have been accustomed to using. The grid should be one to two feet above the water surface but may be taller if humans need access to the area under the grid. There should be no more than five feet of space between gridlines. To prevent geese from walking under the grid, install a perimeter fence. Regularly monitor the grid for holes, trapped wildlife, and sagging.

- Canada geese are protected under federal and state law and a hunting license and open season are required to hunt them. Where lethal control of Canada geese is necessary outside of hunting seasons, it should be carried out only after the above nonlethal control techniques have proven unsuccessful and only under permits issued by the U.S. Fish and Wildlife Service. Currently, the only agency permitted for lethal removal is the U.S. Department of Agriculture's Wildlife Services. Lethal control techniques include legal hunting, shooting out of season by permit, egg destruction by permit, and euthanasia of adults by government officials.
- Scare geese away when they are around. Geese often learn quickly to ignore scare devices that are not a real physical danger. Vary the use, timing, and location of tactics. Take advantage of geese being fearful of new objects. Examples of harassment and scare tactics:
    - Dog patrols: When directed by a handler, dogs are the method of choice for large open areas. Results are often immediate. After an aggressive initial use (several times a day for one or two weeks), geese get tired of being harassed and will use adjacent areas instead. A dog can be tethered to a long lead (which may require relocating the dog and tether frequently to cover more area), be allowed to chase and retrieve a decoy thrown over a large flock of geese or be periodically released to chase the birds (if this is not against leash laws).
    - Eyespot Balloons: Large, helium-filled balloons with large eye-like images. Tether balloons on a 20- to 40-foot monofilament line attached to a stake or heavy object. Locate balloons where they will not tangle with trees or utility lines.
    - Flags and Streamers: Simple flags from plastic mounted on tall poles or mylar tape to make 6-foot streamers attached to the top of 8-foot long poles. Flags and streamers work best in areas where there is steady wind.
    - Scarecrows: Effective in areas where geese view humans as dangerous predators. For maximum effect, the arms and legs should move in the wind, use bright colors, and large eyes. Large, blowup toy snakes are reported to work as a type of scarecrow.
    - Noisemakers: Devices that make a loud bang such as propane cannons, blanks, and whistle bombs can scare geese. Making the noise as soon as geese arrive and persistence are the keys to success when using these devices. Consult noise ordinances and other permitting authorities (such as the local police department) before using.
    - Lasers: Relatively low-power, long wavelength lasers provide an effective means of dispersing geese under low light conditions. The birds view the light as a physical object or predator coming toward them and generally fly away to escape. Never aim lasers in the direction of people, roads, or aircrafts.
- Geese's favorite food is new shoots of grass. Low lying grass also allows easy access to the water for protection from predators. Let grass grow to six inches or taller. Stop fertilizing and watering the lawn to reduce the palatability of the lawn.
- Minimize open sight lines for geese to less than 30-feet.
- Plant shrubs or trees along ponds to limit takeoff and landing opportunities.

Refer to: <http://www.humanesociety.org/assets/pdfs/wild_neighbors/canada_goose_guide.pdf> and <https://wdfw.wa.gov/species-habitats/species/branta-canadensis> for additional information.

Chapter 6. Regulations and Requirements

The information in this chapter is provided to help you comply with other Pierce County and Washington State regulations, which may apply to your project, industry, or business in terms of protecting water quality. Some of the state regulations are summarized for your convenience. Because of the continuing modification of statutes, regulations, and county ordinances, a listing of relevant regulations is provided but should be verified. It is your responsibility to obtain the current version of any ordinances, statutes, or regulations that apply to your project. Copies of county ordinances are available from https://pierce.county.codes/

6.1 Pierce County Codes and Ordinances

Title 5 Business Licenses and Regulations

- 5.12 Pawnbrokers, Secondhand, Antiques, Junk and/or Salvage Dealers, Transient Traders in Secondhand Property, Garage Sales and Flea Markets
- 5.24 Commercial Kennel or Cattery, Hobby Kennel, Foster Kennel, Private Kennel, Grooming Parlor, Short-Term Boarding Facility, or Pet Shop
- 5.28 Wrecking Yards

Title 8 Health and Welfare

- 8.12 Food Service Sanitation
- 8.24 Weed Control
- 8.28 Solid Waste Management
- 8.34 Underground Storage Tanks
- 8.36 On-Site Sewage Disposal Systems
- 8.38 Infectious Waste Management
- 8.40 Public Water Systems
- 8.44 Swimming Pools
- 8.88 Watercraft Regulations

Title 11 Storm Drainage and Surface Water Management

- 11.02 Storm Drainage and Surface Water Management
- 11.05 Illicit Stormwater Discharges

Title 12 Roads and Rights-of-Way

- 12.40 Refuse on Right-of-Way

Title 13 Public Sanitary Sewer Systems

- 13.06 Industrial Pretreatment Regulations

Title 16 Subdivisions and Platting

- 16.04 Preliminary Plat Procedure – Prefiling Procedure – State Environmental Policy Act (SEPA)

Title 17A Construction and Infrastructure Regulations – Site Development and Stormwater Drainage

Title 17B Construction and Infrastructure Regulations – Road and Bridge Design and Construction Standards

Title 17C Construction and Infrastructure Regulations – Building and Fire Codes

Title 18 Development Regulations – General Provisions

Title 18A Pierce County Development Regulations – Zoning

Title 18B Development Regulations – Signs

Title 18C Development Regulations – Storm Drainage and Site Development

Title 18D Development Regulations – Environmental

Title 18E Development Regulations – Critical Areas

18E.30 Wetlands

18E.40 Regulated Fish and Wildlife Species and Habitat Conservation Areas

18E.50 Aquifer Recharge and Wellhead Protection Areas

18E.70 Flood Hazard Areas

Title 18F Development Regulations – Land Divisions and Boundary Changes

Title 18H Development Regulations – Forest Practices

Title 18I Development Regulations – Natural Resource Lands

18I.30 Agricultural Lands

18I.60 Property Adjacent to Designated Resource Lands

Title 18J Development Regulations – Design Standards and Guidelines

18J.20 – 130 Various Community Plans

Title 18S Development Policies and Regulations - Shorelines

Title 19A Comprehensive Plan

6.2 State, Federal, and Other Regulations and Requirements

R.1 Ecology requirements for the discharge of process wastewaters directly to surface waters

R.2 Ecology requirements for generators of dangerous (hazardous) wastes

R.3 Ecology stormwater NPDES permit requirements

R.4 Ecology requirements for underground and aboveground storage tanks.

R.5 U.S. EPA and Ecology requirements for spill-control and prevention plans

R.6 Washington State Department of Agriculture (WSDA) pesticide regulations

R.7 Puget Sound Air Pollution Control Agency (PSAPCA) air quality regulations

R.8 Requirements of Native American Tribes

R.1 Ecology Requirements for the Discharge of Process Wastewaters Directly to Surface Waters

If a public sanitary sewer is not available, process wastewater may be discharged, after suitable treatment, to a surface water body like a lake or stream, or to a drainage field. If the discharge is to a surface water body, Ecology must be contacted to obtain approval of the type and design of the treatment system, as well as the design and location of the outfall and the need for an NPDES permit. If a septic tank and drainfield are used for treatment, requirements of the Tacoma-Pierce County Health Department will also apply; contact the On-Site Sewage Program directly at (253) 798-6470 for more information.

Ecology's requirements can be found at WAC Chapter 173240. Some of the specific requirements include:

1. An engineering report must be prepared describing the proposed project. The general contents of the engineering report are specified by Ecology (WAC Chapter 173240). The report is reviewed and approved by Ecology.
2. The treatment system must be designed in accordance with Criteria for Sewage Works Design, October 1985, by Ecology.
3. The outfall must be designed in accordance with specific dilution zone dimensions (WAC Chapter 173201A100).
4. The quality of the discharge into the receiving water must be treated and diluted (according to the dilution criteria noted above) so as to not result in a violation of water quality standards (WAC Chapter 173201A).
5. The treatment plant must be properly maintained and operated by a certified operator (WAC Chapter 173230).

R.2 Ecology Requirements for Dangerous Waste Generators

The state dangerous waste regulations (WAC Chapter 173303) cover accumulation, storage, transportation, treatment, and disposal. Of interest to this volume is the temporary accumulation of waste until taken from the site to a permitted disposal site. Only portions of those regulations that apply to temporary storage are summarized here.

Permitted Generators

Businesses that generate 220 pounds or more of waste, either per batch or in the aggregate, over 1 month must comply with the storage specifications outlined below:

If placed in containers:

1. If the container is not in good condition (for example, severe rusting or apparent structural defects) or if it begins to leak, the owner must replace the container.
2. The container must be labeled as to its contents.
3. The container must be lined with a material that does not react with the waste.
4. The container must be kept closed except when adding or removing waste.
5. The container must not be opened, handled, or stored in a manner which may cause a rupture or leak.
6. At least weekly examine the containers for leakage.
7. Containers storing reactive or ignitable waste must meet requirements of the International Fire Code.
8. Incompatible wastes must be stored separately.
9. Ecology may require secondary containment of the storage area. Specifically, the storage area must:
    a. Be capable of collecting and holding spills and leaks.
    b. If uncovered, be capable of handling a 25year recurrence interval storm.
    c. Have a base that is free of cracks or gaps and is sufficiently impervious to leaks, spills, and rainfall.
    d. Be sloped or designed so that liquids can drain to a point for removal.
    e. Have positive drainage control (e.g., a valve) to ensure containment until any liquid is removed, which must occur in a timely manner.
    f. Have a holding capacity equal to 10 percent of the volume of all containers or the volume of the largest container, whichever is greater.
    g. Not allow runon of rainfall from areas adjacent to the storage area.

If the waste does not contain free liquids, the above requirements need not be met, provided that the area is sloped or the containers are elevated.

If placed in tanks:

1. The tank must be lined with a material that does not react with the waste.
2. The tank, tank area, and its ancillary equipment must be inspected according to a written schedule.
3. If retired, the tank is to be cleaned of all contents, and those contents properly disposed of.
4. Tanks storing reactive or ignitable waste must meet the International Fire Code.
5. Incompatible wastes must be stored separately.

The generators must have a designated employee on site or on call with the responsibility for coordinating all emergency response measures. Spills are to be contained and cleaned up as soon as practicable.

Small-Quantity Waste Generators

These are businesses that generate less than 220 pounds of dangerous waste per month or per batch (or 2.2 pounds of extremely hazardous waste). Small-quantity generators still fall under Ecology regulations to the extent that the materials must be properly stored on site until shipment. The wastes must be moved from the property whenever the accumulated quantity equals or exceeds 220 pounds or whenever the material has resided on site for 180 days. The waste must be disposed of at an approved facility. If the business is in compliance with these requirements, they are also considered solid waste generators, and are regulated by the Tacoma-Pierce County Health Department. For technical assistance and site visits, contact the Tacoma-Pierce County Health Department at (253) 798-6047 or the City of Tacoma at (253) 591-5588. Regulations governing small-quantity generators are currently being reviewed to possibly raise the accumulation limit. Call the Hazardous Waste Line at 1-800-287-6429 for the most up-to-date information.

Dangerous Waste Spill Plans

A recent state law established the requirement that generators of dangerous wastes in excess of 220 pounds/month (2,640 pounds/year) prepare a waste reduction plan, called a spill plan, not to be confused with the SWPPP (see R.4). The required content of the plan is set forth in Pollution *Prevention Planning – Guidance Manual*, January 1992, publication No. 912, for WAC Chapter 173-307.

Many of the actions described in these plans may benefit stormwater quality and thus should be integrated into any decisions about the selection of the BMPs described in Chapters 4 and 5 of this volume.

See WAC Chapters 173-303 and -307 for further details, as well as the above-named publication.

R.3 Ecology Stormwater NPDES Permit Requirements

The NPDES program requires industries or industrial-type activities to obtain permits for stormwater discharge.

Coverage under Ecology's General Permit for Stormwater Discharges Associated with Industrial Activities for each regulated facility. A business must obtain permit coverage if its primary activity falls under one of the categories listed in the permit or its fact sheet. The permit and fact sheet may be viewed on Ecology's website at www.ecy.wa.gov/programs/wq/stormwater/industrial/index.html.

The program requires the preparation of a SWPPP. A NPDES permit is required for certain categories of industries and municipalities for discharge to surface water, or a storm drain that discharges to surface water or to surface water and groundwater.

R.4 Ecology Requirements for Underground and Aboveground Storage Tanks

Underground Storage Tanks

Underground storage tanks (UST) that contain fuel and other petroleum products are regulated by Ecology under **WAC Chapter 173-360 Underground Storage Tank Regulations**. This law applies to USTs that have a capacity of greater than 110 gallons. USTs which store federally listed or otherwise regulated hazardous waste, heating fuel on the premises where used, farm or residential USTs less than 1,100 gallons in size and other types are exempt from these regulations (WAC Chapter 173-360-110).

The state UST regulations require permits for USTs in use after July 1991. Specific performance criteria such as design, integrity testing, inventory control, UST performance monitoring, spill control, and reporting for new USTs are outlined in this regulation. USTs in existence prior to adoption of this regulation in 1990 must meet the upgrade criteria or new UST requirements by 1998 or complete closure of the system.

USTs that have been closed or taken out of service after December 1988 must complete closure (removal or in-place closure) in accordance with WAC Chapter 173-360. Requirements for UST closure with Ecology include submittal of a 30day notice of closure, site assessment, and completion of any applicable cleanup actions. A report of the closure actions must be submitted to Ecology.

Aboveground Storage Tanks

Aboveground storage tanks (AST) which store dangerous wastes are regulated under **WAC Chapter 173-303 Dangerous Waste Regulations**, which is administered by Ecology. Underground storage tanks which store dangerous wastes must also meet the criteria for tanks in this regulation. Businesses which store, handle or generate dangerous wastes are regulated under this regulation based on the volume of dangerous waste generated. The Dangerous Waste Regulations have specific requirements for AST integrity, corrosion protection, secondary containment, leak detection, and use and management criteria, in addition to general requirements for businesses that have dangerous wastes.

For ASTs which contain other types of materials such as petroleum products or raw materials, Ecology guidance document *Guidelines to Prevent, Control, and Contain Spills from the Bulk Storage of Petroleum Products* is available for technical guidance.

Inquiries about business-specific requirements and permitting for USTs and ASTs should be directed to Ecology, Southwest Regional Office at (360) 407-6300.

R.5 U.S. EPA and Ecology Emergency Spill Cleanup Requirements

USEPA – Spill Prevention Control and Cleanup Plans (40 CFR 112)

This federal regulation requires that owners or operators of facilities engaged in drilling, producing, gathering, storing, processing, refining, transferring, or consuming oil and oil products are required to have a Spill Prevention and Control and Cleanup Plan (SPCC), provided that the facility is not transportation related; and, that the aboveground storage of a single container is in excess of 660 gallons, or an aggregate capacity greater than 1,320 gallons, or a total below ground capacity in excess of 42,000 gallons.

The plan must:

1. Be well thought out in accordance with good engineering.
2. Achieve three objectives – prevent spills, contain spills that occur, cleanup spills.
3. Identify name, location, owner, and type of facility.
4. Have date of initial operation and oil spill history.
5. Designate the person responsible.
6. Be approved and certified by the person in authority.
7. Contain a facility analysis.
8. Tanks must have secondary containment and leak detection.

Ecology Dangerous Wastes (WAC 173303350)

The regulations state that generators must have a contingency plan that must include:

1. Actions taken in the event of a spill.
2. Descriptions of arrangements with local agencies.
3. Identification of the owner's emergency coordinator.
4. List of emergency equipment.
5. Evaluation plan for business personnel.

See Federal Regulation 40 CFR 112 and WAC 173-303-350 for further information.

R.6 Washington State Department of Agriculture Pesticide Regulations

Washington State pesticide laws are administered by the state's Department of Agriculture, under the Washington Pesticide Control Act (RCW Chapter 15.58), Washington Pesticide Application Action (RCW Chapter 17.21), and regulations in WAC Chapter 16.228. In Tacoma, all pest control operators and fumigators are required to obtain certification from the Tacoma-Pierce County Health Department. Contact the Health Department's Compliance Program at (253) 798-6500 for more information. The requirements relevant to water quality protection are:

1. Persons who apply pesticides are required to be licensed **except**:
    a. People who use general-use pesticides on their own or their employer's property.
    b. Grounds maintenance people using only general use pesticides on an occasional basis not amounting to a regular occupation.
    c. Governmental employees who apply general use pesticides without utilizing any kind of motorized or pressurized apparatus.
    d. Employees of a commercial applicator or a government agency who are under direct onsite supervision by a licensed applicator.
2. Licensed applicators must undergo 40 hours of continuing education to keep the license.
3. No person shall pollute streams, lakes, and other water supplies in pesticide loading, mixing, and application.
4. No person shall transport, handle, store, load, apply, or dispose of any pesticide, pesticide container, or apparatus in such a manner as to pollute water supplies or waterways, or cause damage or injury to land, human beings, desirable plants, or animals.

See WAC Chapter 16.228 for further details.

R.7 Puget Sound Clean Air Agency Air Quality Regulations

The Puget Sound region is under the jurisdiction of regional air quality authorities who in turn must function under Washington State and federal air quality regulations. The Puget Sound Clear Air Agency (PSCAA) is the regulatory agency for air quality in Tacoma.

The air authority has policies on fugitive dust and outside painting. PSCAA requires that reasonable precautions be taken to prevent fugitive particulate material from becoming airborne when handling, loading, transporting, or storing particulate material. PSCAA defines what are reasonable precautions such as: the paving of parking lots and storage areas; housekeeping measures to minimize the accumulation of mud and dust and prevent its tracking onto public roads; and stabilizing storage piles with water spray, chemical stabilizers, tarps, or enclosure.

PSCAA requires that abrasive blasting and spray painting operations be performed inside a booth designed to capture the blast grit or overspray. Outdoor blasting or painting of structures or items too large to be handled indoors are to be enclosed with tarps.

Containers of solvents and coatings are to be kept closed. The *Compliance Guidelines* specify how spraying equipment is to be cleaned. It also requires an O&M plan for spray operations.

See *Compliance Guidance for Spray Coating Operations, PSCAA.*

PSCAA regulations may be viewed on the agency's website at: pscleanair.gov.

R.8 Requirements of Native American Tribes

Tribal staff review federal, state, and local permits for projects on tribal lands or projects on non-tribal lands that may affect treaty-reserved resources or areas. The Puyallup Indian Tribe has lands and continuing treaty interests in natural resources. Check with their Natural Resource or Environmental Divisions for more information on the treaty rights and the permit review role of the tribe.

Chapter 7. Quick Reference Phone Numbers and Websites

Environmental Protection Agency (U.S. EPA) – Region 10 800-424-4372

Pierce County:

- Surface Water Management 253-798-2725
- Flood line or Storm Drain Complaints 253-798-6000
- Sustainable Resources 253-798-2179
- Sewer Industrial Pretreatment Program 253-798-3013
- Environmental Education 253-798-2179
- Development Center – Permits 253-798-3739
- Weed Control/ Noxious Chemical Use 253-798-7263

Tacoma-Pierce County Health Department:

- On-Site Sewage (septic systems) 253-798-6470
- Hazardous Waste Section 253-798-6047
- Solid Waste 253-798-6047
- Hazardous Waste Line 800-287-6429
- Underground Storage Tanks 253-798-2855

Washington State Department of Agriculture 360-902-1800

Pierce County Conservation District 253-845-9770

Washington State Department of Ecology 360-407-6000

- Southwest Regional Office 360-407-6300
- Dangerous/Hazardous Waste 360-407-6700
- NPDES Stormwater or Wastewater Permits 360-407-6279
- Spill Reporting 800-424-8802
- Recycling 800-732-9253
- Groundwater Quality and Protection 360-407-6600
- Underground and Aboveground Storage Tanks 360-407-6000

Washington State University/Pierce County Cooperative Extension 253-798-7180

Industrial Materials Exchange 206-263-8465

Puyallup Tribe 253-573-7800

Puget Sound Clean Air Agency 206-343-8800

Underground Utility Locate “Call Before You Dig” 811

Washington State Departments:

Department of Ecology – Stormwater Home Page
www.ecy.wa.gov/programs/wq/stormwater/index.html

Department of Health: www.doh.wa.gov

Department of Fish and Wildlife: wdfw.wa.gov

Government Information and Services: www.access.wa.gov

Department of Ecology – Flood Information: www.ecy.wa.gov/programs/sea/floods

Department of Ecology – Digital Coastal Atlas: fortress.wa.gov/ecy/coastalatlas

Federal Departments:

Federal Emergency Management Agency (FEMA): fema.gov

FEMA Response to Endangered Species Act
www.fema.gov/national-flood-insurance-program-endangered-species-act

U.S. EPA Office of Water, Academy 2000: epa.gov/watertrain

U.S. Geological Survey (USGS) Departments:

USGS Historical Water Resource Data
<wa.water.usgs.gov/realtime/historical.html>

USGS National Water Information System (NWISWeb): water.usgs.gov/nwis

Water Quality and NPDES:

Natural Resources Conservation Service (NRCS) and U.S. Department of Agriculture (USDA)
<www.nrcs.usda.gov>

Washington Stormwater Center: www.wastormwatercenter.org

Center for Urban Waters: www.urbanwaters.org

Weather and Flood Information:

National Weather Service Seattle Office: water.weather.gov/ahps

National Climatic Data Center Data Archive: www.ncdc.noaa.gov

USGS Real Time Gauging Info: wa.water.usgs.gov/realtime/current.html

NWS River Forecast Center – Flood Outlook: www.nwrfc.noaa.gov/river/fop.cgi

NOAA Tide and Current Predictions:
https://tidesandcurrents.noaa.gov/noaacurrents/Stations?g=698

Pierce County:

Pierce County homepage: https://www.piercecountywa.gov/

Planning and Public Works Sustainable Resources - Recycling and Environmental Education
https://www.piercecountywa.gov/recycle

Public GIS (mapping): https://matterhornwab.co.pierce.wa.us/publicgis/

Pierce Conservation District: https://piercecd.org/

Tacoma-Pierce County Health Department: www.tpchd.org

Volume IV References

Campbell, Robert, Street Waste Characterization Testing Program, VTP1, Snohomish County Public Works Maintenance and Operations Division, March 1994.

Collins, Jay, Oregon Department of Transportation, Street Waste Issues and Options, FHWA ORRD9905, July 1998.

Ecology, Techniques for Dust Prevention and Suppression, publication #96-433, 1996.

Ecology, Dangerous Waste Regulations, Chapter 173303 WAC.

Ecology, Model Toxics Control Act (MTCA) Cleanup Regulations, Chapter 173340 WAC.

Ecology, Solid Waste Handling Standards, Chapter 173350 WAC.

Ecology, Water Quality Standards for Surface Waters of the State of Washington, Chapter 173201A.

Herrera Environmental Consultants, Inc., King County Maintenance Waste Disposal Characterization Study, prepared for King County Surface Water Management Division, January 1995 Draft.

Seattle Public Utilities and Herrera Environmental Consultants, Inc. Seattle Street Sweeping Pilot Study, 2009.

King County's Renton Facility Decant Data, Personal Correspondence with Jerry Creek, and Susan Turner, June 1999.

Landau Associates, Inc. Snohomish County Street Waste Characterization, Final Report, December 1995.

Sartor, J.D. and B.G. Boyd, Water Pollution Aspects of Street Surface Contaminants, EPA-R2-72-081, November 1972, P.7.

Serdar, Dave, Ecology, Contaminants in Vactor Truck Wastes, April 1993.

Sutherland, Roger, High Efficiency Sweeping as an Alternative to the Use of Wet Vaults for Stormwater Treatment, 1998.

Thurston County Environmental Health Division, (Environmental Health Division-Unpublished data), 1993.

Thurston County Environmental Health Division, Report on Street Facility Monitoring, Grant Tax No. 91129, April 1993.

W&H Pacific, Inc., Street and Street Sweeping Waste Characteristics Snohomish County, Washington, February 1994.

Appendix IV-A – Recycling/Disposal of Vehicle Fluids/Other Wastes*

	Recommended Management
Antifreeze	Store separately for resale. Separate ethylene glycol from propylene glycol for offsite recycling. If not recyclable, send to Treatment, Storage, and Disposal Facility (TSDF) for disposal.
Batteries	INTACT: Accumulate under cover prior to sale, deliver to recycler or, return to manufacturer. BROKEN: Accumulate acid from broken batteries in resistant containers with secondary containment. Send to TSDF for disposal.
Brake fluid	Accumulate in separate, marked, closed container. Do not mix with waste oil. Recycle.
Fuel	Store gasoline, and diesel separately for use or resale. Mixtures of diesel, gasoline, oil, and other fluids may not be recyclable and may require expensive disposal.
Fuel filters	Drain fluids for use as product. With approval of local landfill operator, dispose of in dumpster, if needed.
Oil filters	Puncture the filter dome and drain it for 24 hours. Put oil drained from filters into a "USED OIL ONLY" container. Keep drained filters in a separate container marked "USED OIL FILTERS ONLY." Locate a scrap metal dealer who will pick up and recycle filters. With approval of local landfill operator, dispose of drained filters to dumpster.
Paint	Accumulate oil-based and water-based paints separately for use or resale. If not recyclable, send accumulations to TSDF for disposal.
Power steering fluid	Same as for used oils.
Shop towels/oily rags	Use cloth towels that can be laundered and reused. Accumulate used shop towels in a closed container. Sign up with an industrial laundry service that can recycle towels.
Solvents	Consider using less hazardous solvents or switching to a spray cabinet that doesn't use solvent. Accumulate solvents separately. Consider purchasing a solvent still and recycling solvent on site. Do not mix with used oil. Do not evaporate as a means of disposal.
Transmission oil, differential and rear end fluids	Accumulate in a "USED OIL ONLY" container. Arrange for pickup for offsite recycling.
Used oils; including, crankcase oil, transmission oil, power steering fluid and differential/rear end oil	Keep used oil in a separate container marked "USED OIL ONLY." Do not mix with brake fluid, or used antifreeze. Do not mix with any other waste if burning for heating. Arrange for pickup for offsite recycling.
Windshield washer fluid	Accumulate separately for use or resale. Discharge to onsite sewage disposal, or, if acceptable by the Industrial Pretreatment Program ((253) 7983-013) discharge to sanitary sewer.

* Ecology's Hazardous Waste Program developed this information.

The Hazardous Waste Services Provider Directory is available online at https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Dangerous-waste-guidance/Dispose-recycle-or-treat/Hiring-a-contractor

Appendix IV-B – Example of an Integrated Pest Management Program

Integrated Pest Management is a natural, long-term, ecologically based systems approach to controlling pest populations. This system uses techniques either to reduce pest populations or maintain them at levels below those causing economic injury, or to manipulate the populations they are preventing from causing injury. The goals of Integrated Pest Management are to encourage optimal selective pesticide use (away from prophylactic, broad spectrum use), and to maximize natural controls to minimize the environmental side effects.

A step-by-step comprehensive Integrated Pest Management program is provided below as a guide.

Introduction

This section provides a sound cultural approach to managing lawns and landscapes and minimizing runoff. Many homeowners or property managers will be able to implement most or all of this approach, others will wish to hire these services out. For the do-it yourselfer, an array of resources are available to assist in the effort. Landscaping businesses, agricultural extensions, local agencies, master gardener programs, local nurseries, and the library can all provide assistance. Landscaping professionals (businesses) are particularly encouraged to practice integrated pest management.

Definition

Integrated Pest Management is an approach to pest control that uses regular monitoring to determine if and when treatments are needed, and employs physical, mechanical, cultural, and biological tactics to keep pest numbers low enough to prevent intolerable damage or annoyance. Least-toxic chemical controls are used as a last resort."

True Integrated Pest Management is a powerful approach that anticipates and prevents most problems through proper cultural practices and careful observation. Knowledge of the life cycles of the host plants and both beneficial and pest organisms is also important. The Integrated Pest Management section of this study guide is adapted from Least Toxic Pest Management for Lawns by Sheila Daar. Following the integrated pest management process gives you the information you need to minimize damage by weeds, diseases, and pests and to treat those problems with the least toxic approaches.

The Integrated Pest Management Process

Step One: Correctly identify problem pests and understand their life cycle.

Learn more about the pest. Observe it and pay attention to any damage that may be occurring. Learn about the life cycle. Many pests are only a problem during certain seasons, or can only be treated effectively in certain phases of the life cycle.

Step Two: Establish tolerance thresholds for pests.

Every landscape has a population of some pest insects, weeds, and diseases.

Beneficial organisms may compete with, eat, or parasitize disease or pest organisms. Decide on the level of infestation that must be exceeded before treatment needs to be considered. Pest

populations under this threshold should be monitored but do not need treatment. For instance, European crane flies usually do not do serious damage to a lawn unless there are between 25 to 40 larvae per square foot feeding on the turf in February (in normal weather years). Also, most people consider a lawn healthy and well maintained even with up to 20 percent weed cover, so treatment, other than continuing good maintenance practices, is generally unnecessary.

Step Three: Monitor to detect and prevent pest problems.

Regular monitoring is a key practice to anticipate and prevent major pest outbreaks. It begins with a visual evaluation of the lawn or landscape's condition. Take a few minutes before mowing to walk around and look for problems. Keep a notebook, record when and where a problem occurs, then monitor for it at about the same time in future years. Specific monitoring techniques can be used in the appropriate season for some potential problem pests, such as European crane fly.

Step Four: Modify the maintenance program to promote healthy plants and discourage pests.

Review your landscape maintenance practices to see if they can be modified to prevent or reduce the problem. A healthy landscape is resistant to most pest problems. Lawn aeration and overseeding along with proper mowing height, fertilization, and irrigation will help the grass/lawn-compete with weeds. Correcting drainage problems and letting soil dry out between waterings in the summer may reduce the number of crane-fly larvae that survive.

Step Five: If pests exceed the tolerance thresholds ...

Consider the most effective management options concurrent with reducing impacts to the environment. Use cultural, physical, mechanical, or biological controls first. If those prove insufficient, use the chemical controls described below that have the least non-target impact. When a pest outbreak strikes (or monitoring shows one is imminent), implement integrated pest management then consider control options that are the least toxic, or have the least non-target impact. Here are two examples of an integrated pest management approach:

1. **Red thread disease** is most likely under low nitrogen fertility conditions and most severe during slow growth conditions. Mow and bag the clippings to remove diseased blades. Fertilize lightly to help the grass recover, then begin grass-cycling and change to fall fertilization with a slow-release or natural-organic fertilizer to provide an even supply of nutrients. Chemical fungicides are not recommended because red thread cannot kill the lawn.
2. **Crane fly damage** is most prevalent on lawns that stay wet in the winter and are irrigated in the summer. Correct the winter drainage and/or allow the soil to dry between irrigation cycles; larvae are susceptible to drying out, these changes can reduce their numbers. It may also be possible to reduce crane fly larvae numbers by using a power de-thatcher on a cool, cloudy day when feeding is occurring close to the surface. Studies are being conducted using beneficial nematodes that parasitize the crane fly larvae; this type of treatment may eventually be a reasonable alternative.

Only after trying suitable non-chemical control methods, or determining that the pest outbreak is causing too much serious damage, should chemical controls be considered. Study to determine what products are available and choose a product that is the least toxic and has the least non-target impact. Refer to the operational BMPs for the use of pesticides below for guidelines on choosing, storing, and using lawn and garden chemicals.

Step Six: Evaluate and record the effectiveness of the control, and modify maintenance practices to support lawn or landscape recovery and prevent recurrence.

Keep records! Note when, where, and what symptoms occurred, or when monitoring revealed a potential pest problem. Note what controls were applied and when, and the effectiveness of the control. Monitor next year for the same problems. Review your landscape maintenance and cultural practices to see if they can be modified to prevent or reduce the problem.

A comprehensive Integrated Pest Management program should also include the proper use of pesticides as a last resort, and vegetation/fertilizer management to eliminate or minimize the contamination of stormwater.

Appendix IV-C – Recommendations for Management of Street Wastes

Introduction

This appendix addresses waste generated from stormwater maintenance activities such as street sweeping and the cleaning of catch basins and, to a limited extent, other stormwater conveyance and treatment facilities. Limited information is available on the characteristics of wastes from detention/retention ponds, bioswales, and similar stormwater treatment facilities. The recommendations provided here may be generally applicable to these facilities, with extra diligence given to waste characterization.

These recommendations do not constitute rules or regulations, but are suggestions for street waste handling, reuse, and disposal using current regulations and the present state of knowledge of street waste constituents. The recommendations address the liquid and solid wastes collected during routine maintenance of stormwater catch basins, detention/retention ponds, ditches and similar stormwater treatment and conveyance structures, and street and parking lot sweeping. In addition to these recommendations, end users and other authorities may have their own requirements for street waste reuse and handling.

"Street Wastes" include liquid and solid wastes collected during maintenance of stormwater catch basins and detention/retention ponds, ditches and similar stormwater treatment and conveyance structures, and solid wastes collected during street and parking lot sweeping.

"Street Wastes," as defined here, does not include solids and liquids from street washing using detergents, cleaning of electrical vaults, vehicle wash sediment traps, restaurant grease traps, industrial process waste, sanitary sewage, mixed process, or combined sewage/stormwater wastes. Wastes from oil/water separators at sites that load fuel are not included as street waste. Street waste also does not include flood debris, landslide debris, and chip seal gravel.

Street waste does not ordinarily classify as dangerous waste. The owner of the stormwater facility and/or collector of street waste is considered the waste generator and is responsible for determining whether the waste designates as dangerous waste. Sampling to date has shown that material from routine maintenance of streets and stormwater facilities does not classify as dangerous waste (see Table C.6 at the end of this appendix). However, it is possible that street waste from spill sites could classify as dangerous waste. Street waste from areas with exceptionally high average daily traffic counts may contain contaminants – such as heavy metals, total petroleum hydrocarbons (TPH), and carcinogenic polycyclic aromatic hydrocarbons (cPAH) – at levels that limit reuse options.

Contamination in Street Waste Solids

Street waste is solid waste. While street waste from normal street and highway maintenance is not dangerous waste, it is solid waste, as defined under The Solid Waste Management Act (Chapter 70.95 RCW) and under Solid Waste Handling Standards (Chapter 173-350 WAC). The Solid Waste Management Act gives local health departments primary jurisdiction over solid waste management. Street waste solids may contain contaminants at levels too high to allow unrestricted reuse. There are no specific references in the Solid Waste Handling Standards to facilities managing street waste solids, although these facilities will typically fit under the section dealing with Piles Used for Storage and Treatment (Section 320). There are no specific references for reuse and disposal options for street wastes in the Solid Waste Handling Standards because

they do not apply to clean soils. Clean soils are defined as 'soils and dredged material which are not dangerous wastes, contaminated soils, or contaminated dredged material...' (WAC 173350100). Whether or not a soil is a clean soil depends primarily upon the level of contaminants and, to a lesser degree, on the background level of contaminants at a particular location and the exposure potential to humans or other living organisms. Therefore, evaluate both the soil and potential land application sites to determine if a soil is a clean soil.

There is no simple regulatory mechanism available to classify street waste solids for uncontrolled reuse or disposal. Street wastes are not defined simply as solid waste. Local health districts have historically used the Model Toxics Control Act (MTCA) Cleanup Regulation Method A residential soil cleanup levels to approximate "clean" and to make decisions on land application proposals. The MTCA regulation is not intended to be directly applied to setting contaminant concentration levels for land application proposals. However, they may provide human health and environmental threat information and a useful framework for such decisions, when used in conjunction with other health and environmental considerations. In addition to MTCA, Ecological Soil Screening Levels from EPA, ODEQ Risk-based concentrations, Toxicological benchmarks from Oak Ridge National Labs, and natural background levels can be considered. Contact the Tacoma-Pierce County Health Department to determine local requirements for making this determination.

Using the old MTCA regulations, many local health departments have set a criterion of 200 mg/kg Total Petroleum Hydrocarbons (TPH) for diesel and heavy fuel oils as a threshold level for clean soil. Using the new MTCA terrestrial ecological evaluation procedures, allowable TPH levels for land application could range from 200 to 460, depending on site characteristics and intended land use. Street waste sampling has historically yielded TPH values higher than 200 mg/kg for hydrocarbons in the diesel and heavy oil range. These values typically reflect interference from natural organic material and, to a lesser extent, relatively immobile petroleum hydrocarbons. The mobile hydrocarbons that are of concern for groundwater protection are generally not retained with street waste solids. Ecology's Manchester Lab has developed an analytical method to reduce the problem of natural organic material being included in the TPH analysis for diesel and heavier range hydrocarbons. This method, called NWTPH-Dx, reduces the background interference associated with vegetative matter by as much as 85 percent to 95 percent. However, even with the new methodology, TPH test results for street waste may still be biased by the presence of natural vegetative material and may still exceed 200 mg/kg. Where the laboratory results report no 'fingerprint' or chromatographic match to known petroleum hydrocarbons, the soils should not be considered to be petroleum contaminated soils. Table C.1 at the end of this appendix lists typical TPH levels in street sweeping and catch basin solids.

Street waste solids frequently contain levels of carcinogenic PAHs (cPAH) that make unrestricted use inappropriate. This is complicated further by analytical interference caused by organic matter that raises practical quantitation or reporting limits. To greatly reduce the level of interference, the use of U.S. EPA Test Method 8270, incorporating the silica gel cleanup step, is recommended. The calculated cPAH value can vary greatly depending upon how non-detect values are handled. The new MTCA Method A criterion for cPAH is 0.1 mg/kg (the sum of all seven cPAH parameters multiplied by the appropriate toxicity equivalency factor) for unrestricted land uses. The MTCA criteria for soil cleanup levels for industrial properties is 2.0 mg/kg. Following this guidance, most sites where street wastes could be reused as soil will be commercial or industrial sites, or sites where public exposure will be limited or prevented. See Table C.2 at the end of this appendix for typical c-PAH values in Street Waste Solids and Related Materials. See Table C.3 for typical metals concentrations in Catch Basin Sediments.

Permitting of street waste treatment and storage facilities as solid waste handling facilities by the Tacoma-Pierce County Health Department is required. Under the Solid Waste Management Act, local health departments have primary jurisdiction over solid waste management.

Street waste handling facilities are subject to the requirements of the Solid Waste Handling Standards. Specific requirements depend upon the manner in which the waste is managed. Most facilities are permitted under the section dealing with Piles Used for Storage and Treatment (Section 320).

For most facilities, permit requirements include a plan of operation, sampling, record keeping and reporting, inspections, and compliance with other state and local requirements. The plan of operation should include a procedure for characterization of the waste and appropriate reuse and disposal options, consistent with the recommendations in this document and applicable federal, State, and local requirements.

Ecology suggests a street waste site evaluation (see sample at end of this appendix) for all street waste as a method to identify spill sites or locations that are more polluted than normal. Ecology based the disposal and reuse options listed below on characteristics of routine street waste and are not appropriate for more polluted wastes. The collector of street waste should evaluate it for its potential to be classified as dangerous waste. The collector should also be aware that this waste may not meet end user requirements.

Street waste suspected to be dangerous waste should not be collected with other street waste. Material in catch basins with obvious contamination (unusual color, staining, corrosion, unusual odors, fumes, or oily sheen) should be left in place or segregated until tested. Base testing activities on probable contaminants. Street waste that is suspected to be dangerous waste should be collected and handled by someone experienced in handling dangerous waste. If collecting potential dangerous waste because of emergency conditions, or if the waste becomes suspect after it is collected, it should be handled and stored separately until a determination as to proper disposal is made. Street waste treatment and storage facilities should have separate "hot load" storage areas for such waste. **Dangerous Waste i**ncludes street waste known and suspected to be dangerous waste. This waste must be handled following the Dangerous Waste Regulations (Chapter 173303 WAC) unless testing determines it is not dangerous waste.

Spills should be handled by trained specialists. Public works maintenance crews and private operators conducting street sweeping or cleaning catch basins should have written policies and procedures for dealing with spills or suspected spill materials. Emergency Spill Response telephone numbers should be immediately available as part of these operating policies and procedures.

The end recipient of street waste must be informed of its source and may have additional requirements for its use or testing that are not listed here. This document is based primarily on average street waste's chemical constituents and their potential effect on human health and the environment. There are physical constituents (for example, broken glass or hypodermic needles) or characteristics (for example, fine grain size) that could also limit reuse options. Additional treatment such as drying, sorting, or screening may also be required, depending on the needs and requirements of the end user.

Street waste treatment and storage facilities owned or operated by governmental agencies should be made available to private waste collectors and other governmental agencies on a cost recovery basis. Proper street waste collection and disposal reduces the amount of waste

released to the environment. The operators of street waste facilities should restrict the use of their facilities to certified and/or licensed waste collectors who meet their training and liability requirements.

The use of street waste solids under this guidance should not lead to designation as a dangerous waste site, requiring cleanup under MTCA. Exceeding MTCA Method A unrestricted land use cleanup levels in street waste and products made from street waste does not automatically make the site where street waste is reused a cleanup site. A site is reportable only if "a release poses a threat to human health or the environment" (Model Toxic Control Act). The reuse options proposed below are designed to meet the condition of not posing a threat to human health or the environment.

Testing of street waste solids will generally be required as part of a plan of operation that includes procedures for characterization of the waste. Testing frequency, numbers of samples, parameters to be analyzed, and contaminant limit criteria should all be provided as part of an approved plan of operation. However, street sweepings that consist primarily of leaves, pine needles, branches, and grass clippings do not require testing. Tables C.4 and C.5 at the end of this appendix provide some recommended parameters and sampling frequencies for street waste solids from routine street maintenance. These are provided as guidance only, and are intended to assist the county and the Tacoma-Pierce County Health Department in determining appropriate requirements. Sampling requirements may be modified over time, based on accumulated data. When the material is from a street waste facility or an area that has never been characterized by testing, the test should be conducted on a representative sample before co-mingling with other material. Testing in these instances would be to demonstrate that the waste does not designate as dangerous waste and to characterize the waste for reuse. At a minimum, the parameters in Table C.4 are recommended for these cases. Note that it will generally not be necessary to conduct TCLP analyses when the observed values do not exceed the recommended values in Table C.4. Table C.6 illustrates some observed relationships between total metals and TCLP metals values.

For further information on testing methods and sampling plans, refer to:

- SW 846 (U.S. EPA, Office of Solid Waste, Test Methods for Evaluating Solid Wastes, 3rd Edition); and
- Standard Methods for the Examination of Water and Wastewater (American Public Health Association, et al., 18th Edition, 1992).

For street waste not exceeding the suggested maximum values in Table C.4, the following street waste solids reuse and disposal options are recommended:

- Compost street sweepings that consist primarily of leaves, pine needles and branches, and grass cuttings from mowing grassy swales. Remove litter and other foreign material prior to composting or the composting facility must provide for such removal as part of the process. Dispose of the screened trash as solid waste at an appropriate solid waste handling facility.
- It is possible to reuse coarse sand screened from street sweeping after recent road sanding, providing there is no obvious contamination from spills. The screened trash is solid waste and must be disposed of at an appropriate solid waste handling facility.
- Screen roadside ditch cleanings, not contaminated by a spill or other release and not associated with a stormwater treatment system such as a bioswale, to remove litter and separate into soil and vegetative matter (leaves, grass, needles, branches, etc.). The soils

from these activities are typically unregulated as solid waste. Ditching material that may be contaminated must be stored, tested, and handled in the same manner as other street waste solids. It is the generator's responsibility to visually inspect and otherwise determine whether the materials may be contaminated.

- Construction street waste – solids collected from sweeping or in stormwater treatment systems at active construction sites – may be placed back onto the site that generated it, or managed by one of the methods listed below, provided that it has not been contaminated as a result of a spill. For concrete handling at construction sites, refer to BMPs C151 and C154 in Volume II.
- Use screened street waste soils as feedstock materials for topsoil operations. Reserve this option for street waste soils with very low levels of contaminants. Evaluate the allowable level of contaminants based on the proposed use of the soil. At a minimum, the contaminate level in the soil should be below established action levels for in situ soils. Do not dilute street waste soils with clean soils or composted material as a substitute for treatment or disposal. There may be unscreened physical contaminants (for example, glass, metal, nails, etc.) in street waste. Where present, these contaminants in street waste could preclude its use as feedstock material for topsoil operations.
- Fill in parks, play fields, golf courses, and other recreational settings, where direct exposure by the public is limited or prevented. One way to accomplish is to cover the fill with sod, grass, or other capping material to reduce the risk of soil being ingested. The level of contaminants in the street waste must be evaluated to ensure that the soils meet the definition of clean soils when used in this manner.
- Fill in commercial and industrial areas, including soil or top dressing for use at industrial sites, roadway medians, airport infields, and similar sites where there is limited direct human contact with the soil, and stabilize the soils with vegetation or other means. Evaluate the level of contaminants in the street waste to ensure that the soils meet the definition of clean soils when used in this manner.
- Top dressing on roadway slopes, road or parking lot construction material, road or parking lot subgrade, or other road fill. Evaluate the level of contaminants in the street waste to ensure that the soils meet the definition of clean soils when used in this manner.
- Daily cover or fill in a permitted municipal solid waste landfill, provided the street waste solids have been dewatered. Street waste solids may be acceptable as final cover during a landfill closure. Consult the Tacoma-Pierce County Health Department and landfill operator to determine conditions of acceptance.
- Treatment at a permitted contaminated soil treatment facility.
- Recycling through incorporation into a manufactured product, such as Portland cement, prefabricated concrete, or asphalt. Consult the facility operator to determine conditions of acceptance.
- Other end-use as approved by the Tacoma-Pierce County Health Department.
- Disposal at an appropriate solid waste handling facility.

For street waste that exceeds the suggested maximum values in Table C.4, the following street waste solids reuse and disposal options are recommended:

- Treatment at a permitted contaminated soil treatment facility.
- Recycling through incorporation into a manufactured product, such as Portland cement, prefabricated concrete, or asphalt. Consult the facility operator to determine conditions of acceptance.
- Other end-use as approved by the Tacoma-Pierce County Health Department.
- Disposal at an appropriate solid waste handling facility.

Street Waste Liquids

General Procedures:

Street waste collection should emphasize retention of solids in preference to liquids. Street waste solids are the principal objective in street waste collection and are substantially easier to store and treat than liquids.

Street waste liquids require treatment before their discharge. Street waste liquids usually contain high amounts of suspended and total solids and adsorbed metals. Treatment requirements depend on the discharge location.

The Industrial Pretreatment Program responsible for O&M of the system must approve discharges to sanitary sewer and storm drain systems. Ecology will not generally require waste discharge permits for discharge of stormwater decant to sanitary sewers or to stormwater treatment BMPs constructed and maintained in accordance with Ecology's *Stormwater Management Manual for Western Washington* (see Volume V for further detail).

Follow the following required order of preference for disposal of catch basin decant liquid and water removed from stormwater treatment facilities.

1. **Discharge of catch basin decant liquids to the municipal sanitary sewer is the preferred disposal option.** Discharge to a municipal sanitary sewer requires the approval of the Industrial Pretreatment Program at (253) 7983-013. Approvals for discharge to a municipal sanitary sewer will likely contain pretreatment quantity, and location conditions to protect the municipal system. Following the Industrial Pretreatment Program's conditions is a permit requirement.
2. **Discharge of catch basin decant liquids may be allowed into a basic or enhanced stormwater treatment BMP, if option 1 is not available.** Only discharge liquid collected from cleaning catch basins and stormwater treatment wet vaults back into the storm drain system under the following conditions:
    - The preferred disposal option of discharge to sanitary sewer is not reasonably available.
    - The discharge is to a basic or enhanced stormwater treatment facility (see Volume V). If pretreatment does not remove visible sheen from oils, the treatment facility must be able to prevent the discharge of oils causing a visible sheen.
    - The discharge is as near to the treatment facility as is practical, to minimize contamination or recontamination of the collection system.
    - The storm drain system owner/operator has granted approval and has determined

that the treatment facility will accommodate the increased loading. Part of the approval process may include pretreatment conditions to protect the treatment BMP. Following local pretreatment conditions is a permit requirement.

- Ecology must approve in advance flocculants for the pretreatment of catch basin decant liquids. The liquids must be non-toxic under the circumstances of use.

The discharger shall determine if reasonable availability of sanitary sewer discharge exists, by evaluating such factors as distance, time of travel, load restrictions, and capacity of the stormwater treatment facility.

3. Operators may return water removed from stormwater ponds, vaults, and oversized catch basins to the storm drain system. Stormwater ponds, vaults, and oversized catch basins contain substantial amounts of liquid, which hampers the collection of solids and poses problems in hauling the removed waste away from the site. Water removed from these facilities may be discharged back into the pond, vault, or catch basin provided:

- Operators may discharge clear water removed from a stormwater treatment structure directly to a down gradient cell of a treatment pond or into the storm drain system.
- Turbid water may be discharged back into the structure it was removed from if:
  - The removed water has been stored in a clean container (eductor truck, Baker tank, or other appropriate container used specifically for handling stormwater or clean water); and
  - There will be no discharge from the treatment structure for at least 24 hours.
- The storm drain system owner/operator must approve the discharge.

Site Evaluation

Ecology suggests use of a site evaluation as a method to identify spill sites or locations that potentially contain dangerous wastes.

The site evaluation will aid in determining if waste is a dangerous waste and in determining what to test for if dangerous waste is suspected. The site evaluation will also help to determine if the waste does not meet the requirements of the end users.

There are three steps to a site evaluation:

1. A **historical review** of the site for spills, previous contamination, and nearby toxic cleanup sites and dangerous waste and materials.

   The historical review will be easier if done on an area wide basis prior to scheduling any waste collection. The historical review should be more thorough for operators who never collected waste at a site before. At a minimum, the historical review should include operator knowledge of the area's collection history or records kept from previous waste collections.

   Private operators should ask the owner of the site for records of previous contamination and the timing of the most recent cleaning. Ecology's Hazardous Substance Information Office maintains a Toxic Release Inventory and a "Facility Site" webpage, tracking more than 15,000 sites. This information is available from Ecology at https://ecology.wa.gov/Research-Data/Data-resources/Toxics-Release-Inventory or by calling a toll-free telephone number (1-800-633-7585). The webpage allows anyone with Internet access to search for facility information by address, facility name, town, zip code, and SIC code, etc. It lists why Ecology is tracking each one (NPDES, TSCA, RCRA, Clean Air Act, etc.), as well as who to call within

Ecology to find out more about the given facility. EPA's toxic release website is https://www.epa.gov/toxics-release-inventory-tri-program.

2. An **area visual inspection** for potential contaminant sources such as a past fire, leaking tanks and electrical transformers, and surface stains.

   Evaluate the area around the site for contaminant sources prior to collection of the waste. The area visual inspection may be done either as part of multiple or as single site inspections. If the inspection finds a potential contaminant source, delay the waste collection until the potential contaminant is assessed.

   A second portion of the area visual inspection is a subjective good housekeeping evaluation of the area. Locations with poor housekeeping commonly cut corners in less obvious places. Inspect these sites in greater detail for illegal dumping and other contamination spreading practices.

3. **A waste and container inspection** before and during collection.

   The inspection of the waste and catch basin or vault is the last and perhaps most critical step in the site evaluation.

   For example, if the stormwater facility has an unusual color in or around it, then there is a strong possibility that someone dumped something into it. Some colors to be particularly wary of are yellowgreen from antifreeze dumping and black and/or rainbow sheen from oil and/or grease dumping. In addition, if the inspector observes any staining or corrosion, then a solvent may have been dumped.

   Fumes are also good indicators of potential dangerous waste. Avoid deliberate smelling of catch basins for worker safety, but suspicious odors may be encountered from catch basins thought to be safe. Some suspicious odors are rotten eggs (hydrogen sulfide is present), gasoline or diesel fumes, or solvent odors. If unusual odors are noted, contact a dangerous waste inspector before cleaning the basin.

   Finally, operator experience is the best guide to avoid collection of contaminated waste.

Table C.1. - Typical TPH Levels in Street Sweeping and Catch Basin Solids.

Reference	Street Sweeping (mg/kg)	Catch Basin Solid (mg/kg)
Snohomish County (1) (Landau 1995)	390 – 4,300	
King County (1) (Herrera 1995)		123 – 11,049 (Median 1,036)
Snohomish County and Selected Cities (1) (W & H Pacific, 1993)	163 – 1,500 (Median 760)	163 – 1,562 (Median 760)
City of Portland (2) (Bresch)		MDL – 1,830 (Median 208)
City of Seattle – Diesel Range(2) (Herrera 2009)	330-520	780-1700
City of Seattle – Motor Oil(2) (Herrera 2009)	2000-2800	3500-7000
Oregon (1) (Collins; ODOT 1998) Oregon (3) (Collins; ODOT 1998)	1,600 – 2,380 98 – 125	

(1) Method WTPH 418.1; does not incorporate new methods to reduce background interference due to vegetative material

(2) Method NWTPH-Dx.

(3) Method WTPH – HCID.

Table C.2. - Typical c-PAH Values in Street Waste Solids and Related Materials.

Sample Source	City of Everett					WSDOT	
Analyte	Street Sweepings	Soil	3-Way Topsoil	Vactor Solids	Leaf & Sand	Sweepings Fresh	Sweepings Weathered
Benzo(a)anthracene	0.1U	0.076U	0.074U	0.21	0.45	0.56	0.40
Chrysene	0.14	0.09	0.074U	0.32	0.53	0.35	0.35
Benzo(b)fluoranthene	0.11	0.076U	0.074U	0.27	0.52	0.43	0.51
Benzo(k)fluoranthene	0.13	0.076U	0.074U	0.25	0.38	0.39	0.40
Benzo(a)pyrene	0.13	0.076U	0.074U	0.26	0.5	0.41	0.33U
Indeno(1,2,3-cd) pyrene	0.1U	0.076U	0.074U	0.19	0.39	NR	NR
Dibenzo(a,h) anthracene	0.1U	0.076U	0.074U	0.081	0.12	0.39	0.33U
Revised MTCA Benzo(a)pyrene [ND=PQL]	0.215	0.134	0.134	0.388	0.727	0.708	0.597
Benzo(a)pyrene [ND=½ PQL]	0.185	0.069	0.067	0.388	0.727	0.708	0.366
Benzo(a)pyrene [See * below]	0.185	0.069	0	0.388	0.727	0.708	0.366
Benzo(a)pyrene [ND=0]	0.155	0.001	0	0.388	0.727	0.708	0.135

*If the analyte was not detected for any PAH, then ND=0; If analyte was detected in at least 1 PAH, then ND=½PQL; If the average concentration (using ND=½ PQL) is greater than the maximum detected value, then ND=Maximum value.

The new Method A soil cleanup level for unrestricted land use is 0.1 mg/kg for BAP. (WAC 173-340-900, Table 7401).

The new Method A soil cleanup level for industrial properties is 2 mg/kg for BAP. (WAC 173-340-900, Table 7451).

Table C.3. - Typical Metals Concentrations in Catch Basin Sediments.

Parameter	Ecology 1993	Thurston 1993	King County 1995	King County 1995	City of Seattle 2003 through 2011
Metals; Total (mg/kg)	(Min – Max)	(Min – Max)	(Min – Max)	Mean	Min- Max (Mean)
Arsenic (As)	< 3 – 24	0.39 – 5.4	4 – 56	0.250	< 5 – 50 (9.3)
Cadmium (Cd)	0.5 – 2.0	<0.22 – 4.9	0.2 – 5.0	0.5	
Chromium (Cr)	19 – 241	5.9 – 71	13 – 100	25.8	
Copper (Cu)	18 – 560	25 – 110	12 – 730	29	9.1 – 3,280 (166)
Lead (Pb)	24 – 194	42 – 640	4 – 850	80	3 – 3,690 (154)
Nickel (Ni)	33 – 86	23 – 51	14 – 41	23	
Zinc (Zn)	90 – 558	97 – 580	50 – 2,000	130	44 – 4,170 (479)
Mercury (Hg)	0.04 – 0.16	0.024 – 0.193			< 0.03 – 3.8 (0.16)

Table C.4. - Recommended Parameters and Suggested Values for Determining Reuse and Disposal Options.

Parameter	Suggested Maximum Value
Arsenic (As), Total	20.0 mg/kg (a)
Cadmium (Cd), Total	2.0 mg/kg (b)
Chromium (Cr), Total	42 mg/kg (c)
Copper (Cu), Total	100 mg/kg (d)
Lead (Pb), total	250 mg/kg (e)
Nickel (Ni)	100 mg/kg (d)
Zinc (Zn)	270 mg/kg (d)
Mercury (Hg), Inorganic	2.0 mg/kg (f)
PAHs (Carcinogenic)	0.1 – 2.0 mg/kg (see Note at (g) below)
TPH (Heavy Fuel Oil)	2,000 mg/kg (see Note at (h) below)
TPH (Diesel)	200 mg/kg (see Note at (j) below)
TPH (Gasoline)	100 mg/kg (j)
Benzene	0.03 mg/kg (j)
Ethylbenzene	6 mg/kg (j)
Toluene	7 mg/kg (j)
Xylenes (Total)	9 mg/kg (j)

(a) Arsenic: from MTCA Method A – Table 740-1: Soil cleanup levels for unrestricted land uses

(b) Cadmium: from MTCA Method A – Table 740-1: Soil cleanup levels for unrestricted land uses.

(c) Chromium; from MTCA Method A – Table 740-1: Soil cleanup levels for unrestricted land uses

(d) Copper, Nickel, and Zinc; from MTCA Table 749-2: Protection of Terrestrial Plants and Animals

(e) Lead; from MTCA Method A – Table 740-1: Soil cleanup levels for unrestricted land uses

(f) Mercury; from MTCA Method A – Table 740-1: Soil cleanup levels for unrestricted land uses

(g) PAH-Carcinogenic; from MTCA Method A – Table 740-1: Soil cleanup levels for unrestricted land uses and

Table 745-1, industrial properties, based on cancer risk via direct contact with contaminated soil (ingestion of soil) in residential land use situations and commercial/industrial land uses. Note: The Tacoma-Pierce County Health Department may permit higher levels as part of a Plan of Operation, where they determine that the proposed end use poses little risk of direct human contact or ingestion of soil.

(h) TPH (Heavy Fuel Oil); from MTCA Method A – Table 740-1: Soil cleanup levels for unrestricted land uses

(i) TPH (Diesel): from MTCA Table 749-3: Protection of Terrestrial Plants and Animals..

(j) BETX; from MTCA Method A – Table 740-1: Soil cleanup levels for unrestricted land uses.

Table C.5. - Recommended Sampling Frequency for Street Waste Solids.

Cubic Yards of Solids	Minimum Number of Samples
0 – 100	3
101 – 500	5
501 – 1,000	7
1,001 – 2,000	10
>2,000	10 + 1 for each additional 500 cubic yards

Modified from Ecology's Interim Compost Guidelines (no longer in effect)

Table C.6. - Pollutants in Catch Basin Solids – Comparison to Dangerous Waste Criteria.

Parameter	Range of Values in Catch Basin Waste	Range of Values in Catch Basin Waste	Dangerous Waste Criteria
Metals	Total Metals (mg/kg)	TCLP Metals (mg/kg)	TCLP values (mg/l)
Arsenic	< 3 – 56	< 0.02 – 0 .5	5.0
Cadmium	< 0.22 – 5	0.0002 – 0.03	1.0
Chromium	5.9 – 241	0.0025 – 0.1	5.0
Copper	12 – 730	0.002 – 0.88	none
Lead	4 – 850	0.015 – 3.8	5.0
Nickel	23 – 86	< 0.01 – 0.36	none
Zinc	50 – 2,000	0.04 – 6.7	none
Mercury	0.02 – 0.19	0.0001 – 0.0002	0.2

Data from Thurston County (Thurston County 1993), King County (Herrera 1995) and Ecology (Serdar; Ecology 1993).

Table C.7. - Typical Catch Basin Decant Values Compared to Surface Water Quality Criteria.

Parameter	State Surface Water Quality Criteria		Range of Values Reported	Range of Values Reported
Metals	Freshwater Acute (ug/l – dissolved metals)	Freshwater Chronic (ug/l – dissolved metals)	Total Metals (ug/l)	Dissolved Metals (ug/l)
Arsenic	360	190	100 – 43,000	60 – 100
Cadmium*	2.73	0.84	64 – 2,400	2 – 5
Chromium (total)			13 – 90,000	3 – 6
Chromium (III)*	435	141		
Chromium (VI)	0.5	10		
Copper*	13.04	8.92	81 – 200,000	3 – 66
Lead*	47.3	1.85	255 – 230,000	1 – 50
Nickel*	1114	124	40 – 330	20 – 80
Zinc*	90.1	82.3	401 – 440,000	1,900 – 61,000
Mercury	2.10	0.012	0.5 – 21.9	

*Hardness dependent; hardness assumed to be 75 mg/l

Table C.8. - Typical Values for Conventional Pollutants in Catch Basin Decant.

Parameter (values as mg/l; except where stated)	Ecology 1993 Mean	(Min – Max)	King County 1995 Mean	(Min – Max)
PH	6.94	6.18 – 7.98	8	6.18 – 11.25
Conductivity (umhos/cm)	364	184 – 1110	480	129 – 10,100
Hardness (mg/l CaCO3)	234	73 – 762		
Fecal Coliform (MPN/100 ml)	3,000			
BOD	151	28 – 1,250		
COD	900	120 – 26,900		
Oil and Grease	11	7.0 – 40	471	15 – 6,242
TOC	136	49 – 7,880	3,670	203 – 30,185
Total Solids	1,930	586 – 70,400		
Total Dissolved Solids	212	95 – 550		
Total Suspended Solids	2,960	265 – 111,000		
Settleable Solids (ml/l/hr)	27	2 – 234	57	1 – 740
Turbidity (ntu)	1,000	55 – 52,000	4,673	43 – 78,000

Table C.9. - Catch Basin Decant Values Following Settling.

Parameter: Total Metals in mg/l	Portland – Inverness Site Min – Max	King County – Renton Min – Max	METRO Pretreatment Discharge Limits
Arsenic	0.0027 – 0.015	< MDL – 0.12	4
Cadmium	0.0009 – 0.0150	< MDL – 0.11	0.6
Chromium	0.0046 – 0.0980	0.017 – 0.189	5
Copper	0.015 – 0.8600	0.0501 – 0.408	8
Lead	0.050 – 6.60	0.152 – 2.83	4
Nickel	0.0052 – 0.10	0.056 – 0.187	5
Silver	0.0003 – 0.010	< MDL	3
Zinc	0.130 – 1.90	0.152 – 3.10	10
Settleable Solids; ml/L	No Data	0.02 – 2	7
Nonpolar fat, oil and grease	5.7 – 25	5 – 22	100
Ph (std)	6.1 – 7.2	6.74 – 8.26	5.0 – 12.0
Total Suspended Solids	2.8 – 1,310		
Recorded Total Monthly Flow; Gallons	Data not available	31,850 – 111,050	
Recorded Max. Daily Flow; Gallons	Data not available	4,500 – 18,600	25,000 GPD
Calculated Average Daily Flow; GPD	Data not available	1,517 – 5,428	

* Data from King County's Renton Facility (data from 1998 – 199) and the City of Portland's Inverness Site (data from 1999 – 2001); detention times not provided

Pierce County Stormwater Management and Site Development Manual

Volume V
Runoff Treatment BMPs

Prepared by: Pierce County Planning and Public Works

Ordinance No. 2021-45

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Table of Contents

Volume V Runoff Treatment BMPs

Chapter 1. Introduction **1-1**

1.1 Purpose of This Volume **1-1**

1.2 Content and Organization of This Volume **1-1**

1.3 How to Use This Volume **1-1**

1.4 Runoff Treatment Facilities **1-1**

1.4.1 General Considerations 1-1

1.4.2 Operations and Maintenance 1-2

1.4.3 Treatment Methods 1-2

Chapter 2. Treatment Facility Selection Process **2-1**

2.1 Step-by-Step Selection Process for Treatment Facilities **2-1**

2.1.1 Step 1: Determine the Receiving Waters and Pollutants of Concern Based on Offsite Analysis 2-1

2.2 Other Treatment Facility Selection Factors **2-8**

2.2.1 Soil Type 2-8

2.2.2 High Sediment Input 2-8

2.2.3 Other Physical Factors 2-8

Chapter 3. Treatment Facility Menus **3-1**

3.1 Guide to Applying Menus **3-1**

3.2 Oil Control Menu **3-1**

3.3 Phosphorus Treatment Menu **3-3**

3.4 Enhanced Treatment Menu **3-4**

3.5 Basic Treatment Menu **3-5**

Chapter 4. General Requirements for Stormwater Treatment Facilities **4-7**

4.1 Design Volume and Flow **4-7**

4.1.1 Water Quality Design Storm Volume 4-7

4.1.2 Water Quality Design Flow Rate 4-7

4.1.3 Flows Requiring Treatment 4-7

4.2 Sequence of Facilities **4-9**

4.3 Facility Liners **4-9**

4.3.1 General Design Criteria 4-10

4.3.2 Treatment Liner Design Criteria 4-11

4.3.3 Low Permeability Liner Design Criteria 4-12

Chapter 5. Pretreatment **5-1**
5.1 Purpose **5-1**
5.2 Applications **5-1**
5.3 Best Management Practices for Pretreatment **5-1**
5.3.1 Presettling Basin (Ecology BMP T6.10) 5-1
Chapter 6. Infiltration and Bioretention Treatment Facilities **6-1**
6.1 Purpose **6-1**
6.2 Applications and Limitations **6-1**
6.3 Soil Requirements for Infiltration for Water Quality Treatment **6-2**
6.4 Best Management Practices for Infiltration and Bioretention Treatment **6-3**
6.4.1 Infiltration Basins (Ecology BMP T7.10) 6-3
6.4.2 Infiltration Trenches (Ecology BMP T7.20) 6-3
6.4.3 Bioretention Cells, Swales, and Planter Boxes (Ecology BMP T7.30) 6-3
6.4.4 Compost-amended Vegetated Filter Strips (CAVFS) (Ecology BMP T7.40) 6-3
Chapter 7. Filtration Treatment Facilities **7-1**
7.1 Purpose **7-1**
7.2 Description **7-1**
7.3 Performance Objectives **7-11**
7.4 Applications and Limitations **7-11**
7.5 Site Suitability **7-11**
7.6 Design Requirements **7-12**
7.6.1 Sand Filter Sizing Procedure 7-12
7.7 Construction Criteria **7-13**
7.8 Best Management Practices for Sand Filtration **7-14**
7.8.1 Sand Filter Basin (Ecology BMP T8.10) 7-14
7.8.2 Sand Filter Vault (Ecology BMP T8.20) 7-17
7.8.3 Linear Sand Filter (Ecology BMP T8.30) 7-18
7.8.4 Media Filter Drain (previously referred to as Ecology Embankment) (Ecology BMP T8.40) 7-19
Chapter 8. Biofiltration Treatment Facilities **8-1**
8.1 Purpose **8-1**
8.2 Applications **8-1**
8.3 Site Suitability **8-1**
8.4 Best Management Practices **8-1**

8.4.1 Basic Biofiltration Swale (Ecology BMP T9.10) 8-1
8.4.2 Wet Biofiltration Swale (Ecology BMP T9.20) 8-19
8.4.3 Continuous Inflow Biofiltration Swale (Ecology BMP T9.30) 8-21
8.4.4 Basic Filter Strip (Ecology BMP T9.40) 8-22
Chapter 9. Wet Pool Facilities 9-1
9.1 Purpose 9-1
9.2 Applications 9-1
9.3 Best Management Practices for Wet Pool Facilities 9-1
9.3.1 Wet Ponds – Basic and Large (Ecology BMP T10.10) 9-1
9.3.2 Wet Vaults (Ecology BMP T10.20) 9-9
9.3.3 Stormwater Treatment Wetlands (Ecology BMP T10.30) 9-14
9.3.4 Combined Detention and Wet Pool Facilities (Ecology BMP T10.40) 9-19
Chapter 10. Oil and Water Separators 10-1
10.1 Purpose 10-1
10.2 Description 10-1
10.3 Performance Objectives 10-1
10.4 Site Suitability 10-1
10.5 Design Criteria – General Considerations 10-4
10.5.1 Criteria for Separator Bays 10-5
10.5.2 Criteria for Baffles 10-5
10.6 Oil and Water Separator BMPs 10-5
10.6.1 API (Baffle type) Separator Bay (Ecology BMP T11.10) 10-5
10.6.2 Coalescing Plate (CP) Separator Bay (Ecology BMP T11.11) 10-7
Chapter 11. Emerging Technologies 11-1
11.1 Background 11-1
11.2 Evaluation of Emerging Technologies 11-1
11.3 Applicability and Restrictions 11-1
Volume V References Ref-1
Appendix V-A – Geotextile Specifications A-1

List of Tables

Table 3.1. - Treatment Trains for Phosphorus Removal. 3-4
Table 3.2. - Treatment Trains for Dissolved Metals Removal. 3-5
Table 4.1. - Treatment Facility Placement in Relation to Detention. 4-10
Table 4.2. - Lining Types Required for Runoff Treatment Facilities. 4-11
Table 4.3. - Compacted Till Liners. 4-12
Table 7.1. - Sand Filter Design Parameters. 7-13
Table 7.2. - Sand Filter Design and Sizing Criteria. 7-14
Table 7.3. - Sand Medium Specification. 7-16
Table 7.4. - Clay Liner Specifications. 7-17
Table 7.5. - Western Washington Design Widths for Media Filter Drains. 7-26
Table 7.6. - Media Filter Drain Mix. 7-31
Table 8.1. - Sizing Criteria. 8-3
Table 8.2. - Guide for Selecting Degree of Retardance. 8-12
Table 8.3. - Grass Seed Mixes Suitable for Biofiltration Swale Treatment Areas. 8-18
Table 8.4. - Groundcovers and Grasses Suitable for the Upper Side Slopes of a Biofiltration Swale in Western Washington. 8-18
Table 8.5. - Recommended Plants for Wet Biofiltration Swale. 8-18
Table 9.1. - Emergent Wetland Plant Species Recommended for Wet Ponds. 9-8
Table 9.2. - Distribution of Depths in Wetland Cell. 9-17
Table A.1. - Geotextile Property Requirements for Underground Drainage. A-1
Table A.2. - Geotextile Property Requirements for Underground Drainage Filtration. A-1
Table A.3. - Geotextile Strength Property Requirements for Impermeable Liner Protection. A-2

Table of Figures

Figure 2.1. - Treatment Facility Selection Flow Chart. 2-2
Figure 6.1. - Example of a Compost Amended Vegetated Filter Strip (CAVFS). 6-4
Figure 7.1a. - Sand Filter Basin with Pretreatment Cell. 7-2
Figure 7.1b. - Sand Filter Basin with Pretreatment Cell (continued). 7-3
Figure 7.2a. - Sand Filter Basin with Level Spreader. 7-4
Figure 7.2b. - Sand Filter Basin with Level Spreader (continued). 7-5
Figure 7.3a. - Flow Splitter Option A. 7-6
Figure 7.3b. - Flow Splitter Option B. 7-7
Figure 7.4a. - Sand Filter Vault. 7-8
Figure 7.4b. - Sand Filter Vault (continued). 7-9
Figure 7.5. - Linear Sand Filter. 7-10
Figure 7.6. - Media Filter Drain: Cross Section. 7-21
Figure 7.7. - Dual Media Filter Drain: Cross Section. 7-22
Figure 7.8. - Media Filter Drain Without Underdrain Trench. 7-23
Figure 7.9. - Media Filter Drain Underdrain Installation. 7-30
Figure 8.1. - Biofiltration Swale Access Features. 8-4
Figure 8.2. - Biofiltration Swale Underdrain Detail. 8-5
Figure 8.3. - Biofiltration Swale Low-Flow Drain Detail. 8-5
Figure 8.4. - Swale Dividing Berm. 8-6
Figure 8.5. - Geometric Formulas for Common Swale Shapes. 8-9
Figure 8.6a. - Ratio of SBUH Peak/Water Quality Flow. 8-10
Figure 8.6b. - Ratio of SBUH Peak/Water Quality Flow. 8-10
Figure 8.7. - The Relationship of Manning's n with VR for Various Degrees of Flow Retardance (A-E). 8-13
Figure 8.8. - Typical Filter Strip. 8-23
Figure 9.1. - Wet Vault Geometry. 9-10
Figure 9.2. - Stormwater Wetland – Option One. 9-16
Figure 9.3. - Stormwater Wetland – Option Two. 9-18
Figure 9.4a. - Combined Detention and Wet Pond. 9-22
Figure 9.4b. - Combined Detention and Wet Pond (continued). 9-23
Figure 9.5. - Alternative Configurations of Detention and Wet Pool Areas. 9-24
Figure 10.1. - API (baffle type) Separator. 10-2
Figure 10.2. - Coalescing Plate Separator. 10-3

Figure 10.3. - Spill Control Separator (not for oil treatment). 10-4

Chapter 1. Introduction

1.1 Purpose of This Volume

This volume of the stormwater manual focuses on best management practices (BMPs) for the treatment of runoff to remove sediment and other pollutants at developed sites. These BMPs are required to ensure that development or redevelopment do not impair waters of the state. These controls are also to protect wetlands, riparian corridors, and groundwaters to the maximum extent practicable.

The purpose of this volume is to provide guidance for selection, design, and maintenance of permanent runoff treatment facilities.

BMPs with respect to controlling stormwater flows and control of pollutant sources are presented in Volumes III and IV, respectively.

1.2 Content and Organization of This Volume

Volume V of the stormwater manual contains 11 chapters:

- Chapter 1 serves as an introduction and summarizes available options for treatment of stormwater.
- Chapter 2 outlines a step-by-step process for selecting treatment facilities for new development and redevelopment projects.
- Chapter 3 presents treatment facility "menus" that are used in applying the step-by-step process presented in Chapter 2. These menus cover different treatment needs that are associated with different sites.
- Chapter 4 discusses general requirements for treatment facilities.
- Chapters 5 through 10 provide detailed information regarding specific types of treatment identified in the menus.
- Chapter 11 discusses special considerations of emerging technologies for stormwater treatment.

The appendices to this volume contain more detailed information on selected topics described in the various chapters.

1.3 How to Use This Volume

The reader should consult this volume to select specific BMPs for runoff treatment for the stormwater site plans (see Volume I). After the minimum requirements have been identified from Volume I, this volume can be used to select specific treatment facilities for permanent use at developed sites, and as an aid in designing and constructing these facilities.

1.4 Runoff Treatment Facilities

1.4.1 General Considerations

Runoff treatment facilities are designed to remove pollutants contained in stormwater runoff. The pollutants of concern include sand, silt, and other suspended solids; metals such as copper, lead, and zinc; nutrients (e.g., nitrogen and phosphorous); certain bacteria and viruses;

and organics such as petroleum hydrocarbons and pesticides. Methods of pollutant removal include sedimentation/settling, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Floatable pollutants such as oil, debris, and scum can be removed with separator structures.

1.4.2 Operations and Maintenance

Maintenance is required for all types of runoff treatment facilities. See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

1.4.3 Treatment Methods

Methods used for runoff treatment facilities and common terms used in runoff treatment are discussed below:

- **Wet pools.** Wet pools provide runoff treatment by allowing settling of particulates during quiescent conditions (sedimentation), by biological uptake, and by vegetative filtration. Wet pool facilities include wet ponds, wet vaults, and constructed stormwater wetlands. Wet pools may be single-purpose facilities, providing only runoff treatment, or they may be combined with a detention pond or vault to also provide flow control. If combined, the wet pool facility can often be placed beneath the detention facility without increasing further loss of the development area.
- **Biofiltration.** Biofiltration uses vegetation in conjunction with slow and shallow-depth flow for runoff treatment. As runoff passes through the vegetation, pollutants are removed through the combined effects of filtration, infiltration, and settling. These effects are aided by the reduction of the velocity of stormwater as it passes through the biofilter. Biofiltration facilities include swales that are designed to convey and treat concentrated runoff at shallow depths and slow velocities, and filter strips that are broad areas of vegetation for treating sheet flow runoff.
- **Oil/Water Separation.** Oil/water separators remove oil floating on the top of the water. There are two general types of separators – the American Petroleum Institute (API) separators and coalescing plate (CP) separators. Both use gravity to remove floating and dispersed oil. API separators, or baffle separators, are generally composed of three chambers separated by baffles. The efficiency of these separators is dependent on detention time in the center, or detention chamber, and on droplet size. CP separators use a series of parallel plates, which improve separation efficiency by providing more surface area, thus reducing the space needed for the separator. Oil/water separators must be located off-line from the primary conveyance/detention system, therefore bypassing flows greater than the water quality design flow. Other devices/facilities that may be used for removal of oil include “emerging technologies” (see definition below), and linear sand filters. Oil control devices/facilities should be placed upstream of other treatment facilities and as close to the source of oil generation as possible. **Note that Pierce County will not accept ownership of some types of Oil Control BMPs without prior approval.** See Chapters 2 and 3 for additional information.
- **Pretreatment.** Presettling basins are often used to remove sediment from runoff prior to discharge into other treatment facilities. Basic treatment facilities, listed in Chapter 2, Step 7 – Figure 2.1, can also be used to provide pretreatment. Pretreatment often must be provided for filtration and infiltration facilities to protect them from clogging

or to protect groundwater. Appropriate pretreatment devices include a presettling basin, wet pond/vault, biofilter, constructed wetland, or oil/water separator. A number of patented technologies have received General and Conditional Use Level Designations for Pretreatment through Ecology's TAPE (Technology Assessment Protocol – Ecology) Program. A listing and descriptions are available at Ecology's Emerging Technologies website Only those technologies that have received General Use Level Designations (GULD) may be used to meet the requirements of this Stormwater Management and Site Development Manual. Prior approval is required for GULD BMPs that are to be maintained by the County.

- **Infiltration.** Infiltration refers to the use of the filtration, adsorption, and biological properties of soils, with or without amendments, to remove pollutants as stormwater soaks into the ground. Infiltration can provide multiple benefits including pollutant removal, peak flow control, groundwater recharge, and flood control. One condition that can limit the use of infiltration is the potential adverse impact on groundwater quality. You must understand the difference between infiltrating in soils that are suitable for runoff treatment and soils only suitable for flow control to protect groundwater. To be used for runoff treatment, soils must include sufficient organic content and sorption capacity to remove pollutants. Examples of suitable soils are silty and sandy loams. Coarser soils, such as gravelly sands, can provide flow control but are not suitable for providing runoff treatment. The use of coarser soils to provide flow control for runoff from pollution generating surfaces must be preceded by treatment to protect groundwater quality. Thus, there will be instances when soils are suitable for treatment but not flow control, and vice versa. As a result, it is not recommended that large infiltration facilities be designed as combined flow control and treatment facilities. The space requirements and maintenance needs generally make these facilities undesirable in Pierce County. However, smaller onsite stormwater management BMPs (e.g., bioretention) can work well as combined flow control and treatment BMPs. In addition, note that infiltration is regulated by the Washington State Department of Ecology (Ecology) and the Underground Injection Control (UIC) Program (Washington Administrative Code [WAC] 173218). Additional information on UIC and how it applies to infiltration and stormwater management is included in Volume III, Section 2.6 and Volume I, Appendix I-C.
- **Filtration.** Another pollutant removal system for stormwater is the use of various media such as sand, perlite, zeolite, and carbon to remove low levels of total suspended solids. Specific media such as activated carbon or zeolite can remove hydrocarbons and soluble metals. Filter systems are commonly configured as basins, trenches, vaults, or proprietary cartridge filtration systems. Several sand filtration BMPs are discussed in Chapter 7. A number of "emerging technologies" filtration devices have completed or are in the process of being assessed through the emerging technologies process described in the following bullet. **Note that Pierce County will not accept ownership of proprietary media filtration facilities without prior approval.**
- **"Emerging Technologies."** Emerging technologies are those new stormwater treatment devices that are continually being added to the stormwater treatment marketplace. Ecology has established a program called the Technology Assessment Protocol- Ecology (TAPE) to evaluate the capabilities of these emerging technologies. Emerging technologies that have been evaluated by this program are designated with a level of use designation under specified conditions. Their use is restricted in accordance with their evaluation as explained in Chapter 11. The recommendations for use of these emerging technologies may change as Ecology collects more data on their performance. Updated recommendations on their use are posted to the Ecology website. Emerging technologies can also be considered for retrofit

situations where TAPE approval is not required.

- **On-line Systems.** Most treatment facilities can be designed as on-line systems with flows above the water quality design flow or volume simply passing through the facility with lesser or no pollutant removal efficiency. It is sometimes desirable to restrict flows to treatment facilities and bypass excess flows around them. These are called off-line systems. An example of an on-line system is a wet pool that maintains a permanent pool of water for runoff treatment purposes.
- **Design Flow.** For information on determining the design storm and flows for sizing treatment facilities refer to Chapter 4.

Chapter 2. Treatment Facility Selection Process

This chapter describes a step-by-step process for selecting the type of treatment facilities that will apply to individual projects. Physical features of sites that are applicable to treatment facility selection are also discussed. Refer to Chapter 3 for additional details on the four treatment menus – oil control treatment, phosphorous treatment, enhanced treatment, and basic treatment.

Chapter 11 includes links to menus for emerging technologies that have a Use Level Designation for pretreatment, oil, phosphorous, enhanced, or basic treatment. Only technologies with a General Use Level Designation (GULD) can be used to meet the requirements of this manual.

While this chapter provides guidance to the applicant or project engineer regarding the selection of treatment facilities, facility selection remains the responsibility of the project engineer.

2.1 Step-by-Step Selection Process for Treatment Facilities

Please refer to Figure 2.1. Use the step-by-step process outlined below to determine the type of treatment facilities applicable to the project.

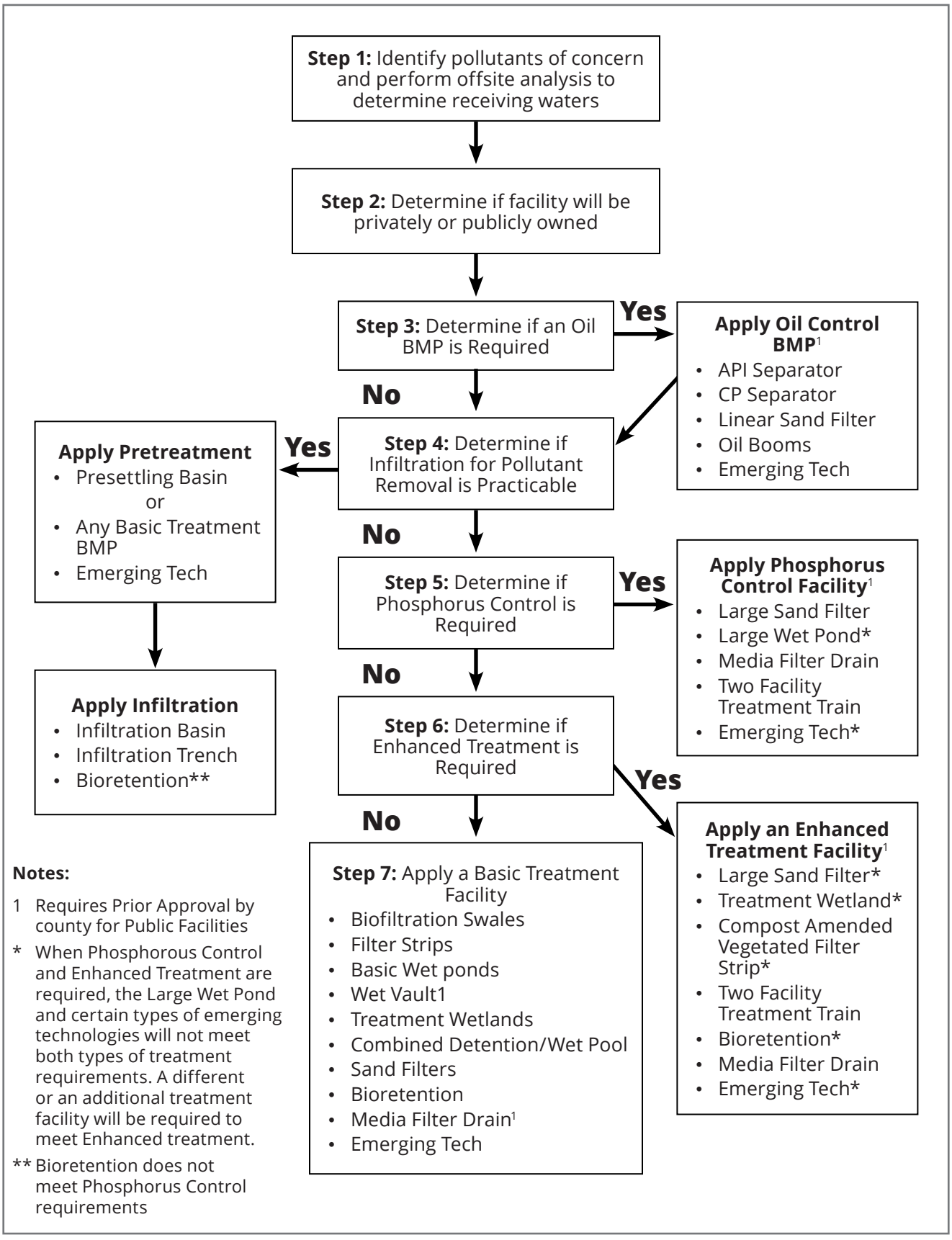
2.1.1 Step 1: Determine the Receiving Waters and Pollutants of Concern Based on Offsite Analysis

An offsite analysis is recommended in order to obtain a more complete determination of the potential impacts of a stormwater discharge. Without an offsite analysis, the project applicant still must determine the natural receiving water for the stormwater drainage from the project site (groundwater, wetland, lake, stream, or salt water). This is necessary to determine the applicable treatment menu from which to select treatment facilities. The identification of the receiving water should be verified by Pierce County. If the discharge is to the municipal stormwater drainage system, the receiving water for the drainage system must be determined.

The following factors must be considered when determining the appropriateness of a treatment facility:

- Whether the receiving water is reported under Section 305(b) of the Clean Water Act (CWA), and designated as not supporting beneficial uses.
- Whether the receiving water is listed under Sections 304(1)(1)(A)(I), 304(1)(1)(A)(II), or 304(1)(1)(B)(1) of the CWA.
- Whether the receiving water is listed in Washington State's Non-point Source Assessment required by Section 319(a) of the CWA.

Figure 2.1. - Treatment Facility Selection Flow Chart.



- Whether any type of water quality management plans and/or local ordinances or regulations have established specific requirements for that (those) receiving waters. These requirements should be verified by Pierce County. Examples of plans to be aware of include:
    - **Watershed or Basin Plans:** These can be developed to cover a wide variety of geographic scales (e.g., Water Resource Inventory Areas [WRIAs], or subbasins of a few square miles), and can be focused solely on establishing stormwater requirements (e.g., "Stormwater Basin Plans"), or can address a number of pollution and water quantity issues, including urban stormwater (e.g., Puget Sound Non-Point Action Plans).
    - **Water Cleanup Plans:** These plans establish a total maximum daily load (TMDL) of a pollutant or pollutants in a specific receiving water or basin, and identify actions necessary to remain below that maximum loading. The plans may identify discharge limitations or management limitations (e.g., use of specific treatment facilities) for stormwater discharges from new and redevelopment projects.
    - **Groundwater Management Plans (Wellhead Protection Plans):** To protect groundwater quality and/or quantity, these plans may identify actions required of stormwater discharges.
    - **Lake Management Plans:** These plans are developed to protect lakes from eutrophication due to inputs of phosphorus from the drainage basin. Control of phosphorus from new development is a likely requirement in any such plans.

An analysis of the proposed land use(s) of the project should also be used to determine the stormwater pollutants of concern. This analysis will help determine whether basic, enhanced, or phosphorus treatment requirements apply to the project. You make those decisions in the steps below.

Step 2: Determine Whether the Facility Will Be County-Owned or Privately Owned

Pierce County will not accept ownership of some types of water quality BMPs without prior approval by the County. As outlined in Figure 2.1, BMPs that require prior approval include:

- Any oil control, phosphorus control, or enhanced treatment facility
- Wet Vaults
- Sand Filter Vaults
- Proprietary treatment devices
- BMPs not in this manual but that have GULD approval.

If ownership of the facility is to be taken over by the County or a Homeowners' Association, and any of the above facilities are required or proposed, the designer must obtain approval from the County before including those facilities in the stormwater design.

Step 3: Determine Whether an Oil Control BMP is Required

The use of oil control devices and facilities is dependent upon the specific land use proposed for development.

Where Applied: The oil control menu (Section 3.2) applies to projects that have "high-use sites" or have National Pollutant Discharge Elimination System (NPDES) permits that require application of oil control. High-use sites are those that typically generate high concentrations of oil due to high

traffic turnover or the frequent transfer of oil. High-use sites include:

- An area of a commercial or industrial site subject to an expected design year average daily traffic count equal to or greater than 100 vehicles per 1,000 square feet of gross building area.
- An area of a commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, not including routinely delivered heating oil.

  Note: The petroleum storage and transfer criterion is intended to address regular transfer operations such as gasoline service stations.
- An area of a commercial or industrial site subject to parking, storage, or maintenance of 25 or more vehicles that are over 10 tons gross weight (trucks, buses, trains, heavy equipment, etc.).

  Note: In general, all-day parking areas are not intended to be defined as high-use sites, and should not require an oil control BMP.
- A road intersection with a design year average daily traffic count of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway, excluding projects proposing primarily pedestrian or bicycle use improvements. See ite.org.

  Note: The design year average daily traffic is defined as the planned traffic 5 years after the road is scheduled to be built. The traffic count can be estimated using information from "Trip Generation," published by the Institute of Transportation Engineers, or from a traffic study prepared by a professional engineer or transportation specialist with experience in traffic estimation.

The County may also require oil control BMPs from this menu to be used on other sites that generate high concentrations of oil.

If oil control is required for the site, please refer to the General Requirements in Chapter 4. These requirements may affect the design and placement of facilities on the site (e.g., flow splitting). Please refer to the oil control menu for a listing of oil control BMP options; then see Chapter 10 for guidance on the proper selection of options and design details.

If an Oil Control Facility is required, select and apply an appropriate Oil Control Facility. Please refer to the oil control menu in Section 3.2. After selecting an Oil Control BMP, proceed to Step 4.

If an Oil Control BMP is not required, proceed directly to Step 4.

Step 4: Determine Whether Infiltration for Pollutant Removal is Practicable

Please check the infiltration treatment design criteria in Chapter 6. Infiltration can be effective at treating stormwater runoff, but soil properties must be appropriate to achieve effective treatment while not adversely impacting groundwater resources. The location and depth to bedrock, the water table, or impermeable layers (such as glacial till), and the proximity to wells, foundations, septic tank drainfields, and unstable or steep slopes can preclude the use of infiltration. Infiltration treatment facilities (except for bioretention and permeable pavement) must be preceded by a pretreatment facility, such as a presettling basin or vault, to reduce the occurrence of plugging. Any of the basic treatment facilities, and detention ponds designed to meet flow control requirements, can also be used for pretreatment. If an oil/water separator is necessary for oil control, it can also function as the presettling basin as long as the influent suspended solids concentrations are not high. However, frequent inspections are necessary to

determine when accumulated solids exceed the 6inch depth at which clean-out is recommended.

If infiltration is planned, please refer to the General Requirements in Chapters 4 and 6. They can affect the design and placement of facilities on your site. For non-residential developments, if your infiltration site is within one-fourth mile of a fresh water body designated for aquatic life use or that has an existing aquatic life use, please refer to Step 6 below to determine if part or the entire site is subject to the enhanced treatment menu (Section 3.4). If the enhanced treatment menu does apply, read the note under "Infiltration with appropriate pretreatment" to identify special pretreatment needs. If your infiltration site is within one-fourth mile of a phosphorus-sensitive receiving water, please refer to the phosphorus treatment menu (Section 3.3) for special pretreatment needs.

Note: Infiltration for flow control outlined in Volume III, Chapter 2 and 3 is allowable. However, the infiltration facility (except for bioretention and permeable pavement) must be preceded by at least a basic treatment facility. Following a basic treatment facility (or an enhanced treatment or a phosphorus treatment facility in accordance with the previous paragraph), infiltration through the bottom of a detention/retention facility for flow control can also be acceptable as a way to help reduce direct discharge volumes to streams and reduce the size of the facility. As noted previously, it is not recommended that large infiltration facilities be designed as combined flow control and treatment facilities. The space requirements and maintenance needs generally make these facilities undesirable in Pierce County.

If infiltration is practicable, select and apply pretreatment and an infiltration facility.

If infiltration is not practicable, proceed to Step 5.

Step 5: Determine Whether Control of Phosphorous is Required

The plans, ordinances, and regulations identified in Step 1 are a good reference to help determine if the subject site is in an area where phosphorus control is required.

The requirement to provide phosphorous control is determined by Pierce County, Ecology, or the USEPA. At the time this volume was developed, there were no established phosphorus control requirements in unincorporated Pierce County. In the future, the County may develop a management plan and implementing ordinances or regulations for control of phosphorus from new development and redevelopment for the receiving water(s) of stormwater drainage. The County may use the following sources of information for pursuing plans and implementing ordinances and/or regulations:

- Those water bodies reported under Section 305(b) of the CWA, and designated as not supporting beneficial uses due to phosphorous;
- Those listed in Washington State's Nonpoint Source Assessment required under Section 319(a) of the CWA due to nutrients.

If phosphorus control is required, select and apply a phosphorous treatment facility. Please refer to the phosphorus treatment menu in Section 3.3. Select an option from the menu after reviewing the applicability and limitations, site suitability, and design criteria of each for compatibility with the site.

If you have selected a phosphorus treatment facility, please refer to the General Requirements in Chapter 4. They may affect the design and placement of the facility on the site.

Note: Project sites subject to the phosphorus treatment requirement could also be subject to the enhanced treatment requirement (see Step 6). In that event, apply a facility or a treatment train

that is listed in both the enhanced treatment menu and the phosphorus treatment menu.

If phosphorus treatment is not required for the site, proceed to Step 6.

Step 6: Determine Whether Enhanced Treatment Is Required

Except where specified under Step 7, enhanced treatment for reduction in dissolved metals is required for the following project sites that: 1) discharge directly to fresh waters or conveyance systems that are tributary to freshwaters designated for aquatic life use or that have an existing aquatic life use; or 2) use infiltration and the site is within one-fourth mile of a freshwater designated for aquatic life use or that has an existing aquatic life use:

- Industrial project sites
- Commercial project sites
- Multi-family residential project sites with 200 units or greater
- High design year average daily traffic roads as follows:
    - Within urban growth areas:
        - Fully controlled and partially controlled limited access highways with design year average daily traffic counts of 15,000 or more
        - All other roads with a design year average daily traffic of 7,500 or greater
    - Outside of urban growth areas:
        - Roads with a design year average daily traffic of 15,000 or greater unless discharging to a 4th Strahler order stream or larger
        - Roads with a design year average daily traffic of 30,000 or greater if discharging to a 4th Strahler order stream or larger (as determined using 1:24,000 scale maps to delineate stream order)
    - The design year average daily traffic is defined as the planned traffic 5 years after the road is scheduled to be built.

However, such sites listed above that discharge directly (or, indirectly through a municipal storm sewer system) to basic treatment receiving waters (see below), and areas of the above-listed project sites that are identified as subject to basic treatment requirements (see Step 7) are also not subject to enhanced treatment requirements. For developments with a mix of land use types, the enhanced treatment requirement shall apply when the runoff from the areas subject to the enhanced treatment requirement comprises 50 percent or more of the total runoff within a threshold discharge area.

Basic treatment receiving waters currently include:

- All salt waters
- Puyallup River (downstream of Carbon River)
- Nisqually River (downstream of Alder Lake)
- White River (downstream of Greenwater River).

If the project must apply enhanced treatment, select and apply an appropriate enhanced treatment facility. Please refer to the enhanced treatment menu in Section 3.4. Select an option from the menu after reviewing the applicability and limitations, site suitability, and design criteria

of each for compatibility with the site.

Note: Project sites subject to the enhanced treatment requirement could also be subject to a phosphorus removal requirement if located in an area designated for phosphorus control. In that event, apply a facility or a treatment train that is listed in both the enhanced treatment menu and the phosphorus treatment menu. If you have selected an enhanced treatment facility, please refer to the General Requirements in Chapter 4. They may affect the design and placement of the facility on the site.

If enhanced treatment does not apply to the site, please proceed to Step 7.

Step 7: Select a Basic Treatment Facility

The basic treatment menu is required in the following circumstances:

- Project sites that discharge to the ground, UNLESS:
    - The soil suitability criteria for infiltration treatment are met and necessary pretreatment is provided (see Chapter 5).
    - The project site uses infiltration strictly for flow control – not treatment – and the infiltration site is within one-fourth mile of a phosphorus sensitive lake (use the phosphorus treatment menu).
    - The project site is industrial, commercial, multi-family, or a high Annual Average Daily Traffic (AADT) and is within one-fourth mile of a freshwater designated for aquatic life use (use the enhanced treatment menu).
- Residential projects not otherwise needing phosphorus control in Step 5 as designated by USEPA, Ecology, or Pierce County.
- Project sites discharging directly (or indirectly through a municipal separate storm sewer system) to basic treatment receiving waters (listed under Step 6).
- Project sites that drain to freshwater that is not designated for aquatic life use; and project sites that drain to waters not tributary to waters designated for aquatic life use or that have an existing aquatic life use.
- Landscaped areas of industrial, commercial, and multi-family project sites; and parking lots of industrial and commercial project sites, dedicated solely to parking of employees' private vehicles that do not involve any other pollution-generating sources (e.g., industrial activities; customer parking; and storage of erodible or leachable material, wastes, or chemicals).

For developments with a mix of land use types, the basic treatment requirement shall apply when the runoff from the areas subject to the basic treatment requirement comprises 50 percent or more of the total runoff within a threshold discharge area.

Please refer to the basic treatment menu in Section 3.5. Select an option from the menu after reviewing the applicability and limitations, site suitability, and design criteria of each for compatibility with the site.

After selecting a basic treatment facility, please refer to the General Requirements in Chapter 4. They may affect the design and placement of the facility on the site.

You have completed the treatment facility selection process.

2.2 Other Treatment Facility Selection Factors

The selection of a treatment facility should be based on site physical factors and pollutants of concern. The requirements for use of enhanced treatment or phosphorus treatment represent facility selection based on pollutants of concern. Even if the site is not subject to those requirements, try to choose a facility that is more likely to do a better job removing the types of pollutants generated on the site. Integration of treatment facilities with flow control and spill containment measures should also be considered (note: it is not recommended that large infiltration facilities be designed as combined flow control and treatment facilities). The types of site physical factors that influence facility selection are briefly summarized below. Additional BMP-specific requirements are listed under the design sections for each BMP.

2.2.1 Soil Type

The permeability of the soil underlying a treatment facility has a profound influence on its effectiveness. This is particularly true for infiltration treatment facilities (see Chapter 6). Likewise, wet pond facilities situated on coarser soils will need a synthetic liner or the soils amended to reduce the infiltration rate and provide treatment. Maintaining a permanent pool in the first cell is necessary to avoid resuspension of settled solids. Biofiltration swales in coarse soils can also be amended to reduce the infiltration rate.

2.2.2 High Sediment Input

High total suspended solids loads can clog infiltration soil, sand filters, and coalescing plate oil/water separators. Pretreatment with a presettling basin, wet vault, or another basic treatment facility is typically required.

2.2.3 Other Physical Factors

Slope and Topography: Steep slopes restrict the use of several BMPs. For example, biofiltration swales are usually situated on sites with slopes of less than 6 percent, although greater slopes can be considered. Infiltration BMPs also have restrictions related to adjacent slope angle.

High Water Table: Unless there is sufficient horizontal hydraulic receptor capacity, the water table acts as an effective barrier to exfiltration and can sharply reduce the efficiency of an infiltration system. If the high water table extends to within a certain distance from the bottom of an infiltration BMP, the site may not be suitable for infiltration.

Depth to Bedrock/Hardpan/Till: The downward exfiltration of stormwater is also impeded if a bedrock or till layer lies too close to the surface. If the impervious layer lies within a certain distance from the bottom of the infiltration BMP, the site may not be suitable for infiltration. Similarly, pond BMPs are often not feasible if bedrock lies within the area that must be excavated.

Proximity to Foundations and Wells: Since infiltration BMPs convey runoff back into the soil, some sites may experience problems with local seepage. This can be a problem if the BMP is located too close to a building foundation. Another risk is groundwater pollution; hence the requirement to site infiltration systems a specified distance away from drinking water wells.

Maximum Depth: Wet ponds are also subject to a maximum depth limit for the “permanent pool” volume. Deep ponds (greater than 8-feet) may stratify during summer and create low oxygen conditions near the bottom resulting in re-release of phosphorus and other pollutants back into the water.

Chapter 3. Treatment Facility Menus

This chapter identifies choices that comprise the treatment facility menus referred to in Chapter 2. The menus in this chapter are discussed in the order of the decision process shown in Figure 2.1 and are as follows:

- Oil control menu, Section 3.2
- Phosphorus treatment menu, Section 3.3
- Enhanced treatment menu, Section 3.4
- Basic treatment menu, Section 3.5.

See Chapter 11 for information on emerging technologies that have a General Use Level Designation which may be used for pretreatment, oil, phosphorous, enhanced, or basic treatment.

3.1 Guide to Applying Menus

Read the step-by-step selection process for treatment facilities in Chapter 2.

Determine which menus apply to the discharge situation. This will require knowledge of 1) the receiving water(s) that the project site ultimately discharges to; 2) whether Pierce County, Ecology or the USEPA has identified the receiving water as subject to phosphorus control requirements; and 3) whether the site qualifies as subject to oil control.

Determine if your project requires oil control.

If the project requires oil control, or if you elect to provide enhanced oil pollution control, choose one of the options presented in the oil control menu, Section 3.2. Detailed designs for oil control BMPs are given in subsequent chapters.

Note: One of the other three treatment menus will also need to be applied along with oil control.

Find the treatment menu that applies to the project – basic, enhanced, or phosphorus.

Each menu presents treatment options. A project site may be subject to both the enhanced treatment requirement and the phosphorus treatment requirement. In that event, select a facility or a treatment train that is listed in both treatment menus.

Note: If flow control requirements apply, it will usually be more economical to use the combined detention/wet pool facilities. Detailed facility designs for all the possible options are given in subsequent chapters in this volume.

Read Chapter 4 concerning general facility requirements.

They apply to all facilities and may affect the design and placement of facilities on the site.

3.2 Oil Control Menu

Note: Where this menu is applicable, it is in addition to facilities required by one of the other treatment menus.

Where Applied: The oil control menu applies to projects that have high-use sites, or are subject to NPDES permits that require oil control. Specific applicability criteria are described in Section 2.1, Step 3.

Application on the Project Site: Oil control BMPs are to be placed upstream of other facilities, as close to the source of oil generation as practical. For high-use sites located within a larger commercial center, only the impervious surface associated with the high-use portion of the site is subject to oil treatment requirements. If common parking for multiple businesses is provided, treatment shall be applied to the number of parking stalls required for the high-use business only. However, if the treatment collection area also receives runoff from other areas, the treatment facility must be sized to treat all water passing through it.

High-use roadway intersections shall treat lanes where vehicles accumulate during the signal cycle, including left and right turn lanes and through lanes, from the beginning of the left turn pocket. If no left turn pocket exists, the treatable area shall begin at a distance equal to three car lengths from the stop line. If runoff from the intersection drains to more than two collection areas that do not combine within the intersection, treatment may be limited to any two of the collection areas.

Performance Goal: The facility choices in the oil control menu are intended to achieve the goals of no ongoing or recurring visible sheen, and to have a 24hour average Total Petroleum Hydrocarbon (TPH) concentration no greater than 10 mg/l, and a maximum of 15 mg/l for a discrete sample (grab sample).

Note: Use the method for NWTPHDx in Ecology publication No. ECY 97602, Analytical Methods for Petroleum Hydrocarbons. If the concentration of gasoline is of interest, the method for NWTPHGx should be used to analyze grab samples.

Options: Oil control options include facilities that are small, treat runoff from a limited area, and require frequent maintenance. The options also include facilities that treat runoff from larger areas and generally have less frequent maintenance needs. **Note that Pierce County will not accept ownership of some types of oil control BMPs without prior approval.**

- **API-Type Oil/Water Separator** (see Chapter 10). Requires prior approval for County ownership.
- **Coalescing Plate Oil/Water Separator** (see Chapter 10). Requires prior approval for County ownership.
- **Emerging Stormwater Treatment Technologies** (see Chapter 11).

  Note: As emerging BMPs are approved by Ecology for meeting oil control requirements, these may be added to Pierce County's approved list of acceptable BMPs. Additional BMPs will be accepted by Pierce County on a case-by-case basis, after approval by Ecology.
- **Linear Sand Filter** (see Chapter 7).

  Note: The linear sand filter is used in the basic, enhanced, and phosphorus treatment menus also. If used to satisfy one of those treatment requirements, the same facility shall not also be used to satisfy the oil control requirement unless increased maintenance (quarterly cleaning) is assured. This increase in maintenance is to prevent clogging of the filter by oil so that it will function for suspended solids and phosphorus removal as well.
- **Oil Control Booms** (see Chapter 10, and WSDOT's *Highway Runoff Manual*).

3.3 Phosphorus Treatment Menu

Where Applied: The phosphorus treatment menu applies to projects within watersheds that have been determined by Pierce County, Ecology, or the USEPA to be sensitive to phosphorus and are being managed to control phosphorus inputs from stormwater. This menu applies to stormwater conveyed to the lake by surface flow as well as to stormwater infiltrated within one-quarter mile of the lake in soils that do not meet the soil suitability criteria in Section 6.4. See Section 2.1, Step 5 for a more detailed explanation of applicability.

Performance Goal: The phosphorus menu facility choices are intended to achieve a goal of 50 percent total phosphorus removal for a range of influent concentrations of 0.1 to 0.5 mg/l total phosphorus. In addition, the choices are intended to achieve the basic treatment performance goal. The performance goal applies to the water quality design storm volume or flow rate, whichever is applicable. The incremental portion of runoff in excess of the water quality design flow rate or volume can be routed around the facility (off-line treatment facilities),or can be passed through the facility (on-line treatment facilities) provided a net pollutant reduction is maintained. The design and operation of treatment facilities that engage a bypass at flow rates higher than the water quality design flow rate is encouraged. This is acceptable provided that the overall reduction in phosphorus loading (treated plus bypassed) is at least equal to that achieved with initiating bypass at the water quality design flow rate.

Options: Any one of the following options may be chosen to satisfy the phosphorus treatment requirement.

- **Infiltration with Appropriate Pretreatment** – see Chapter 5
    - Infiltration treatment:
        - If infiltration is through soils meeting the minimum site suitability criteria for infiltration treatment (see Chapter 6), a presettling basin or a basic treatment facility can serve for pretreatment.
    - Infiltration preceded by basic treatment:
        - If infiltration is through soils that do not meet the soil suitability criteria for infiltration treatment, treatment must be provided by a basic treatment facility, unless the soil and site fit the description in the next option below.
    - Infiltration preceded by phosphorus treatment:
        - If the soils do not meet the soil suitability criteria and the infiltration site is within one-fourth mile of a phosphorus-sensitive receiving water, or a tributary to that water, treatment must be provided by one of the other treatment facility options listed below.
- **Large Sand Filter** – see Chapter 7.
- **Large Wet Pond** – see Chapter 9.
- **Emerging Stormwater Treatment Technologies targeted for phosphorus removal** – As emerging BMPs are approved by Ecology for meeting phosphorus treatment requirements, these may be added to Pierce County's approved list of acceptable BMPs. Additional BMPs may be accepted by Pierce County on a case-by-case basis, after approval by Ecology.
- **Media Filter Drain** – see Chapter 7.
- **Two-Facility Treatment Trains** – see Table 3.1.

Table 3.1. - Treatment Trains for Phosphorus Removal.

First Basic Treatment Facility	Second Treatment Facility
Biofiltration Swale	Basic Sand Filter or Sand Filter Vault
Filter Strip	Linear Sand Filter (no presettling needed)
Linear Sand Filter	Filter Strip
Basic Wet Pond	Basic Sand Filter or Sand Filter Vault
Wet Vault	Basic Sand Filter or Sand Filter Vault
Stormwater Treatment Wetland	Basic Sand Filter or Sand Filter Vault
Basic Combined Detention and Wet Pool	Basic Sand Filter or Sand Filter Vault

3.4 Enhanced Treatment Menu

Where Applied: Except where specified in Section 3.5 – Basic Treatment, enhanced treatment is required for particular project sites that: 1) discharge directly to fresh waters or conveyance systems tributary to freshwaters designated for aquatic use or that have an existing aquatic life use; or 2) use infiltration and the site is within one-fourth mile of a freshwater designated for aquatic life use or that has an existing aquatic life. A description of the project sites that are subject to this requirement is provided in Section 2.1, Step 6.

Performance Goal: The enhanced menu facility choices are intended to provide a higher rate of removal of dissolved metals than basic treatment facilities. The choices are intended to achieve the basic treatment performance goal. Based on a review of dissolved metals removal of basic treatment options, a “higher rate of removal” is currently defined at greater than 30 percent dissolved copper removal and greater than 60 percent dissolved zinc removal. The performance goal assumes that the facility is treating stormwater with dissolved Copper typically ranging from 0.005 to 0.02 mg/l, and dissolved Zinc ranging from 0.02 to 0.3 mg/l.

The performance goal applies to the water quality design storm volume or flow rate, whichever is applicable. The incremental portion of runoff in excess of the water quality design flow rate or volume can be routed around the facility (off-line treatment facilities), or can be passed through the facility (on-line treatment facilities) provided a net pollutant reduction is maintained. The design and operation of treatment facilities that engage a bypass at flow rates higher than the water quality design flow rate is encouraged as long as the reduction in dissolved metals loading exceeds that achieved with initiating bypass at the water quality design flow rate.

Options: Any one of the following options may be chosen to satisfy the enhanced treatment requirement:

- **Infiltration with appropriate pretreatment** – see Chapter 5.
    - Infiltration treatment:
        - If infiltration is through soils meeting the minimum site suitability criteria for infiltration treatment (see Chapter 6), a presettling basin or a basic treatment facility can serve for pretreatment.
    - Infiltration preceded by basic treatment:
        - If infiltration is through soils that do not meet the soil suitability criteria for infiltration treatment, treatment must be provided by a basic treatment facility unless the soil and site fit the description in the next option below.

- Infiltration preceded by enhanced treatment:
  - If the soils do not meet the soil suitability criteria **and** the infiltration site is within one-fourth mile of a freshwater designated for aquatic life use or that has an existing aquatic life use, treatment must be provided by one of the other treatment facility options listed below.

- **Large Sand Filter** – see Chapter 7.
- **Stormwater Treatment Wetland** – see Chapter 9.
- **Compost-amended Vegetated Filter Strip (CAVFS)** – see Chapter 6.
- **Two Facility Treatment Trains** – see Table 3.2

  Note: secondary treatment facilities may include emerging technologies (Chapter 12) where appropriate and approved by the County.

- **Bioretention** – see Volume III.

  Note: Stormwater runoff that infiltrates through the imported soil mix specified in Volume III will have received enhanced treatment. Where bioretention/is intended to fully meet treatment requirements for its drainage area, it must be designed, using an approved continuous runoff model, to pass at least 91 percent of the influent runoff file through the imported soil mix.

Table 3.2. - Treatment Trains for Dissolved Metals Removal.

First Basic Treatment Facility	Second Treatment Facility
Biofiltration Swale	Basic Sand Filter or Sand Filter Vault or
Filter Strip	Linear Sand Filter with no presettling cell needed
Linear Sand Filter	Filter Strip
Basic Wet Pond	Basic Sand Filter or Sand Filter Vault
Wet Vault	Basic Sand Filter or Sand Filter Vault
Basic Combined Detention/Wet Pool	Basic Sand Filter or Sand Filter Vault

- Media Filter Drain – see Chapter 7.
- Emerging Stormwater Treatment Technologies – see Chapter 11 – As other BMPs are approved by Ecology for meeting enhanced treatment requirements, these may be added to Pierce County's approved list of acceptable enhanced treatment BMPs. Additional BMPs will be accepted by Pierce County on a case-by-case basis, after approval by Ecology.

3.5 Basic Treatment Menu

Where Applied: The basic treatment menu is generally applied to projects not subject to phosphorus or enhanced treatment requirements. See Section 2.1 for specific guidance on applicability.

Performance Goal: The basic treatment menu facility choices are intended to achieve 80 percent removal of total suspended solids for influent concentrations that are greater than 100 mg/l, but less than 200 mg/l. For influent concentrations greater than 200 mg/l, a higher treatment goal may be appropriate. For influent concentrations less than 100 mg/l, the facilities are intended to achieve an effluent goal of 20 mg/l total suspended solids.

The performance goal applies to the water quality design storm volume or flow rate, whichever is applicable. The incremental portion of runoff in excess of the water quality design flow rate

or volume can be routed around the facility (off-line treatment facilities), or can be passed through the facility (on-line treatment facilities) provided a net total suspended solids reduction is maintained.

Options: Any one of the following options may be chosen to satisfy the basic treatment requirement:

- **Infiltration** – see Chapter 6.
- **Sand Filters** – see Chapter 7.
- **Biofiltration Swales** – see Chapter 8.
- **Vegetated Filter Strips** – see Chapter 8.
- **Compost-amended Vegetated Filter Strip (CAVFS)** – see Chapter 6.
- **Basic Wet Pond** – see Chapter 9.
- **Wet Vault** – see Chapter 9 (see note).
- **Stormwater Treatment Wetland** – see Chapter 9.
- **Combined Detention and Wet Pool Facilities** – see Chapter 9.
- **Bioretention Cells, Swales, and Planter Boxes** – see Volume III.

  Note: Where bioretention is intended to fully meet treatment requirements for its drainage area, it must be designed, using an approved continuous runoff model, to pass at least 91 percent of the influent runoff file through the imported soil mix.
- **Media Filter Drain** – see Chapter 7.
- **Emerging Stormwater Treatment Technologies** – see Chapter 11 – As other BMPs are approved by Ecology for meeting enhanced treatment requirements, these may be added to Pierce County's approved list of acceptable basic treatment BMPs. Additional BMPs will be accepted by Pierce County on a case-by-case basis, after General Use Level Designation approval by Ecology.

  Note: A wet vault may be used for commercial, industrial, or road projects if there are space limitations. Ecology and Pierce County discourage the use of wet vaults for residential projects. Combined detention/wet vaults are allowed; see Section 9.3.

Chapter 4. General Requirements for Stormwater Treatment Facilities

This chapter addresses general requirements for treatment facilities. Requirements discussed in this chapter include design volumes and flows, sequencing of facilities, liners, and hydraulic structures for splitting or dispersing flows. Additional requirements for individual facilities are discussed in subsequent chapters.

4.1 Design Volume and Flow

4.1.1 Water Quality Design Storm Volume

The water quality design storm volume shall be equal to the simulated daily volume, as estimated by an approved continuous runoff model, that represents the upper limit of the range of daily volumes that accounts for 91 percent of the entire runoff volume over a multi-decade period of record.

4.1.2 Water Quality Design Flow Rate

Downstream of Detention Facilities: The full 2year recurrence interval release rate from the detention facility.

An approved continuous runoff model should identify the 2year recurrence interval flow rate discharged by a detention facility that is designed to meet the flow duration standard.

Preceding Detention Facilities or When Detention Facilities Are Not Required: The flow rate at or below which 91 percent of the runoff volume, as estimated by an approved continuous runoff model, will be treated.

Design criteria for treatment facilities are assigned to achieve the applicable performance goal at the water quality design flow rate (e.g., 80 percent total suspended solids removal).

- **Off-line facilities:** For treatment facilities not preceded by an equalization or storage basin, and when runoff flow rates exceed the water quality design flow rate, the treatment facility should continue to receive and treat the water quality design flow rate to the applicable treatment performance goal. Only the higher incremental portion of flow rates are bypassed around a treatment facility.

  Treatment facilities preceded by an equalization or storage basin may identify a lower water quality design flow rate provided that at least 91 percent of the estimated runoff volume in the time series of an approved continuous runoff model is treated to the applicable performance goals (e.g., 80 percent total suspended solids removal at the water quality design flow rate and 80 percent total suspended solids removal on an annual average basis).
- On-line facilities: Runoff flow rates in excess of the water quality design flow rate can be routed through the facility provided a net pollutant reduction is maintained.

4.1.3 Flows Requiring Treatment

Runoff from pollution-generating hard or pervious surfaces must be treated. Pollution generating hard surfaces (PGHS) are those hard surfaces considered to be a significant source of pollutants in stormwater runoff. PGHS include pollution-generating impervious surfaces (PGIS) and pollution-generating permeable pavements. Permeable pavements subject to pollution-

generating activities are also considered pollution-generating pervious surfaces (PGPS) because of their infiltration capability. The glossary in Volume I provides additional definitions and clarification of these terms.

PGHS, PGIS, and PGPS include those surfaces that receive direct rainfall, or runon or blow-in of rainfall, and are subject to: vehicular use; industrial activities; or storage of erodible or leachable materials, wastes, or chemicals. Erodible or leachable materials, wastes, or chemicals are those substances which, when exposed to rainfall, measurably alter the physical or chemical characteristics of the rainfall runoff. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage. Metal roofs are also considered to be PGIS unless they are coated with an inert, non-leachable material (e.g., baked enamel coating). Roofs subject to venting significant amounts of dusts, mists or fumes from manufacturing, commercial, or other indoor activities are also PGIS.

A surface, whether paved or not, shall be considered subject to vehicular use if it is regularly used by motor vehicles. The following are considered regularly used surfaces: roads, unvegetated road shoulders, bike lanes within the traveled lane of a roadway, driveways, parking lots, unfenced fire lanes, vehicular equipment storage yards, and airport runways.

The following are not considered regularly used surfaces: paved bicycle pathways separated from and not subject to drainage from roads for motor vehicles, restricted access fire lanes, and infrequently used maintenance access roads.

Pollution generating pervious surfaces (PGPS) are any pervious surface that receive direct rainfall, or runon, or blow-in of rainfall and are subject to vehicular use; industrial activities (as further defined in the glossary); storage of erodible or leachable materials, wastes, or chemicals; the use of pesticides and fertilizers; or loss of soil. Typical PGPS include permeable pavement subject to vehicular use, lawns, and landscaped areas, including: golf courses, parks, cemeteries, and sports fields (including natural and artificial turf).

Summary of Areas Needing Treatment

- All runoff from pollution-generating hard surfaces is to be treated through the water quality facilities specified in Chapter 2 and Chapter 3.
- Lawns and landscaped areas specified are pervious but also generate runoff into street drainage systems. In those cases, the runoff from the pervious areas must be estimated and added to the runoff from hard surface areas to size treatment facilities.
- Runoff from backyards can drain into native vegetation in areas designated as open space or buffers. In these cases, the area in native vegetation may be used to provide the requisite water quality treatment, provided it meets the requirements outlined in Volume III, Chapter 3 for dispersion.
- Drainage from hard surfaces that are not pollution - generating need not be treated and may bypass runoff treatment, if it is not mingled with runoff from pollution-generating surfaces.
- Runoff from non-pollution-generating roofs is still subject to flow control per Minimum Requirement #7. The non-pollution-generating roof runoff that is directed to an infiltration trench or drywell must first pass through a catch basin as shown in Downspout Infiltration Systems (see Volume III, Section 3.9.4). Note that metal roofs are considered pollution generating unless they are coated with an inert non-leachable material. Roofs that are

subject to venting of significant amounts of manufacturing, commercial, or other indoor pollutants are considered pollution-generating.

- Drainage from areas in native vegetation should not be mixed with untreated runoff from streets and driveways, if possible. It is best to infiltrate or disperse this relatively clean runoff to maximize recharge to shallow groundwater, wetlands, and streams (see Volume III, Chapter 3 for flow dispersion requirements).
- If runoff from non-pollution generating surfaces reaches a runoff treatment BMP, flows from those areas must be included in the sizing calculations for the facility. Once runoff from non-pollution generating areas is mixed with runoff from pollution-generating areas, it cannot be separated before treatment.

4.2 Sequence of Facilities

The enhanced treatment and phosphorus removal menus, described in Chapter 3, include treatment options in which more than one type of treatment facility is used. In those options, the sequence of facilities is prescribed. This is because the specific pollutant removal role of the second or third facility in a treatment often assumes that significant solids' settling has already occurred. For example, phosphorus removal using a two-facility treatment relies on the second facility (sand filter) to remove a finer fraction of solids than those removed by the first facility.

There is also the question of whether treatment facilities should be placed upstream or downstream of detention facilities that are needed for flow control purposes. In general, all treatment facilities may be installed upstream of detention facilities, although presettling basins are needed for sand filter and sand infiltration systems. However, not all treatment facilities can function effectively if located downstream of detention facilities. Those facilities that treat unconcentrated flows, such as filter strips, are usually not practical downstream of detention facilities. Other types of treatment facilities present special problems that must be considered before placement downstream is advisable.

For instance, prolonged flows discharged by a detention facility that is designed to meet the flow duration standard of Minimum Requirement #7 may interfere with proper functioning of basic biofiltration swales and sand filters. Grasses typically specified in the basic biofiltration swale design will not survive. A wet biofiltration swale design would be a better choice.

For sand filters, the prolonged flows may cause extended saturation periods within the filter. Saturated sand can lose all oxygen and become anoxic. If that occurs, some amount of phosphorus captured within the filter may become soluble and released. To prevent long periods of sand saturation, adjustments may be necessary after the sand filter is in operation to bypass some areas of the filter. This bypassing will allow them to drain completely. It may also be possible to employ a different type of facility that is less sensitive to prolonged flows.

Oil control BMPs for runoff treatment must be located upstream of treatment and detention facilities and as close to the source of oil-generating activity as possible.

Table 4.1 summarizes placement considerations of treatment facilities in relation to detention.

4.3 Facility Liners

Liners are intended to reduce the likelihood that pollutants in stormwater will reach groundwater when runoff treatment facilities are constructed. In addition to groundwater protection considerations, some facility types require permanent water for proper functioning. An example

is the first cell of a wet pond.

Treatment liners amend the soil with materials that treat stormwater before it reaches more freely draining soils. They have slow rates of infiltration, generally less than 2.4 inches per hour, but not as slow as low permeability liners. Treatment liners may use in-place native soils or imported soils.

Low permeability liners reduce infiltration to a very slow rate, generally less than 0.02 inches per hour. These types of liners are used for industrial or commercial sites with a potential for high pollutant loading in the stormwater runoff. Low permeability liners may be fashioned from compacted till, clay, geomembrane, or concrete. See Sections 4.3.2 and 4.3.3 for more specific design criteria for treatment liners and low permeability liners.

Table 4.1. - Treatment Facility Placement in Relation to Detention.

Water Quality Facility	Preceding Detention	Following Detention
Basic biofiltration swale (Chapter 8)	OK	OK. Prolonged flows may reduce grass survival. Consider wet biofiltration swale.
Wet biofiltration swale (Chapter 8)	OK	OK
Filter strip (Chapter 8)	OK	No—must be installed before flows concentrate.
Basic or large wet pond (Chapter 9)	OK	OK—less water level fluctuation in ponds downstream of detention may improve aesthetic qualities and performance.
Basic or large combined detention and wet pond (Chapter 9)	Not applicable	Not applicable
Wet vault (Chapter 9)	OK	OK
Basic or large sand filter or sand filter vault (Chapter 7)	OK, but presettling and control of floatables needed	OK—sand filters downstream of detention facilities may require field adjustments if prolonged flows cause sand saturation and interfere with phosphorus removal.
Stormwater treatment wetland/pond (Chapter 9)	OK	OK—less water level fluctuation and better plant diversity are possible if the stormwater wetland is located downstream of the detention facility.

4.3.1 General Design Criteria

- Table 4.2 shows the type of liner required for use with various runoff treatment facilities. Other liner configurations may be used with prior approval from the County.
- Liners shall be evenly placed over the bottom and/or sides of the treatment area of the facility as indicated in Table 4.2. Areas above the treatment volumes that are required to pass flows greater than the water quality treatment flow (or volume) need not be lined. However, the lining must be extended to the top of the interior side slope and anchored if it cannot be permanently secured by other means.
- For low permeability liners, the following criteria apply:
    - Where the seasonal high groundwater elevation is likely to contact a low permeability liner, liner buoyancy may be a concern. In these instances, use of a low permeability

liner shall be evaluated and recommended by a geotechnical engineer.

- Where grass must be planted over a low permeability liner per the facility design, a minimum of 6 inches of good topsoil or compost-amended native soil must be placed over the liner in the area to be planted. Twelve inches of cover is preferred (see additional requirements for Geomembrane Liners).

- If a treatment liner will be below the seasonal high water level, the pollutant removal performance of the liner and facility must be evaluated by a geotechnical or groundwater specialist and found to be as protective as if the liner and facility were above the level of the groundwater.

Table 4.2. - Lining Types Required for Runoff Treatment Facilities.

Water Quality Facility	Area to be Lined	Type of Liner Required
Presettling basin	Bottom and sides	Low permeability liner or Treatment liner (If the basin will intercept the seasonal high groundwater table, a treatment liner may be recommended.)
Wet pond	First cell: bottom and sides to water quality design water surface --- Second cell: bottom and sides to water quality design water surface	Low permeability liner or Treatment liner --- Treatment liner
Combined detention/ water quality facility	First cell: bottom and sides to water quality design water surface --- Second cell: bottom and sides to water quality design water surface	Low permeability liner or Treatment liner --- Treatment liner
Stormwater wetland	Bottom and sides, both cells	Low permeability liner
Sand filtration basin	Basin sides only	Treatment liner
Sand filter vault	Not applicable	No liner needed
Linear sand filter	Not applicable if in vault Bottom and sides of presettling cell if not in vault	No liner needed Low permeability or treatment liner
Media filter (in vault)	Not applicable	No liner needed
Wet vault	Not applicable	No liner needed

4.3.2 Treatment Liner Design Criteria

This section presents the design criteria for treatment liners.

- A 2-foot thick layer of soil with a minimum organic content of 1 percent AND a minimum cation exchange capacity (CEC) of 5 milliequivalents/100 grams can be used as a treatment layer beneath a water quality or detention facility.

- To demonstrate that in-place soils meet the above criteria, one sample per 1,000 square feet of facility area shall be tested. Each sample shall be a composite of subsamples taken

throughout the depth of the treatment layer (usually 2- to 6feet below the expected facility invert).

- Typically, side wall seepage is not a concern if the seepage flows through the same stratum as the bottom of the treatment BMP. However, if the treatment soil is an engineered soil or has very low permeability, the potential to bypass the treatment soil through the side walls may be significant. In those cases, the treatment BMP side walls may be lined with at least 18 inches of treatment soil, as described above, to prevent untreated seepage. This lesser soil thickness is based on unsaturated flow as a result of alternating wet-dry periods.
- Organic content shall be measured on a dry weight basis using American Society for Testing and Materials (ASTM) D2974.
- CEC shall be tested using U.S. Environmental Protection Agency (U.S. EPA) laboratory method 9081.
- Certification by a soils testing laboratory that imported soil meets the organic content and CEC criteria above shall be provided to Pierce County.
- Animal manures used in treatment soil layers must be sterilized because of potential for bacterial contamination of the groundwater.

4.3.3 Low Permeability Liner Design Criteria

This section presents the design criteria for each of the following four low permeability liner options: compacted till liners, clay liners, geomembrane liners, and concrete liners.

Compacted Till Liners

- Liner thickness shall be 18 inches after compaction.
- Soil shall be compacted to 95 percent minimum dry density, modified proctor method (ASTM D1557).
- A different depth and density sufficient to retard the infiltration rate to 2.4 x 105 inches per minute may also be used instead of Criteria 1 and 2.
- Soil should be placed in 6inch lifts.
- Soils may be used that meet the gradation in Table 4.3 below:

Table 4.3. - Compacted Till Liners.

Sieve Size	Percent Passing
6-inch	100
4-inch	90
#4	70–100
#200	20

Clay Liners

- Liner thickness shall be 12 inches.
- Clay shall be compacted to 95 percent minimum dry density, modified proctor method (ASTM D1557).
- A different depth and density sufficient to retard the infiltration rate to 2.4 x 105 inches per minute may also be used instead of the above criteria.

- Plasticity index shall not be less than 15 percent (ASTM D-423, D424).
- Liquid limit of clay shall not be less than 30 percent (ASTM D2216).
- Clay particles passing shall not be less than 30 percent (ASTM D422).
- The slope of clay liners must be restricted to 3H:1V for all areas requiring soil cover; otherwise, the soil layer must be stabilized by another method so that soil slippage into the facility does not occur. Any alternative soil stabilization method must take maintenance access into consideration.
- Where clay liners form the sides of ponds, the interior side slope should not be steeper than 3H:1V, irrespective of fencing. This restriction is to ensure that anyone falling into the pond may safely climb out.

Geomembrane Liners

- Geomembrane liners shall be ultraviolet (UV) light resistant and have a minimum thickness of 30 mils. A thickness of 40 mils shall be used in areas of maintenance access or where heavy machinery must be operated over the membrane.
- The geomembrane fabric shall be protected from puncture, tearing, and abrasion by installing geotextile fabric on the top and bottom of the geomembrane determined to have a high survivability per the WSDOT standard specifications as amended, specifically Section 933 Construction Geotextile (2014 or the latest version as amended). Equivalent methods for protection of the geomembrane liner will be considered. Equivalency will be judged on the basis of ability to protect the geomembrane from puncture, tearing, and abrasion.
- Geomembranes shall be bedded according to the manufacturer's recommendations.
- Liners must be covered with 12 inches of top dressing forming the bottom and sides of the water quality facility, except for linear sand filters. Top dressing shall consist of 6 inches of crushed rock covered with 6 inches of native soil. The rock layer is to mark the location of the liner for future maintenance operations. As an alternative to crushed rock, 12 inches of native soil may be used if orange plastic "safety fencing" or another highly visible, continuous marker is embedded 6 inches above the membrane.
- If possible, liners should be of a contrasting color so that maintenance workers are aware of any areas where a liner may have become exposed when maintaining the facility.
- Geomembrane liners shall not be used on slopes steeper than 5H:1V to prevent the top dressing material from slipping. Textured liners may be used on slopes up to 3H:1V upon recommendation by a geotechnical engineer that the top dressing will be stable for all site conditions, including maintenance.

Concrete Liners

- Concrete liners may also be used for sedimentation chambers and for sedimentation and filtration basins less than 1,000 square feet in area. Concrete shall be 5inch thick Class 3000 or better and shall be reinforced by steel wire mesh. The steel wire mesh shall be six (6) gauge wire or larger and 6inch by 6inch mesh or smaller. An "Ordinary Surface Finish" is required. When the underlying soil is clay or has an unconfined compressive strength of 0.25 ton per square foot or less, the concrete shall have a minimum 6-inch compacted aggregate base consisting of coarse sand and river stone, crushed stone or equivalent with

diameter of 0.75 to 1 inch. Where visible, the concrete shall be inspected annually and all cracks shall be sealed.

- Portland cement liners are allowed irrespective of facility size, and shotcrete may be used on slopes. However, specifications must be developed by a professional engineer who certifies the liner against cracking or losing water retention ability under expected conditions of operation, including facility maintenance operations. Weight of maintenance equipment can be up to 80,000 pounds when fully loaded.
- Asphalt concrete may not be used for liners due to its permeability to many organic pollutants.
- If grass is to be grown over a concrete liner, slopes must be no steeper than 5H:1V to prevent the top dressing material from slipping. Textured liners may be used on slopes up to 3H:1V upon recommendation by a geotechnical engineer that the top dressing will be stable for all site conditions, including maintenance.

Chapter 5. Pretreatment

5.1 Purpose

This chapter presents the methods that may be used to provide pretreatment prior to basic or enhanced runoff treatment facilities. Presettling basins are a typical pretreatment BMP used to remove suspended solids. All of the basic runoff treatment facilities may also be used for pretreatment to reduce suspended solids.

5.2 Applications

Pretreatment must be provided where the basic treatment facility or the receiving water may be adversely affected by non-targeted pollutants (e.g., oil), or may by overwhelmed by a heavy load of targeted pollutants (e.g., suspended solids). BMPs that require pretreatment include but are not limited to: sand filters, canister systems, infiltrations ponds, and infiltration trenches that receive runoff from pollution generating surfaces.

A detention pond sized to meet the flow control standard in Volume I may also be used to provide pretreatment for suspended solids removal.

5.3 Best Management Practices for Pretreatment

This chapter has only one BMP for presettling basins. Ecology has approved some emerging technologies for pretreatment through the TAPE process. See Ecology's website for a list of approved pretreatment technologies. Only those BMPs that have received General Use Level Designations may be used to meet the requirements of this Stormwater Management and Site Development Manual. If ownership of the facility is to be taken over by the County or a Homeowners' Association, the designer must obtain approval from the County before including those facilities in the stormwater design.

5.3.1 Presettling Basin (Ecology BMP T6.10)

A presettling basin provides pretreatment of runoff in order to remove suspended solids, which can impact other runoff treatment BMPs.

Application and Limitations

Runoff treated by a presettling basin may not be discharged directly to a receiving water or to groundwater; it must be further treated by a basic or enhanced runoff treatment BMP.

Presettling Basin Design Criteria

- A presettling basin shall be designed to include a wet pool sedimentation area at least 6 inches deep at the bottom of the facility. The total treatment volume of the presettling basin shall be at least 30 percent of the total water quality treatment design volume.
- Drawdown time of the presettling storage area (excluding wet pool area) must not exceed 48 hours.
- If the runoff in the presettling basin will be in direct contact with the soil, it must be lined per the liner requirement in Section 4.3.
- The presettling basin shall conform to the following:

- The length-to-width ratio shall be at least 3:1. Berms or baffles may be used to lengthen the flow path.
- The minimum depth shall be 4 feet; the maximum depth shall be 6 feet.

- Inlets and outlets shall be designed to minimize velocity and reduce turbulence. Inlet and outlet structures should be located at extreme ends of the basin in order to maximize particle-settling opportunities.
- Attachments Section B, Detail 6.0 shows an example schematic.

Site Constraints and Setbacks

All facilities shall be a minimum of 20 feet from any structure, property line, and any vegetative buffer required by Pierce County.

All facilities shall be 100 feet from any septic tank/drainfield (except wet vaults shall be a minimum of 20 feet).

All facilities shall be a minimum of 50 feet from any steep (greater than 15 percent) slope. A geotechnical assessment must address the potential impact of a wet pond on a steep slope.

Embankments that impound water must comply with the Washington State Dam Safety Regulations (Chapter 173175 WAC). If the impoundment has a storage capacity (including both water and sediment storage volumes) greater than 10 acre-feet (435,600 cubic feet or 3.26 million gallons) above natural ground level, then dam safety design and review are required by Ecology. See Volume III for more detail.

Chapter 6. Infiltration and Bioretention Treatment Facilities

6.1 Purpose

This chapter provides site suitability, design, and maintenance criteria for infiltration treatment systems. Infiltration treatment BMPs serve the dual purpose of removing pollutants (total suspended solids, heavy metals, phosphates, and organics) and recharging aquifers.

A stormwater infiltration treatment facility is an impoundment; typically a basin, trench, or bioretention system whose soil removes pollutants from stormwater. The infiltration BMPs described in this chapter include:

- Infiltration Basins (Section 6.4.1)
- Infiltration Trenches (Section 6.4.2)
- Bioretention Cells, Swales, and Planter Boxes (Section 6.4.3)
- Compost-amended Vegetated Filter Strips (Section 6.4.4).

Note that the soil infiltration requirements for water quality treatment are substantially different from those for flow control. Infiltration treatment soils must contain sufficient organic matter and/or clays to sorb, decompose, and/or filter stormwater pollutants. Pollutant/soil contact time, soil sorptive capacity, and soil aerobic conditions are important design considerations. Specific requirements are outlined in Section 6.3 and 6.4 below.

Although they are very effective at water quality treatment, bioretention cell, swale, and planter box BMPs are more commonly designed to provide flow control, and therefore the design details for these BMPs are provided in Volume III, Section 3.4. This includes the imported soil requirements for bioretention BMPs, which will meet the enhanced treatment requirements and does not typically require pretreatment.

6.2 Applications and Limitations

These infiltration and bioretention treatment measures are capable of achieving the performance objectives cited in Chapter 3 for specific treatment menus. In general, these treatment techniques can capture and remove or reduce the target pollutants to levels that will not adversely affect public health or beneficial uses of surface and groundwater resources and will not cause a violation of groundwater quality standards.

The terms bioretention and rain garden are sometimes used interchangeably. However, in Pierce County (in accordance with the Washington State Department of Ecology's distinction), the term bioretention is used to describe an engineered facility that includes designed soil mixes and perhaps underdrains and control structures. The term "rain garden" is used to describe a landscape feature to capture stormwater on small project sites. Rain gardens have less restrictive design criteria for the soil mix and do not include underdrains and other control structures.

Infiltration treatment systems are typically installed:

- As off-line systems, or on-line for small drainages.
- As a polishing treatment for street/highway runoff after pretreatment for total suspended solids and oil.

- As part of a treatment train.
- As retrofits at sites with limited land areas, such as residential lots, commercial areas, parking lots, and open space areas.
- With appropriate pretreatment for oil and silt control to prevent clogging. Appropriate pretreatment devices include a presettling basin, wet pond/vault, constructed wetland, media filter, and oil/water separator. An infiltration basin is preferred over a trench for ease of maintenance reasons.
- Rain gardens are an onsite stormwater management BMP option for projects that only have to comply with Minimum Requirements #1 through #5.
- Bioretention areas are an onsite stormwater management BMP option for 1) projects that only have to comply with Minimum Requirements #1 through #5; and 2) projects that trigger Minimum Requirements #1 through #10.
- Bioretention areas and rain gardens are applications of the same LID concept and can be highly effective for reducing surface runoff and removing pollutants.

6.3 Soil Requirements for Infiltration for Water Quality Treatment

Infiltration treatment (i.e., an infiltration basin or trench) meets the requirements for *basic, phosphorus,* and *enhanced* treatment if 91 percent of the influent runoff file (indicated by Western Washington Hydrology Model [WWHM]) is successfully infiltrated within 48 hours. Soil suitability criteria below apply for infiltration treatment basins and trenches (related requirements for bioretention areas are covered in Volume III, Section 3.4):

The measured (initial) soil infiltration rate (field measured, before safety factors) must be 9 inches per hour, or less. Design (long-term) infiltration rates up to 3.0 inches per hour can be used with approval by Pierce County, if the infiltration receptor is not a sole-source aquifer, and in the judgment of the site professional, the treatment soil has characteristics comparable to those specified below to adequately control the target pollutants:

- CEC of the soil must be greater than or equal to 5 milliequivalents per 100 grams of dry soil. Lower CEC content may be considered if it is based on a soil loading capacity determination for the target pollutants that is approved by Pierce County.
- Organic content of the treatment soil (ASTM D2974): Organic matter can increase the sorptive capacity of the soil for some pollutants. A minimum of 1 percent organic content is necessary.
- Depth of soil used for infiltration runoff treatment must be a minimum of 18 inches. Below permeable pavements serving as pollution-generating hard surfaces may be reduced to 1 foot if the permeable pavement does not accept runon from other surfaces.

For all infiltration treatment facilities, the site infiltration rate must be determined using one of the methods described in Volume III, Appendix IIIA and must meet all the requirements in Volume I, Appendix I-C.

6.4 Best Management Practices for Infiltration and Bioretention Treatment

The four BMPs discussed below are recognized as effective treatment techniques using infiltration and bioretention. Selection of a specific BMP should be coordinated with the treatment facility menus provided in Chapter 3.

6.4.1 Infiltration Basins (Ecology BMP T7.10)

See Volume III, Section 2.5 for information pertinent to infiltration ponds/basins and trenches.
See Volume III, Section 3.7 for information specific to infiltration basins.

6.4.2 Infiltration Trenches (Ecology BMP T7.20)

See Volume III, Section 2.5 for information pertinent to infiltration ponds/basins and trenches.
See Volume III, Section 3.6 for information specific to infiltration trenches.

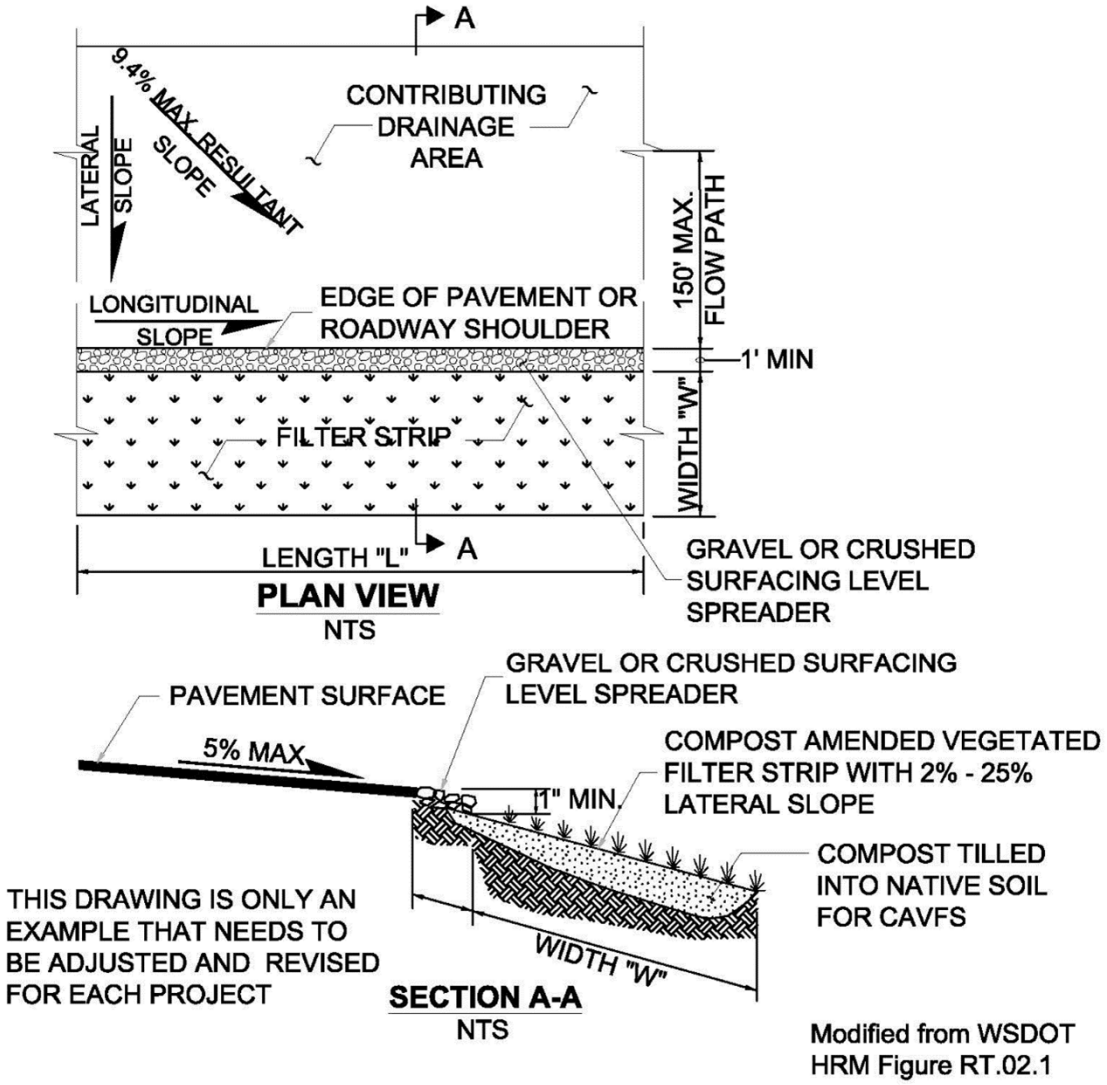
6.4.3 Bioretention Cells, Swales, and Planter Boxes (Ecology BMP T7.30)

See Volume III, Section 3.4 for information specific to bioretention cells, swales, and planter boxes.

6.4.4 Compost-amended Vegetated Filter Strips (CAVFS) (Ecology BMP T7.40)

The CAVFS is a variation of the basic vegetated filter strip that adds soil amendments to the roadside embankment (see Figure 6.1). The soil amendments improve infiltration characteristics, increase surface roughness, and improve plant sustainability. Once permanent vegetation is established, the advantages of the CAVFS are higher surface roughness, greater retention and infiltration capacity, improved removal of soluble cationic contaminants through sorption, improved overall vegetative health, and a reduction of invasive weeds. Compost-amended systems have somewhat higher construction costs due to more expensive materials, but require less land area for runoff treatment, which can reduce overall costs.

Figure 6.1. - Example of a Compost Amended Vegetated Filter Strip (CAVFS).



Applications and Limitations

CAVFS can be used to meet basic runoff treatment and enhanced runoff treatment objectives. It has practical application in areas where there is space for roadside embankments that can be built to the CAVFS specifications.

Soil Design Criteria

The CAVFS design incorporates composted material into the native soils in accordance with the criteria in Soil Preservation and Amendment BMP for turf areas (see Volume III, Section 3.1). However, as noted below, the compost shall not contain biosolids or manure. The goal is to create a healthy soil environment for a lush growth of turf.

- **Soil/Compost Mix:**
  - **Presumptive approach:** Place and rototill 1.75 inches of composted material into 6.25 inches of soil (a total amended depth of about 9.5 inches), for a settled depth of 8

inches. Water or roll to compact soil to 85 percent maximum. Plant grass.

- **Custom approach:** Place and rototill the calculated amount of composted material into a depth of soil needed to achieve 8 inches of settled soil at 5 percent organic content. Water or roll to compact soil to 85 percent maximum. Plant grass. The amount of compost or other soil amendments used varies by soil type and organic matter content. If there is a good possibility that site conditions may already contain a relatively high organic content, then it may be possible to modify the pre-approved rate described above and still be able to achieve the 5 percent organic content target.
- The final soil mix (including compost and soil) should have an initial saturated hydraulic conductivity less than 12 inches per hour, and a minimum long-term hydraulic conductivity of 1 inch per hour, per ASTM Designation D 2434 (Standard Test Method for Permeability of Granular Soils) at 85 percent compaction per ASTM Designation D 1557 (Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort. Infiltration rate and hydraulic conductivity are assumed to be approximately the same in a uniform mix soil.

  Note: Long-term saturated hydraulic conductivity is determined by applying the appropriate infiltration correction factors as explained under "Determining Design Bioretention Soil Mix Infiltration Rate" in bioretention cells, swales, and planter boxes (Volume III, Section 3.4).
- The final soil mixture should have a minimum organic content of 5 percent by dry weight per ASTM Designation D 2974 (Standard Test Method for Moisture, Ash and Organic Matter of Peat and Other Organic Soils) (Tackett 2004).
- Achieving the above recommendations will depend on the specific soil and compost characteristics. In general, the recommendation can be achieved with 60 percent to 65 percent loamy sand mixed with 25 percent to 30 percent compost or 30 percent sandy loam, 30 percent coarse sand, and 30 percent compost.
- The final soil mixture should be tested prior to installation for fertility, micronutrient analysis, and organic material content.
- Clay content for the final soil mix should be less than 5 percent.
- Compost must not contain biosolids, manure, any street or highway sweepings, or any catch basin solids.
- The pH for the soil mix should be between 5.5 and 7.0 (Stenn 2003). If the pH falls outside the acceptable range, it may be modified with lime to increase the pH or iron sulfate plus sulfur to lower the pH. The lime or iron sulfate must be mixed uniformly into the soil prior to use in LID areas (Low-Impact Development Center 2004).
- The soil mix should be uniform and free of stones, stumps, roots, or other similar material larger than 2 inches.
- When placing topsoil, it is important that the first lift of topsoil is mixed into the top of the existing soil. This allows the roots to penetrate the underlying soil easier and helps prevent the formation of a slip plane between the two soil layers.

- **Soil Component:**
  - The texture for the soil component of the LID BMP soil mix should be loamy sand (USDA Soil Textural Classification).

- **Compost Component:**
    - Follow the specifications for compost for bioretention cells, swales, and planter boxes in (see Volume III, Section 3.4).

Landscaping (Planting Considerations) and Vegetation Establishment

- Plant vegetated filter strips with grass that can withstand relatively high-velocity flows as well as wet and dry periods. Projects may also incorporate native vegetation into filter strips, such as small shrubs to make the system more effective in treating runoff and providing root penetration into subsoils, thereby enhancing infiltration. Consult with a landscape architect for recommendations on grasses and plants suitable for the project site.

Design Modeling Method

The CAVFS will have an "element" in most of the approved continuous runoff models that should be used for determining the amount of water that is treated by the CAVFS. To fully meet treatment requirements, 91 percent of the influent runoff file must pass through the soil profile of the CAVFS. Water that merely flows over the surface is not considered treated. Approved continuous runoff models should be able to report the amount of water that is designed to pass through the soil profile.

Chapter 7. Filtration Treatment Facilities

Note: Figures in Chapter 7 are courtesy of King County, except as noted.

7.1 Purpose

This chapter presents criteria for the design and construction of runoff treatment filters including basin, vault, and linear filters. Filtration treatment facilities collect and treat design runoff volumes to remove total suspended solids, phosphorous, and insoluble organics (including oils) from stormwater. See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

Five BMPs are discussed in this chapter:

- Sand Filter Basin (Section 7.8.1)
- Sand Filter Vault (Section 7.8.2)
- Linear Sand Filter (Section 7.8.3)
- Media Filter Drain (previously referred to as the Ecology Embankment) (Section 7.8.4).

7.2 Description

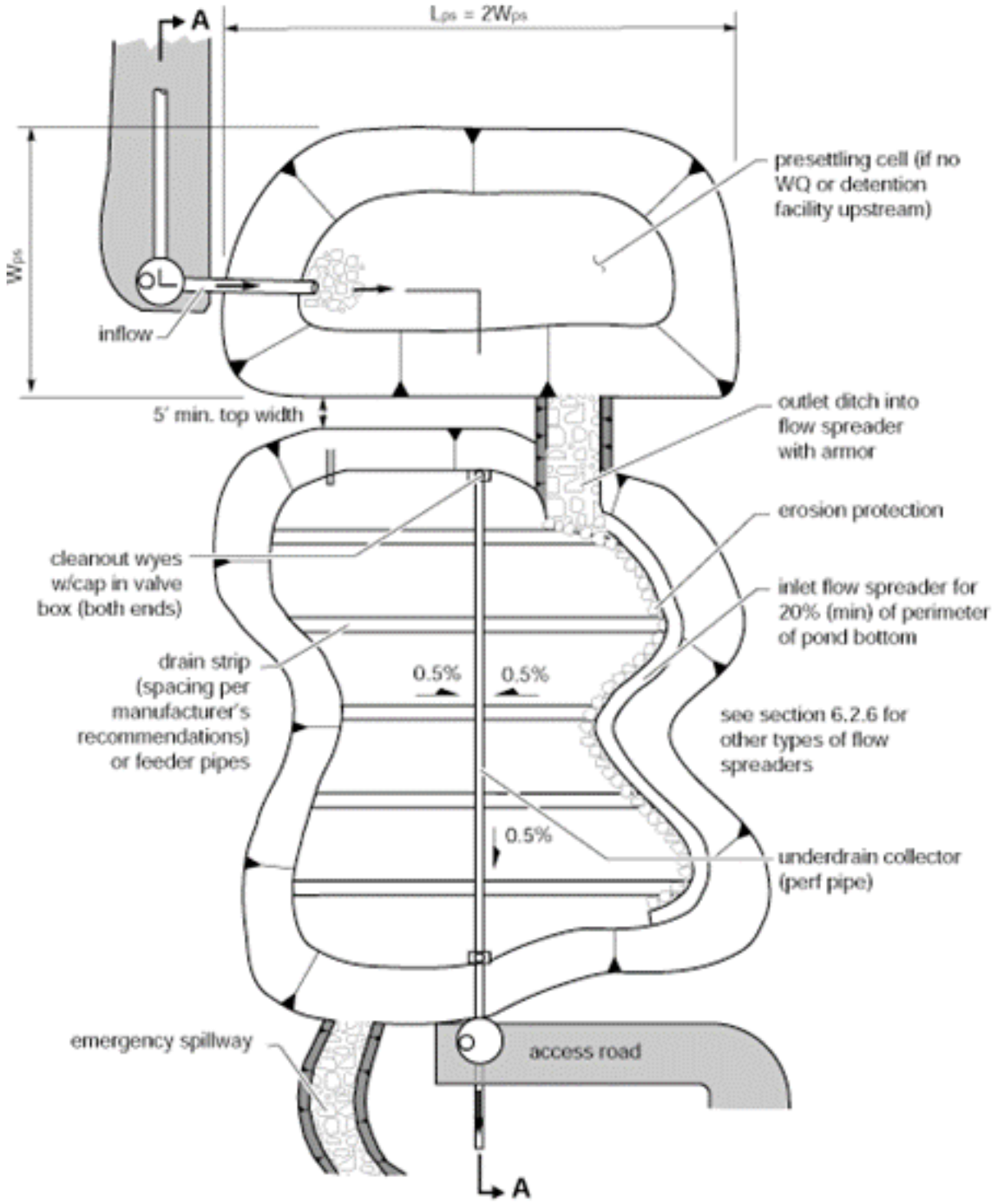
A typical sand filtration system consists of a pretreatment system, flow spreader(s), sand bed, and underdrain piping. The sand filter bed includes a geotextile fabric between the sand bed and the bottom underdrain system.

Provide an impermeable liner under the facility if the filtered runoff requires additional treatment to remove soluble groundwater pollutants; or where additional groundwater protection is mandated.

The variations of a sand filter include a basic or large sand filter basin, sand filter basin with level spreader, sand filter vault, and linear sand filter. Figures 7.1 through 7.5 provide examples of various sand filter configurations. Attachments Section B, Details 12.0 and 13.0 provide additional sand filtration schematics. Details 8.0 and 9.0 also provide example diversion structure details.

The media filter drain (MFD) has four basic components: a gravel no-vegetation zone, a grass strip, the MFD mix bed, and a conveyance system for flows leaving the MFD mix. The MFD mix is composed of gravel, perlite, dolomite, and gypsum.

Figure 7.1a. - Sand Filter Basin with Pretreatment Cell.



PLAN VIEW
NTS

Figure 7.1b. - Sand Filter Basin with Pretreatment Cell (continued).

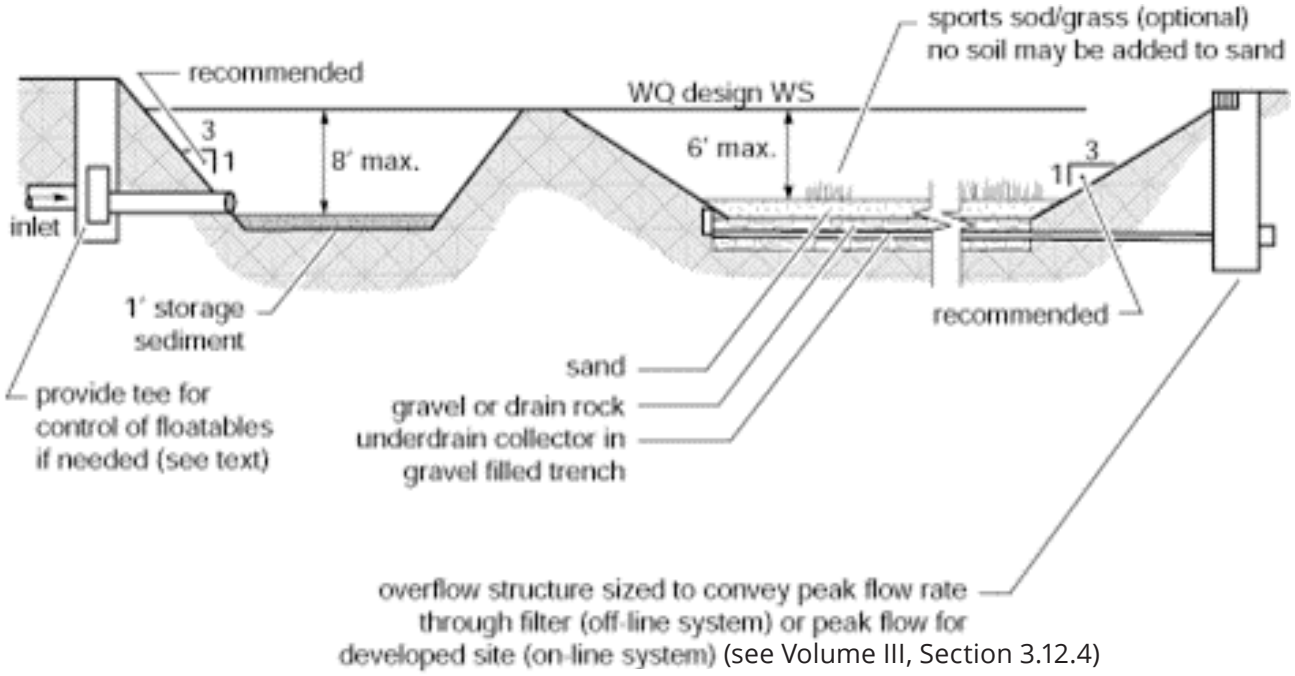
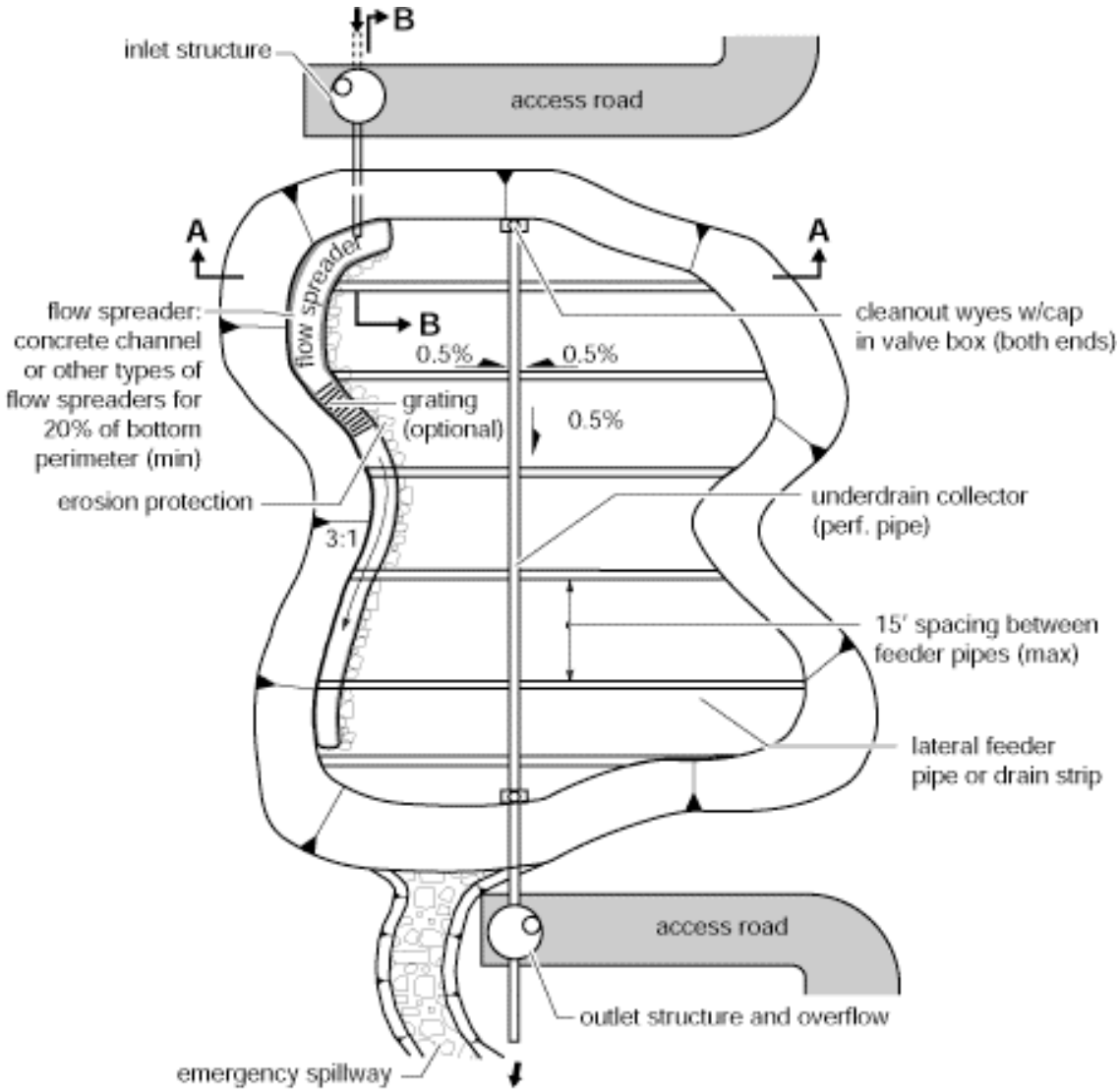


Figure 7.2a. - Sand Filter Basin with Level Spreader.



PLAN VIEW
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Figure 7.2b. - Sand Filter Basin with Level Spreader (continued).

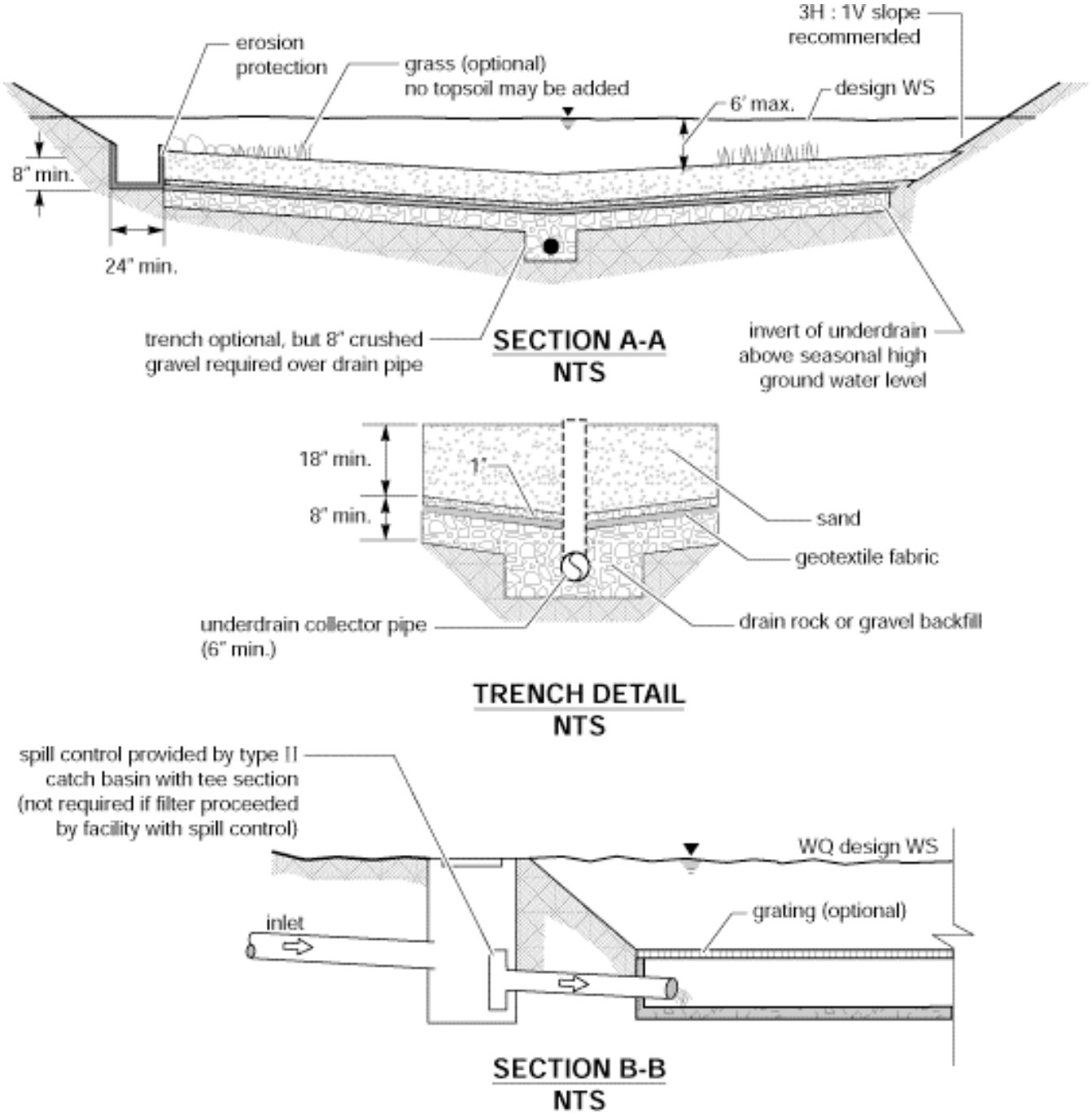
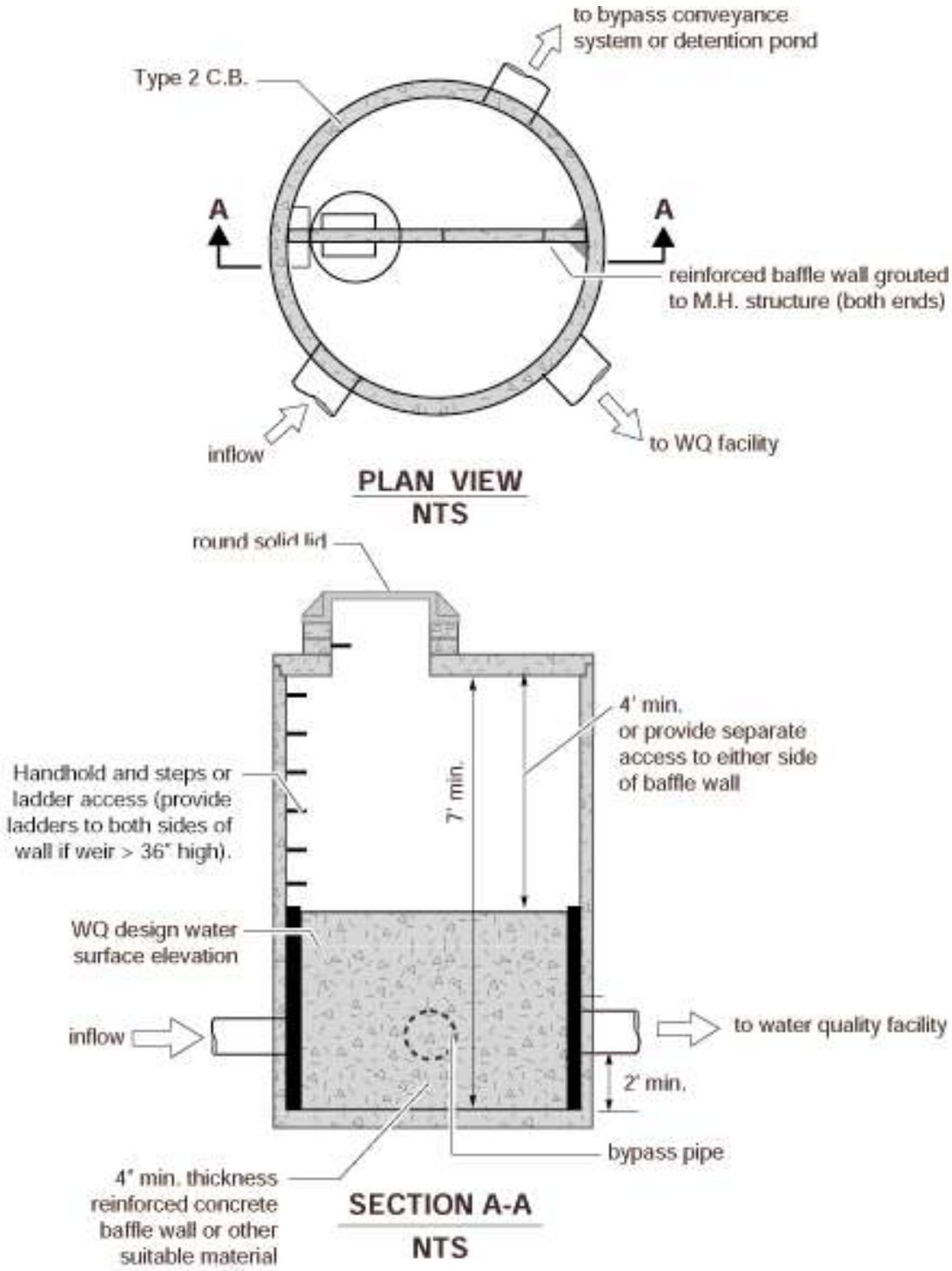
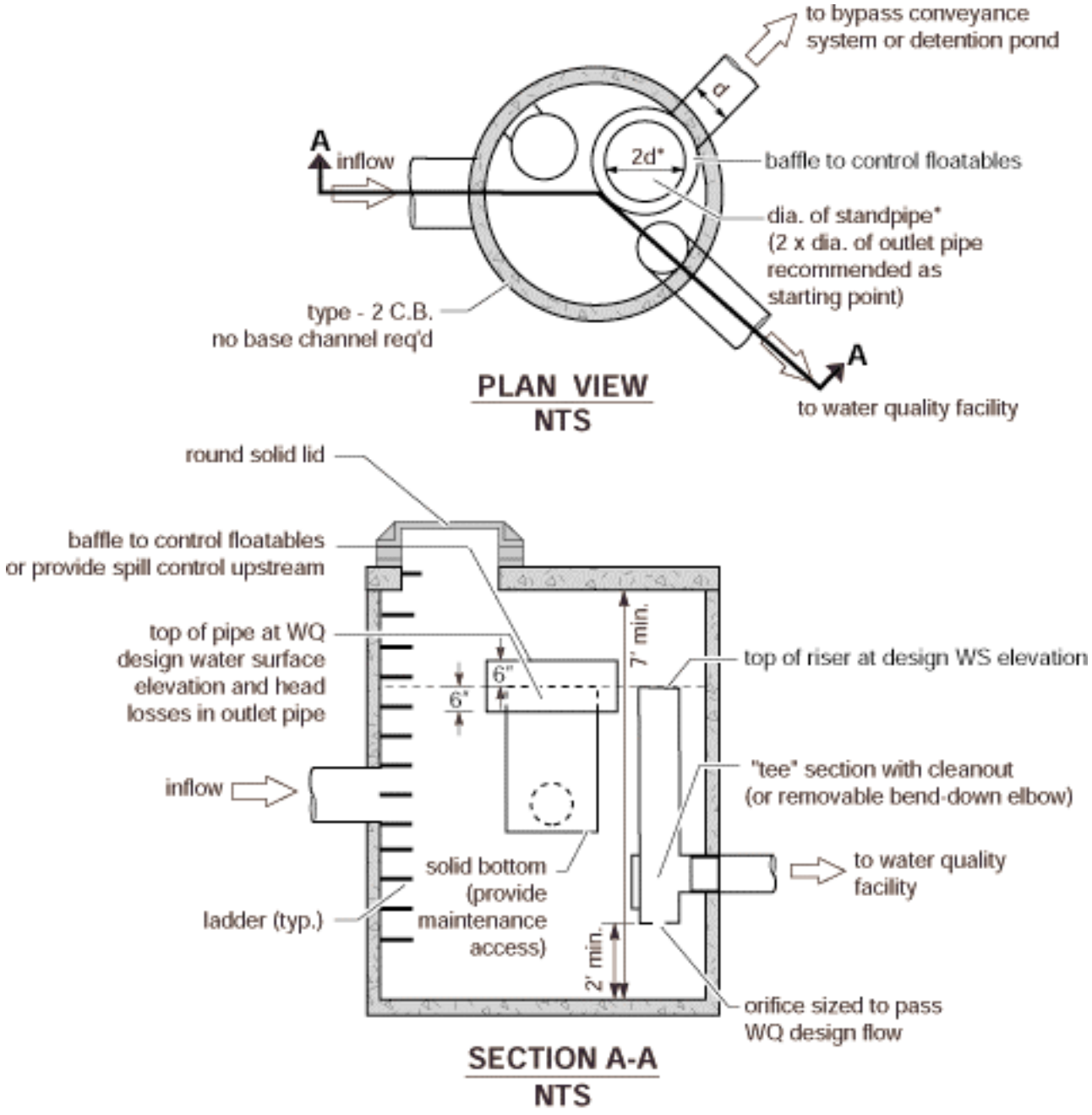


Figure 7.3a. - Flow Splitter Option A.



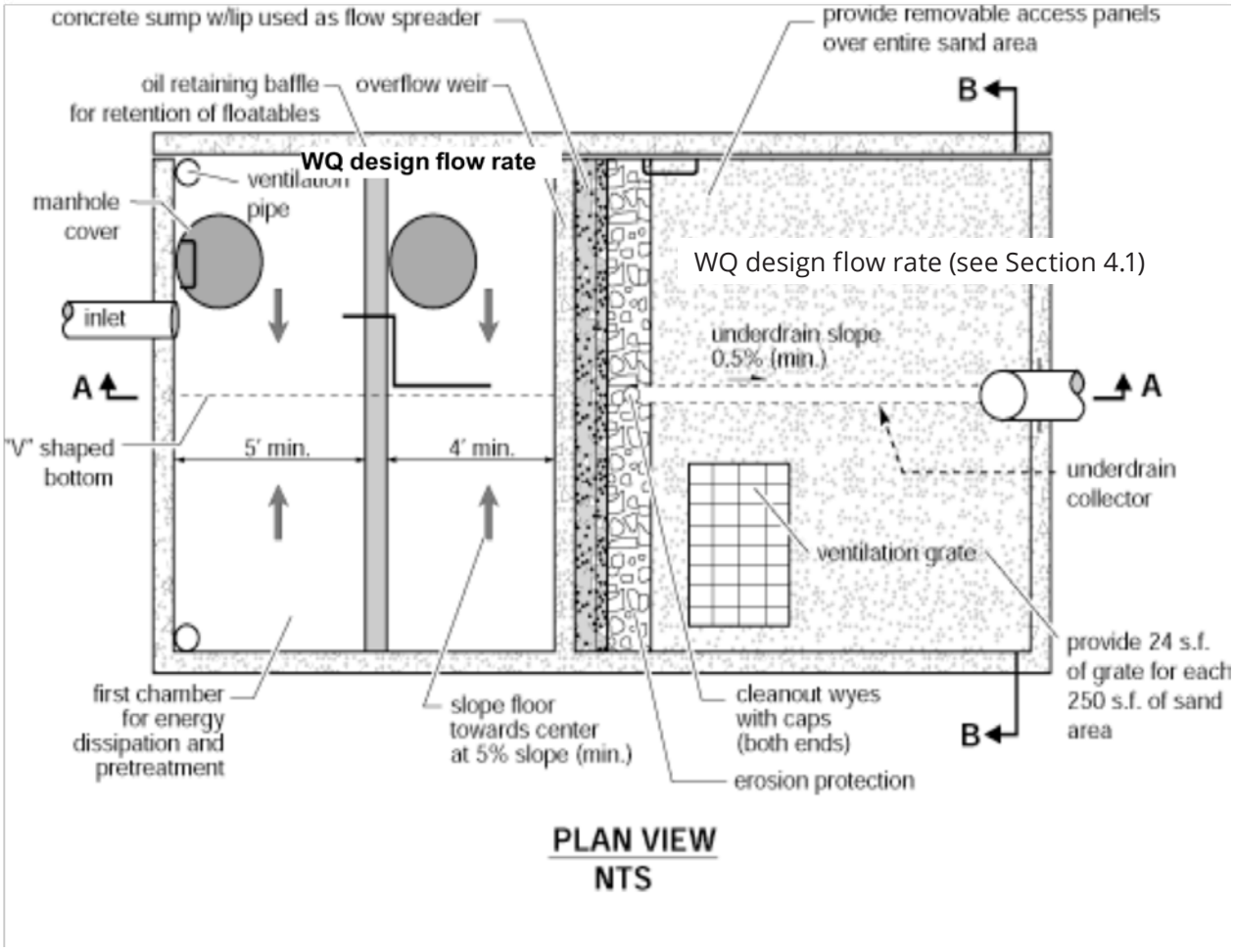
Note: The water quality discharge pipe may require an orifice plate be installed on the outlet to control the height of the design water surface (weir height). The design water surface should be set to provide a minimun headwater/diameter ratio of 2.0 on the outlet pipe.

Figure 7.3b. - Flow Splitter Option B.



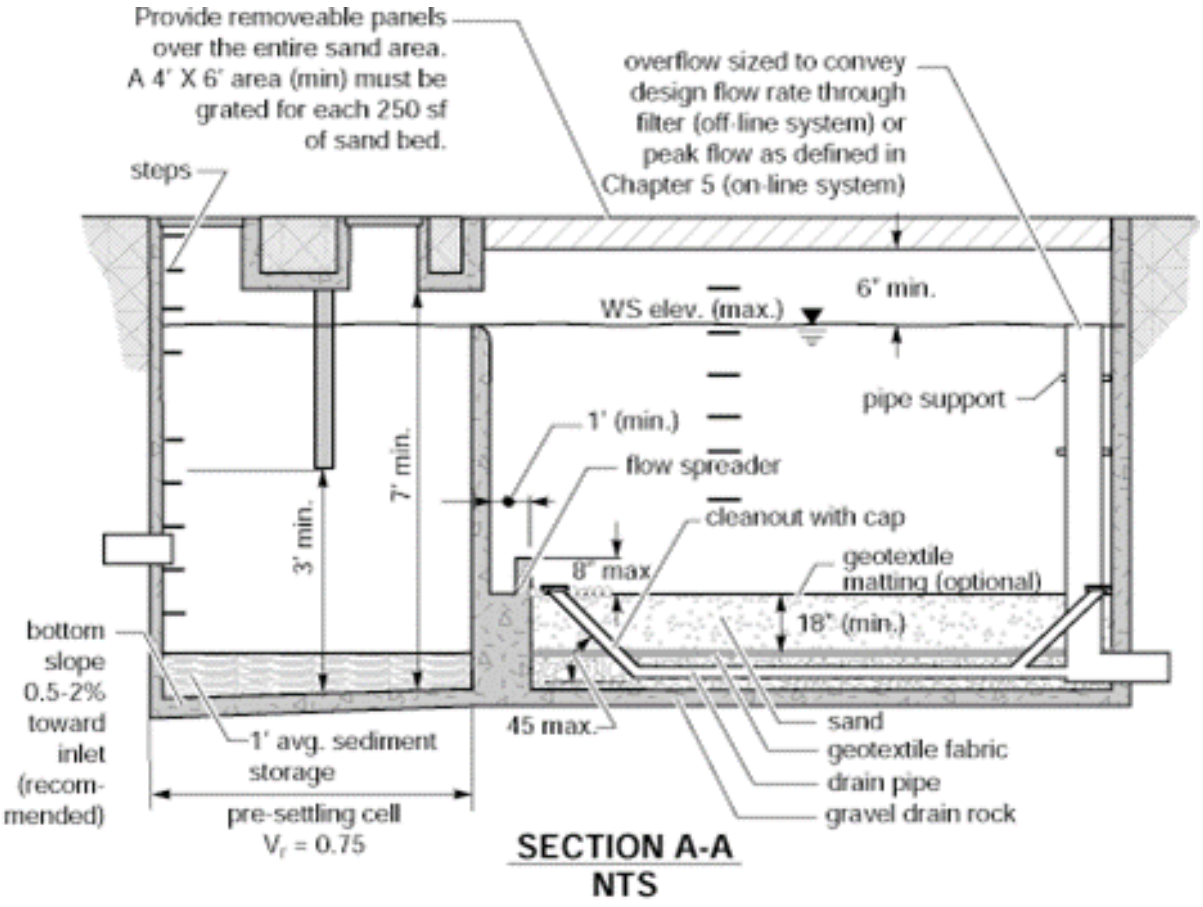
*__NOTE__: Diameter (d) of standpipe should be large enough to minimize head above WQ design WS and to keep WQ design flows from increasing more than 10% during 100-year flows.

Figure 7.4a. - Sand Filter Vault.



Source: City of Austin

Figure 7.4b. - Sand Filter Vault (continued).



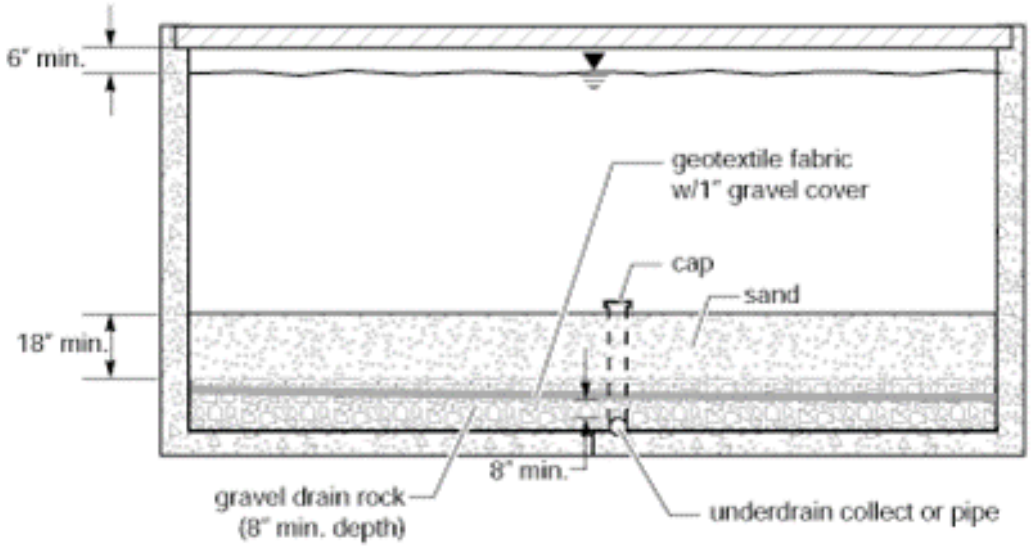
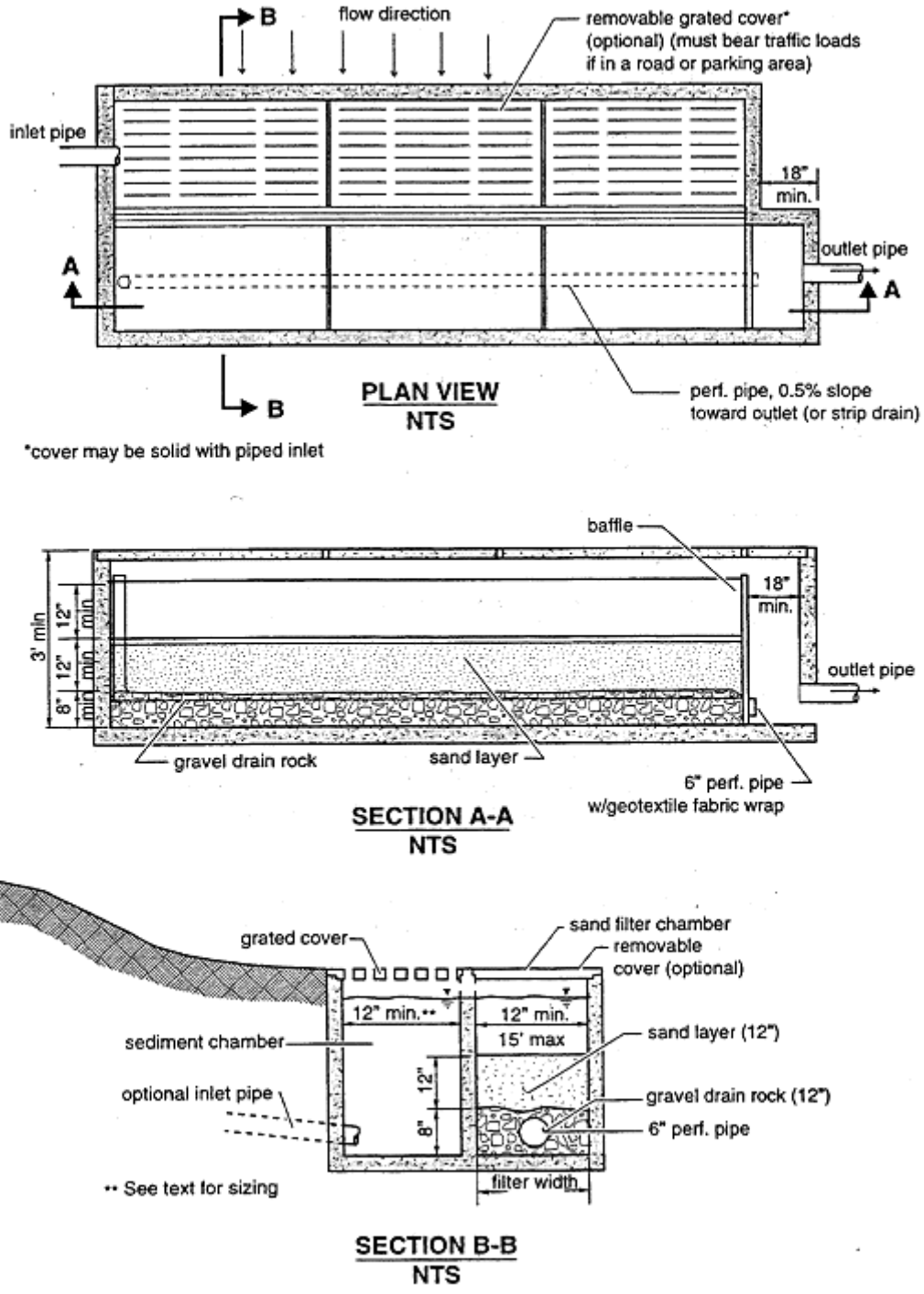


Figure 7.5. - Linear Sand Filter.



7.3 Performance Objectives

Refer to Chapter 3 for descriptions of the basic, oil, phosphorus, and enhanced treatment goals.

Basic sand filter vault, sand filter vault, and linear sand filter: Basic sand filters are expected to achieve the following average pollutant removals:

- Basic treatment goal: 80 percent total suspended solids at influent Event Mean Concentrations (EMCs) of 100-200 mg/L
- Oil treatment goal: Oil and grease to below 10 mg/L daily average and 15 mg/L at any time, with no ongoing or recurring visible sheen in the discharge.

Large sand filter: Large sand filters are expected to meet the phosphorus treatment goal by removing at least 50 percent of the total phosphorous compounds (influent 0.1 to 0.5 mg/L, as total phosphorus) by collecting and treating 95 percent of the runoff volume (ASCE and WEF 1998).

Media filter drain: Media filter drains are expected to achieve the:

- Basic treatment goal
- Phosphorous treatment goal
- Enhanced treatment goal: greater than 30 percent reduction of dissolved copper, and greater than 60 percent reduction of dissolved zinc.

7.4 Applications and Limitations

Filtration can be used in most residential, commercial, and industrial developments where debris, heavy sediment loads, and oils and greases will not clog or prematurely overload the filter, or where adequate pretreatment is provided for these pollutants. Specific applications include residential subdivisions, parking lots for commercial and industrial establishments, gas stations, high-use sites, high-density multifamily housing, roadways, and bridge decks.

Locate sand filters off-line before or after detention (Chang 2000). Sand filters are also suited for locations with space constraints in retrofit and new/redevelopment situations. Carefully design overflow or bypass structures to handle the larger storms. Size off-line systems to treat 91 percent of the runoff volume predicted by a continuous runoff model. If a project must comply with Minimum Requirement #7: Flow Control, route the flows bypassing the filter and the filter discharge to an infiltration/detention facility.

Pretreatment is necessary to reduce velocities to the sand filter and remove debris, floatables, large particulate matter, and oils. In high water table areas, adequate drainage of the filter may require additional engineering analysis and design considerations. Consider an underground filter in areas subject to freezing conditions (Urbonas 1997).

7.5 Site Suitability

The following site characteristics should be considered in siting a sand filtration system:

- Space availability, including a presettling basin
- Sufficient hydraulic head from inlet to outlet
- Adequate operation and maintenance capability including accessibility for O&M
- Sufficient pretreatment of oil, debris and solids in the tributary runoff

7.6 Design Requirements

Sand filters must capture and treat the Water Quality Design Storm volume which is 91 percent of the total runoff volume (95 percent for large sand filter) as predicted by an approved, equivalent continuous runoff model. Only 9 percent of the total runoff volume (5 percent for large sand filter) would bypass or overflow from the sand filter facility. **Additional design criteria specific to each sand filter BMP are provided at the end of this chapter. The criteria outlined under the Sand Filter Basin BMP apply to all sand filter BMPs, unless otherwise noted under the subsequent BMP descriptions for Sand Filter Vaults and Linear Sand Filters.**

7.6.1 Sand Filter Sizing Procedure

The following design criteria apply to all sand filter BMPs, unless otherwise noted under the subsequent BMP descriptions for sand filter vaults and linear sand filters.

General facility sizing methods are provided below, followed by design criteria to be used when designing a sand filter with an approved continuous runoff model.

General Design Method

Whether performing the sand filter design manually, or with an approved model, either method is based on Darcy's law for modeling flow through a porous media like sand or soil:

$$Q = KiA$$

where:

Q = water quality design flow (cfs)
K = hydraulic conductivity of the media (fps)
A = surface area perpendicular to the direction of flow (sf)
i = hydraulic gradient (ft/ft) for a constant head and constant media depth

$$i = \frac{+L}{L}$$

and:

h = average depth of water above the filter (ft), defined as d/2
d = maximum water storage depth above the filter surface (ft)
L = thickness of sand media (ft)

Darcy's law underlies both the manual and the modeling design methods. V, or more correctly, 1/V, is the direct input in the sand filter design. The relationship between V and K is revealed by equating Darcy's law and the equation of continuity, Q = VA. (Note: When water is flowing into the ground, V is commonly called the filtration rate. It is ordinarily measured via a soil infiltration test.)

Specifically:

$$Q = KiA \quad \text{and} \quad Q = VA \text{ so,}$$

$$VA = KiA \quad \text{or} \quad V = Ki$$

Note that V ≠ K. The filtration rate is not the same as the hydraulic conductivity, but they do have the same units (distance per time). K can be equated to V by dividing V by the hydraulic gradient i, which is defined above. The hydraulic conductivity K does not change with head nor is it dependent on the thickness of the media, only on the characteristics of the media and the fluid. The hydraulic conductivity of 1 inch per hour (2.315×10^{-5} fps) specified for sand filter design is based on bench-scale tests of conditioned rather than clean sand. This design hydraulic conductivity represents the average sand bed condition as silt is captured and held in the filter bed. Unlike the hydraulic conductivity, the filtration rate V changes with head and media thickness, although the media thickness is constant in the sand filter design. Table 7.1 shows values of V for different water depths d (d = 2h).

Table 7.1. - Sand Filter Design Parameters.

	Sand Filter Design Parameters					
Facility ponding depth d (ft)	1	2	3	4	5	6
Filtration rate V (in/hr)[a]	1.33	1.67	2.00	2.33	2.67	3.00
1/V (min/in)	45	36	30	26	22.5	20

a The filtration rate is not used directly, but is provided for information. V equals the hydraulic conductivity, K, times the hydraulic gradient, i. The hydraulic conductivity used is 1 inch/hr. The hydraulic gradient = (h + L)/L, where h = d/2 and L = the sand depth (1.5 ft).

Modeling Method

When using continuous modeling to size a sand filter, apply the assumptions listed in Table 7.2. Several available modeling programs include built-in modules to size sand filters.

7.7 Construction Criteria

Until all project improvements which produce surface runoff are completed and all exposed ground surfaces are stabilized by revegetation or landscaping, sand filtration systems may not be operated, and no surface runoff may be permitted to enter the system. Construction runoff may be routed to a pretreatment sedimentation facility, but discharge from sedimentation facilities should bypass downstream sand filters. Careful level placement of the sand is necessary to avoid formation of voids within the sand that could lead to short-circuiting (particularly around penetrations for underdrain cleanouts), and to prevent damage to the underlying geomembranes and underdrain system. Over-compaction should be avoided to ensure adequate filtration capacity. Sand is best placed with a low ground pressure bulldozer (4 psig or less). After the sand layer is placed water settling is recommended. Flood the sand with 10 to 15 gallons of water per cubic foot of sand.

Table 7.2. - Sand Filter Design and Sizing Criteria.

Variable	Assumption
Precipitation Series	Pierce County extended precipitation time series
Computational Time Step	15minutes
Inflows to Facility	Model output for water quality design
Ponding Depth	Maximum water depth over the filter media
Precipitation Applied to Facility	Checked (always activated when sizing above ground sand filters)
Evaporation Applied to Facility	Checked (always activated when sizing above ground sand filters)
Media depth	18 inches or other as designed
Infiltration Reduction Factor	Inverse of safety factor (i.e., safety factor of 2 is a reduction factor of 0.5). Safety factors for infiltration rates are discussed in Volume III, Appendix III-A.
Sand Media Hydraulic Conductivity	1 inch per hour
Use Wetted Surface Area	Only if side slopes are 3:1 or flatter

7.8 Best Management Practices for Sand Filtration

7.8.1 Sand Filter Basin (Ecology BMP T8.10)

The following design requirements apply to all sand filter BMPs, unless otherwise noted under the subsequent descriptions for Sand Filter Vaults and Linear Sand Filters.

A sand filter basin is constructed so that its surface is at grade and open to the elements, similar to an infiltration basin. However, instead of infiltrating into native soils, stormwater filters through a constructed sand bed with an underdrain system. See Figures 7.1 through 7.5.

Basic and Large Sand Filters

A summary of the basic sand filter design requirements are given below.

On-Line:

- On-line sand filters shall only be located downstream of detention to prevent exposure of the sand filter surface to high flow rates that could cause loss of media and previously removed pollutants.
- Size on-line sand filters placed **downstream** of a detention facility to filter 91 percent of the runoff volume (95 percent for large sand filter).

Off-Line:

- Off-line sand filters placed **upstream** of a detention facility must have a flow splitter designed to send all flows at or below the 15minute water quality flow rate, as predicted by an approved continuous runoff model, to the sand filter.
- The sand filter must be sized to filter all the runoff sent to it (no overflows from the treatment facility should occur). Note that WWHM allows any bypasses and the runoff filtered through the sand to be directed to the downstream detention facility.
- **Off-line** sand filters placed **downstream** of a detention facility must have a flow splitter designed to send all flows at or below the 2year recurrence interval flow from the detention

pond, as predicted by an approved continuous runoff model, to the treatment facility. The treatment facility must be sized to filter all the runoff sent to it (no overflows from the treatment facility should occur).

Additional Design Criteria for Basic and Large Sand Filters

Hydraulics:

- Pretreat (e.g., presettling basin, etc., depending on pollutants) runoff directed to the sand filter to remove debris and other solids. In high-use sites, the pretreatment should be an appropriate oil treatment as described in Section 3.2.
- If the drainage area maintains a base flow between storm events, bypass the base flow around the filter to keep the sand from remaining saturated for extended periods.
- Assume a design filtration rate of 1 inch per hour. Though the sand specified below will initially infiltrate at a much higher rate, that rate will slow as the filter accumulates sediment. When the filtration rate falls to 1 inch per hour, removal of sediment is necessary to maintain rates above the rate assumed for sizing purposes.
- Design inlet bypass and flow spreading structures (e.g., flow spreaders, weirs or multiple orifice openings) to capture the applicable design flow rate, minimize turbulence, and to spread the flow uniformly across the surface of the sand filter. Install stone riprap or other energy dissipation devices to prevent gouging of the sand medium and to promote uniform flow. Include emergency spillway or overflow structures.
    - If the sand filter is curved or an irregular shape, provide a flow spreader for a minimum of 20 percent of the filter perimeter.
    - If the length-to-width ratio of the filter is 2:1 or greater, locate a flow spreader on the longer side of the filter for a minimum length of 20 percent of the facility perimeter.
    - Provide erosion protection along the first foot of the sand bed adjacent to the flow spreader. Methods for this include geotextile weighted with sand bags at 15-foot intervals and quarry spalls.
- Include an overflow in the design. The overflow height should be at the maximum hydraulic head of the pond above the sand bed. On-line filters shall have overflows (primary, secondary, and emergency) in accordance with the design criteria for detention ponds (Volume III, Section 3.12.1).

Underdrains

- Types of underdrains include:
    - A central collector pipe with lateral feeder pipes, in an 8-inch gravel backfill or drain rock bed.
    - A central collector pipe with a geotextile drain strip in an 8-inch gravel backfill or drain rock bed.
    - Longitudinal pipes in an 8inch gravel backfill or drain rock with a collector pipe at the outlet end.
- Size underdrain piping to handle the 2year recurrence interval flow indicated by an approved continuous runoff model (using a 15minute time step). Note that for large sand filters, size the underdrain using: (95 percent Runoff Volume)/(91 percent Runoff Volume) *

2year recurrence interval flow (using a 15minute time step).

- Use underdrain pipe with a minimum internal diameter of 6 inches, with two rows of three-eighth-inch holes spaced 6 inches apart longitudinally (maximum), and rows 120 degrees apart (laid with holes downward). Maintain a maximum perpendicular distance between two feeder pipes, or the edge of the filter and a feeder pipe, of 10 feet. All piping is to be schedule 80 PVC or greater wall thickness.
- Slope the main collector underdrain pipe 1 percent minimum.
- Use a geotextile fabric (specifications in Appendix VA) between the sand layer and drain rock or gravel. Cover the geotextile fabric with 2 inches of drain rock or gravel. Drain rock should be 0.75 to 1.5 inch rock or gravel backfill, washed free of clay and organic material.
- Place cleanout wyes with caps or junction boxes at both ends of the collector pipes. Extend cleanouts to the surface of the filter. Supply a valve box for access to the cleanouts.

Sand Specification

- Sand shall be 18 inches minimum depth. The sand in a filter must consist of a medium sand meeting the size gradation (by weight) given in Table 7.3 below. The contractor must obtain a grain size analysis from the supplier to certify that the sand meets the No. 100 and No. 200 sieve requirements. (Note: Do not use WSDOT Std. Spec. 9-03.13 Backfill for Sand Drains or 9-03.13(1) Sand Drainage Blanket, neither of these WSDOT Std. Spec. meet the required specification for the sand filter BMP).

Table 7.3. - Sand Medium Specification.

U.S. Sieve Number	Percent Passing
4	100
8	70–100
16	40–90
30	25–75
50	2–25
100	< 4
200	< 2

Impermeable Liners for Sand Bed Bottom

- Impermeable liners are required where the underflow could cause problems with structures. If an impermeable liner is not provided, then an analysis must be provided identifying possible adverse effects of seepage zones on groundwater, and near building foundations, basements, roads, parking lots and sloping sites. Sand filters without impermeable liners should not be built on fill sites and should be located at least 20 feet downslope and 100 feet upslope from building foundations.
- Impermeable liners consist of clay, concrete, or geomembrane. Clay liners should have a minimum thickness of 12 inches and meet the specifications given in Table 7.4. If a geomembrane liner is used it must have a minimum thickness of 30 mils and be ultraviolet resistant. Protect the geomembrane liner from puncture, tearing, and abrasion by installing geotextile fabric on the top and bottom of the geomembrane.
- Concrete liners may also be used for sedimentation chambers and for sedimentation and sand filtration basins less than 1,000 square feet in area. Concrete must be 5 inches thick

Class A or better and reinforced by steel wire mesh. The steel wire mesh must be 6 gauge wire or larger and 6inch by 6inch mesh or smaller. An "Ordinary Surface Finish" is required. When the underlying soil is clay or has an unconfined compressive strength of 0.25 ton per square foot or less, the concrete must have a minimum 6inch compacted aggregate base. This base must consist of coarse sand and river stone, crushed stone or equivalent with diameter of 0.75 to 1 inch.

- If an impermeable liner is not required then a geotextile fabric liner must be installed that retains the sand and meets the specifications listed in Appendix VA, unless the basin has been excavated to bedrock.

Table 7.4. - Clay Liner Specifications.

Property	Test Method	Unit	Specification
Permeability	ASTM D-2434	cm/sec	1×10^{-6} max.
Plasticity Index of Clay	ASTM D-423 and D-424	%	Not less than 15
Liquid Limit of Clay	ASTM D-2216	%	Not less than 30
Clay Particles Passing	ASTM D-422	%	Not less than 30
Clay Compaction	ASTM D-2216	%	95% of Standard Proctor Density

Source: City of Austin 1988

Other Criteria

- Include an access ramp with a maximum grade of 15 percent, or equivalent, for maintenance purposes at the inlet and the outlet of a surface filter. Consider an access port for inspection and maintenance.
- Side slopes for earthen/grass embankments must not exceed 3:1 to facilitate mowing.
- High groundwater may damage underground structures or affect the performance of filter underdrain systems. There must be sufficient clearance (at least 2 feet) between the seasonal high groundwater level and the bottom of the sand filter to obtain adequate drainage.

7.8.2 Sand Filter Vault (Ecology BMP T8.20)

A sand filter vault (see Figures 7.4a and 7.4b) is similar to an open sand filter except that the sand layer and underdrains are installed below grade in a vault. It consists of presettling and sand filtration cells.

Applications and Limitations

- Use where space limitations preclude aboveground facilities.
- Not suitable where high water table and heavy sediment loads are expected.
- An elevation difference of 4 feet between inlet and outlet is needed to allow sufficient hydraulic head for water to pass through the filter.

Design Criteria for Vaults

- See design criteria for sand filter basins in Sections 7.8 and 7.8.1 above.
- Vaults may be designed as off-line systems or on-line for small drainages.
- In an off-line system a diversion structure should be installed to divert the design flow

rate into the sediment chamber and bypass the remaining flow to detention/infiltration (if necessary to meet Minimum Requirement #7), or to surface water.

- Optimize sand inlet flow distribution with minimal sand bed disturbance. A maximum of 8inch distance between the top of the spreader and the top of the sand bed is suggested. Flows may enter the sand bed by spilling over the top of the wall into a flow spreader pad or alternatively a pipe and manifold system may be used. Any pipe and manifold system must retain the required dead storage volume in the first cell, minimize turbulence, and be readily maintainable.
- If an inlet pipe and manifold system is used, the minimum pipe size should be 8 inches. Multiple inlets are recommended to minimize turbulence and reduce local flow velocities.
- Erosion protection must be provided along the first foot of the sand bed adjacent to the spreader. Geotextile fabric secured on the surface of the sand bed, or equivalent method, may be used.
- The filter bed should consist of a sand top layer, and a geotextile fabric second layer with an underdrain system.
- Design the presettling cell for sediment collection and removal. A Vshaped bottom, removable bottom panels, or equivalent sludge handling system should be used. One foot of sediment storage in the presettling cell must be provided.
- The presettling chamber must be sealed to trap oil and trash. This chamber is usually connected to the sand filtration chamber through an invert elbow to protect the filter surface from oil and trash.
- If a retaining baffle is necessary for oil/floatables in the presettling cell, it must extend at least 1 foot above to 1 foot below the design flow water level. Provision for the passage of flows in the event of plugging must be provided. Access opening and ladder must be provided on both sides of the baffle.
- To prevent anoxic conditions, a minimum of 24 square feet of ventilation grate should be provided for each 250 square feet of sand bed surface area. For sufficient distribution of airflow across the sand bed, grates may be located in one area if the sand filter is small, but placement at each end is preferred. Small grates may also be dispersed over the entire sand bed area.
- Provision for access is the same as for wet vaults. Removable panels must be provided over the entire sand bed.
- Sand filter vaults must conform to the materials and structural suitability criteria specified for wet vaults.
- Provide a sand filter inlet shutoff/bypass valve for maintenance.
- A geotextile fabric over the entire sand bed may be installed that is flexible, highly permeable, three-dimensional matrix, and adequately secured. This is useful in trapping trash and litter.

7.8.3 Linear Sand Filter (Ecology BMP T8.30)

Linear sand filters (see Figure 7.5) are typically long, shallow, two-celled, rectangular vaults. The first cell is designed for settling coarse particles, and the second cell contains the sand bed. Stormwater flows into the second cell via a weir section that also functions as a flow spreader.

Application and Limitations

- Applicable in long narrow spaces such as the perimeter of a paved surface.
- As a part of a treatment train such as downstream of a filter strip, upstream of an infiltration system, or upstream of a wet pond or a biofilter for oil control.
- To treat small drainages (less than 2 acres of impervious area).
- To treat runoff from high-use sites for total suspended solids and oil/grease removal, if applicable.

Additional Design Criteria for Linear Sand Filters

- The two cells should be divided by a divider wall that is level and extends a minimum of 12 inches above the sand bed.
- Stormwater may enter the sediment cell by sheet flow or a piped inlet.
- The width of the sand cell must be 1 foot minimum to 15 feet maximum.
- The sand filter bed must be a minimum of 12 inches deep and have an 8inch layer of drain rock with perforated drainpipe beneath the sand layer.
- The drainpipe must be 6inch diameter minimum and be wrapped in geotextile and sloped a minimum of 0.5 percent.
- Maximum sand bed ponding depth: 1 foot.
- Must be vented as for sand filter vaults.
- Linear sand filters must conform to the materials and structural suitability criteria specified for wet vaults.
- Set sediment cell width as follows:

Sand filter width, (w) inches	12-24	24-48	48-72	72+
Sediment cell width, inches	12	18	24	w/3

7.8.4 Media Filter Drain (previously referred to as Ecology Embankment) (Ecology BMP T8.40)

The media filter drain (MFD), previously referred to as the ecology embankment, is a linear flow-through stormwater runoff treatment device that can be sited along roadway side slopes (conventional design) and medians (dual media filter drains), borrow ditches, or other linear depressions. Cut-slope applications may also be considered. The MFD can be used where available right-of-way is limited, sheet flow from the roadway surface is feasible, and lateral gradients are generally less than 25 percent (4H:1V). The MFD has a General Use Level Designation (GULD) for basic, enhanced, and phosphorus treatment. Updates/changes to the use-level designation and any design changes will be posted in the Postpublication Updates section of the Highway Runoff Manual Resource webpage.

Media filter drains have four basic components: a gravel no-vegetation zone, a grass strip, the MFD mix bed, and a conveyance system for flows leaving the MFD mix. This conveyance system usually consists of a gravel-filled underdrain trench or a layer of crushed surfacing base course (CSBC). This layer of CSBC must be porous enough to allow treated flows to freely drain away from the MFD mix.

Typical MFD configurations are shown in Figures 7.6, 7.7, and 7.8.

The MFD removes suspended solids, phosphorus, and metals from roadway runoff through physical straining, ion exchange, carbonate precipitation, and biofiltration.

The underdrain trench is an option for hydraulic conveyance of treated stormwater to a desired location, such as a downstream flow control facility or stormwater outfall. The trench's perforated underdrain pipe is a protective measure to ensure free flow through the MFD mix and to prevent prolonged ponding. It may be possible to omit the underdrain pipe if it can be demonstrated that the pipe is not necessary to maintain free flow through the MFD mix and underdrain trench.

It is critical to note that water should sheet flow across the MFD. Channelized flows or ditch flows running down the middle of the dual MFD (continuous offsite inflow) should be minimized.

Application and Limitations

In many instances, conventional runoff treatment is not feasible due to right-of-way constraints (such as adjoining wetlands and geotechnical considerations). The MFD and the dual MFD designs are runoff treatment options that can be sited in most right-of-way confined situations. In many cases, a MFD or a dual MFD can be sited without the acquisition of additional right-of-way needed for conventional stormwater facilities or capital-intensive expenditures for underground wet vaults.

Figure 7.6. - Media Filter Drain: Cross Section.

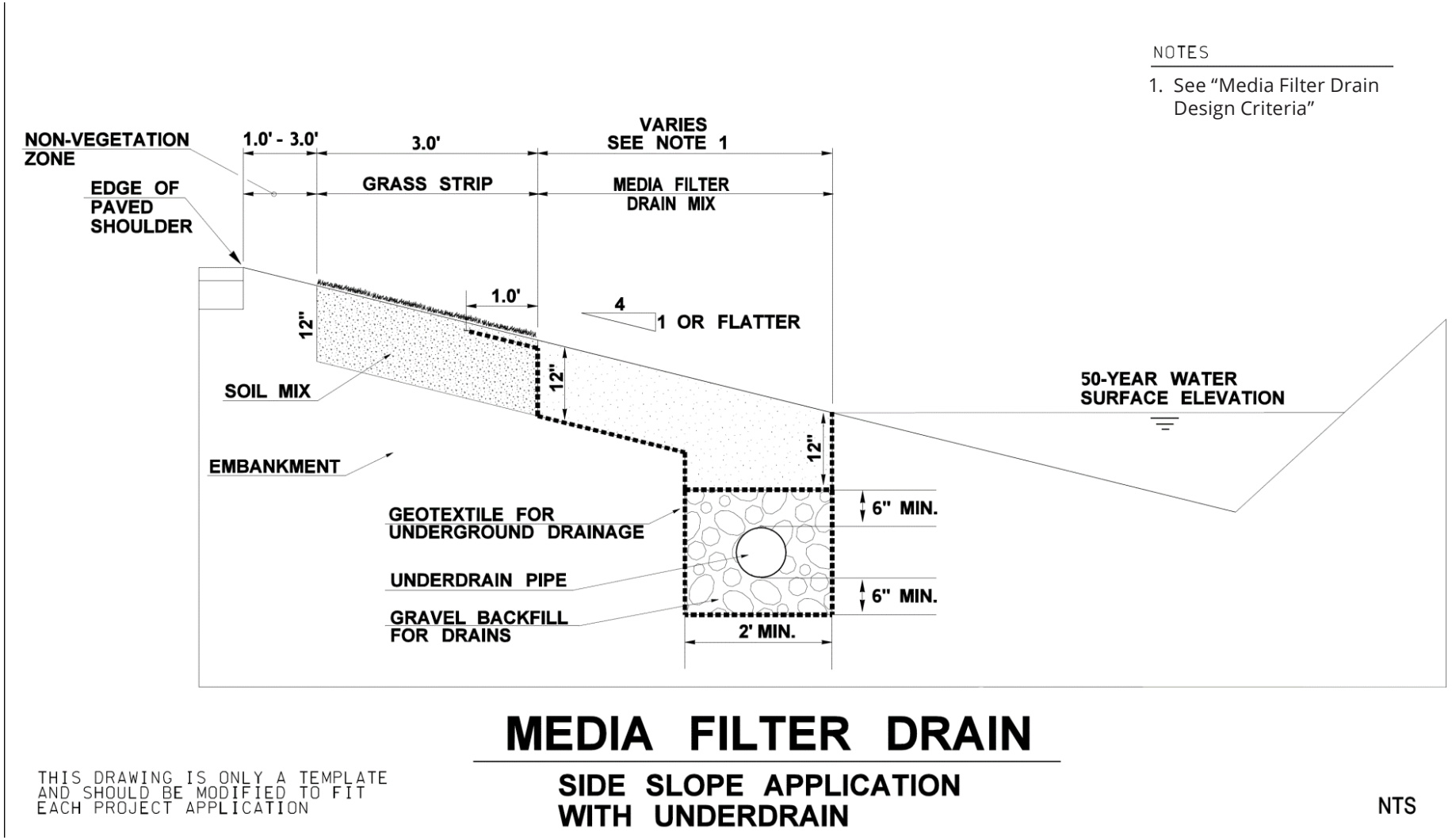
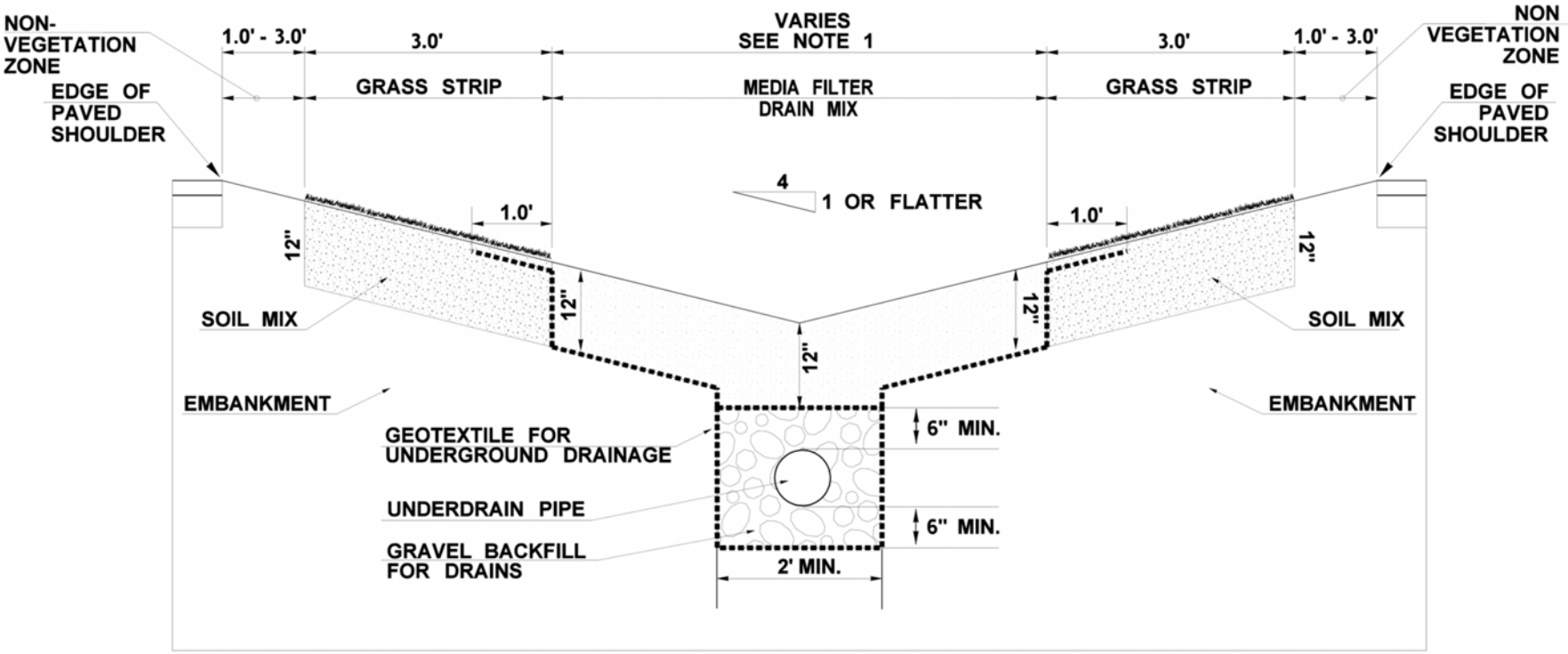


Figure 7.7. - Dual Media Filter Drain: Cross Section.



NOTES

1. See “Media Filter Drain Design Criteria”

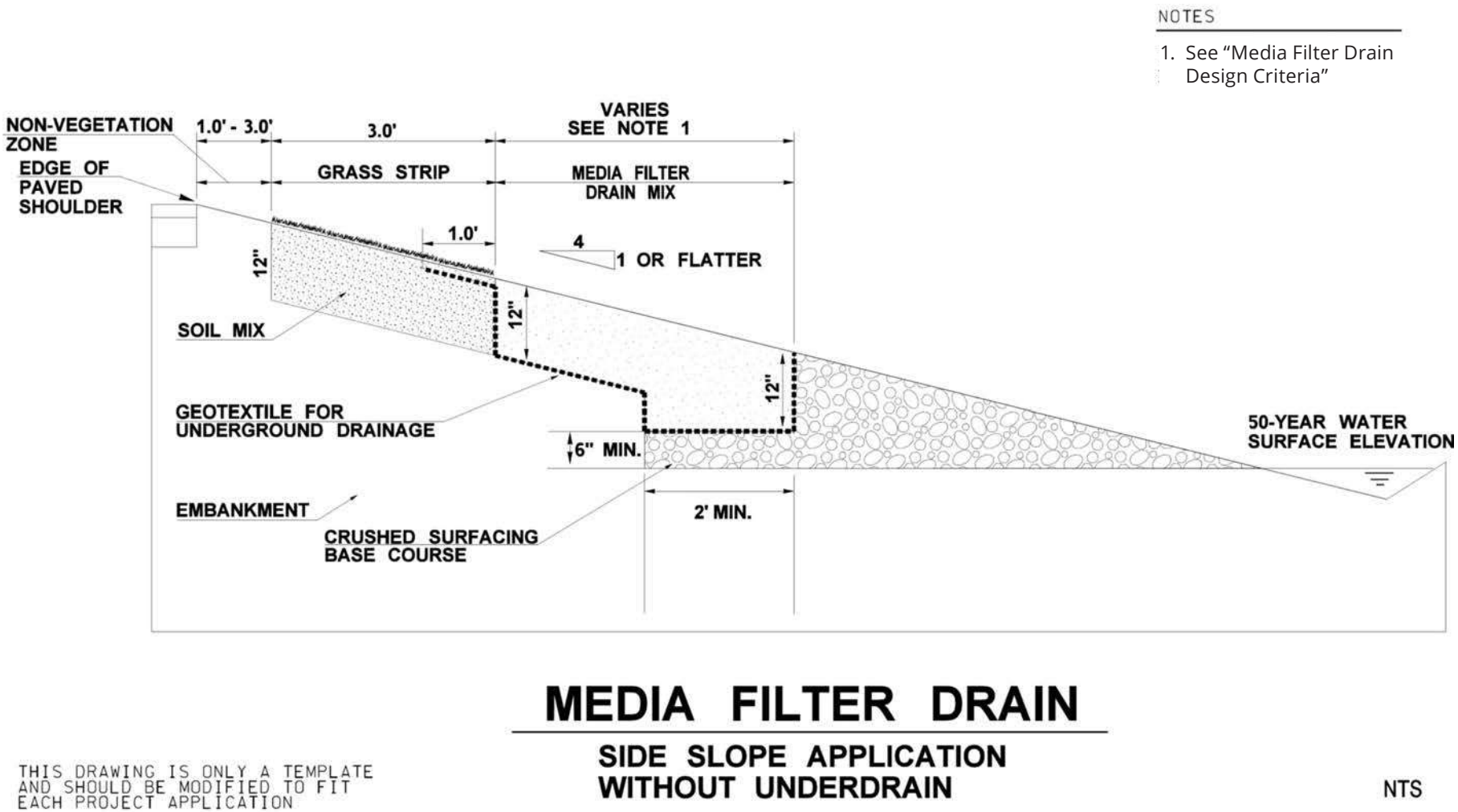
DUAL MEDIA FILTER DRAIN

MEDIAN APPLICATION

THIS DRAWING IS ONLY A TEMPLATE
AND SHOULD BE MODIFIED TO FIT
EACH PROJECT APPLICATION

NTS

Figure 7.8. - Media Filter Drain Without Underdrain Trench.



Applications

Media Filter Drains

The MFD can achieve basic, phosphorus, and enhanced water quality treatment.

Since maintaining sheet flow across the MFD is required for its proper function, the ideal locations for MFDs in roadway settings are roadway side slopes or other long, linear grades with lateral side slopes less than 4H:1V and longitudinal slopes no steeper than 5 percent. As side slopes approach 3H:1V, without design modifications, sloughing may become a problem due to friction limitations between the separation geotextile and underlying soils. The longest flow path from the contributing area delivering sheet flow to the MFD should not exceed 150 feet.

If there is sufficient roadway embankment width, the designer should consider placing the grass strip and media mix downslope when feasible. The project engineer should ensure the MFD does not intercept seeps, springs, or groundwater.

Dual Media Filter Drain for Roadway Medians

The dual MFD is fundamentally the same as the side-slope version. It differs in siting and is more constrained with regard to drainage options. Prime locations for dual MFDs in a roadway setting are medians, roadside drainage, borrow ditches, or other linear depressions. It is especially critical for water to sheet flow across the dual MFD. Channelized flows or ditch flows running down the middle of the dual MFD (continuous off site inflow) should be minimized.

Limitations

- **Steep slopes.** Avoid construction on longitudinal slopes steeper than 5 percent. Avoid construction on 3H:1V lateral slopes, and preferably use less than 4H:1V slopes. In areas where lateral slopes exceed 4H:1V, it may be possible to construct terraces to create 4H:1V slopes or to otherwise stabilize up to 3H:1V slopes. (For details, see Geometry, Components and Sizing Criteria, Cross Section in the Media Filter Drain Design Criteria section below.)
- **Wetlands.** Do not construct in wetlands or wetland buffers. In many cases, a MFD (due to its small lateral footprint) can fit within the roadway fill slopes adjacent to a wetland buffer. In those situations where the roadway fill prism is located adjacent to wetlands, an interception trench/underdrain will need to be incorporated as a design element in the MFD.
- **Shallow groundwater.** Mean high water table levels at the project site need to be determined to ensure the MFD mix bed and the underdrain (if needed) will not become saturated by shallow groundwater.
- **Unstable slopes.** In areas where slope stability may be problematic, consult a geotechnical engineer.
- **Areas of seasonal groundwater inundations or basement flooding.** Site-specific piezometer data may be needed in areas of suspected seasonal high groundwater inundations. The hydraulic and runoff treatment performance of the dual MFD may be compromised due to backwater effects and lack of sufficient hydraulic gradient.
- **Narrow roadway shoulders.** In areas where there is a narrow roadway shoulder that does not allow enough room for a vehicle to fully stop or park, consider placing the MFD farther down the embankment slope. This will reduce the amount of rutting in the MFD and decrease overall maintenance repairs.

Media Filter Drain Design Criteria

The basic design concept behind the MFD and dual MFD is to fully filter all runoff through the MFD mix. Therefore, the infiltration capacity of the medium and drainage below needs to match or exceed the hydraulic loading rate.

Media Filter Drain Mix Bed Sizing Procedure

The MFD mix should be a minimum of 12 inches deep, including the section on top of the underdrain trench.

For runoff treatment, sizing of the MFD mix bed is based on the requirement that the runoff treatment flow rate from the pavement area, QRoadway cannot exceed the long-term infiltration capacity of the MFD, QInfiltration:

$$Q_{Roadway/Infiltration} \leq Q$$

For western Washington, $Q_{Roadway}$ is the flow rate at or below which 91 percent of the runoff volume for the developed TDA will be treated, based on a 15-minute time step and can be determined using and approved continuous runoff model.

The long-term infiltration capacity of the MFD is based on the following equation:

$$\frac{LTIR \bullet L \bullet W}{C \bullet SF} = Q_{Infiltration}$$

where:

$LTIR$ = Long-term infiltration rate of the MFD mix (use 10 inches per hour for design) (in/hr)
L = Length of media filter drain (parallel to roadway) (ft)
W = Width of the media filter drain mix bed (ft)
C = Conversion factor of 43200 ((in/hr)/(ft/sec))
SF = Safety Factor (equal to 1.0, unless unusually heavy sediment loading is expected)

Assuming that the length of the MFD is the same as the length of the contributing pavement, solve for the width of the MFD:

$$W \geq \frac{Q_{Roadway} \bullet C \bullet SF}{LTIR \bullet L}$$

Western Washington project applications of this design procedure have shown that, in almost every case, the calculated width of the MFD does not exceed 1 foot. Therefore, Table 7.5 was developed to simplify the design steps and should be used to establish an appropriate width.

Table 7.5. - Western Washington Design Widths for Media Filter Drains.

Pavement Width That Contributes Runoff to the MFD	Minimum MFD Width*
≤ 20 feet	2 feet
≥ 20 and ≤ 35 feet	3 feet
> 35 feet	4 feet

* Width does not include the required 1–3 foot gravel vegetation-free zone or the 3-foot filter strip width (see Figure 7.6).

Sizing Criteria

Width

The width of the MFD mix bed is determined by the amount of contributing pavement routed to the MFD. The surface area of the MFD mix bed needs to be sufficiently large to fully infiltrate the runoff treatment design flow rate using the long-term filtration rate of the MFD mix. For design purposes, a 50 percent safety factor is incorporated into the long-term MFD mix filtration rate to accommodate variations in slope, resulting in a design filtration rate of 10 inches per hour. The MFD mix bed should have a bottom width of at least 2 feet in contact with the conveyance system below the MFD mix.

Length

In general, the length of a MFD or dual MFD is the same as the contributing pavement. Any length is acceptable as long as the surface area MFD mix bed is sufficient to fully infiltrate the runoff treatment design flow rate.

Cross Section

In profile, the surface of the MFD should preferably have a lateral slope less than 4H:1V (< 25 percent). On steeper terrain, it may be possible to construct terraces to create a 4H:1V slope, or other engineering may be employed if approved by the County, to ensure slope stability up to 3H:1V. If sloughing is a concern on steeper slopes, consideration should be given to incorporating permeable soil reinforcements, such as geotextiles, open-graded/permeable pavements, or commercially available ring and grid reinforcement structures, as top layer components to the MFD mix bed. Consultation with a geotechnical engineer is required.

Inflow

Runoff is conveyed to an MFD using sheet flow from the pavement area. The longitudinal pavement slope contributing flow to a MFD should be less than 5 percent.

Although there is no lateral pavement slope restriction for flows going to a MFD, the designer should ensure flows remain as sheet flow.

Underdrain Design

Underdrain pipe can provide a protective measure to ensure free flow through the MFD mix and is sized similar to storm drains. For MFD underdrain sizing, an additional step is required to determine the flow rate that can reach the underdrain pipe. This is done by comparing the contributing basin flow rate to the infiltration flow rate through the MFD mix and then using the smaller of the two to size the underdrain. The analysis described below considers the flow rate per foot of MFD, which allows the flexibility of incrementally increasing the underdrain diameter where long lengths of underdrain are required. When underdrain pipe connects to a stormwater

drain system, place the invert of the underdrain pipe above the 25-year water surface elevation in the storm drain to prevent backflow into the underdrain system.

The following describes the procedure for sizing underdrains installed in combination with MFDs.

- Calculate the flow rate per foot from the contributing basin to the MFD. The design storm event used to determine the flow rate should be relevant to the purpose of the underdrain. For example, if the underdrain will be used to convey treated runoff to a detention BMP, size the underdrain for the 50-year storm event. (See the WSDOT Hydraulics Manual, Figure 22.1, for conveyance flow rate determination).

$$\frac{Q_{highway}}{ft} = \frac{Q_{highway}}{L_{MFD}}$$

where:

$\frac{Q_{highway}}{ft}$ = contributing flow rate per foot (cfs/ft)

L_{MFD} = length of MFD contributing runoff to the underdrain (ft)

- Calculate the MFD flow rate of runoff per foot given an infiltration rate of 10 in/hr through the MFD mix.

$$\frac{Q_{MFD}}{ft} = \frac{f \times W \times 1ft}{ft} \times \frac{1ft}{12in} \times \frac{1hr}{3600\,sec}$$

where:

$\frac{Q_{MFD}}{ft}$ = flow rate of runoff through MFD mix layer (cfs/ft)

W = width of underdrain trench (ft) – see Pierce County Standard Plan B9; the minimum width is 2 feet

f = infiltration rate through the MFD mix (in/hr) = 10 in/hr

- Size the underdrain pipe to convey the runoff that can reach the underdrain trench. This is taken to be the smaller of the contributing basin flow rate or the flow rate through the MFD mix layer.

$$\frac{Q_{UD}}{ft} = smaller \left\{ \frac{Q_{highway}}{ft} \text{ or } \frac{Q_{MFD}}{ft} \right\}$$

where:

$\frac{Q_{UD}}{ft}$ = underdrain design flow rate per foot (cfs/ft)

- Determine the underdrain design flow rate using the length of the MFD and a factor of safety of 1.2.

$$Q_{UD} = 1.2 \times \frac{Q_{UD}}{ft} \times W \times L_{MFD}$$

where:

Q_{UD} = estimated flow rate to the underdrain (cfs)
W = width of the underdrain trench (ft) – per WSDOT std. spec 2-09.4; the minimum width is 2 ft
L_{MFD} = length of MFD contributing runoff to the underdrain (ft)

- Given the underdrain design flow rate, determine the underdrain diameter. Round pipe diameters to the nearest standard pipe size and have a minimum diameter of 6 inches. For diameters that exceed 12 inches, contact County Engineer's Office.

$$D = 1.6\left(\frac{(Q_{UD} \times n)}{s^{0.5}}\right)^{3/8}$$

where:

D = underdrain pipe diameter (inches)
n = Manning's coefficient
s = slope of pipe (ft/ft)

Filter Geometry

- **No-Vegetation Zone:** The no-vegetation zone (vegetation-free zone) is a shallow gravel zone located directly adjacent to the roadway pavement. The no-vegetation zone is a crucial element in a properly functioning MFD or other BMPs that use sheet flow to convey runoff from the roadway surface to the BMP. The no-vegetation zone functions as a level spreader to promote sheet flow and a deposition area for coarse sediments. The no-vegetation zone should be between 1 foot and 3 feet wide. Depth will be a function of how the roadway section is built from subgrade to finish grade; the resultant cross section will typically be triangular to trapezoidal. Within these bounds, width varies depending on maintenance spraying practices.
- **Grass Strip:** The width of the grass strip is dependent on the availability of space within the roadway side slope. The baseline design criterion for the grass strip within the MFD is a 3-foot minimum width, but wider grass strips are recommended if the additional space is available. The designer may consider adding aggregate to the soil mix to help minimize rutting problems from errant vehicles. The soil mix should ensure grass growth for the design life of the MFD. Composted material used in the grass strip shall meet the specifications for compost used in Bioretention Soil Mix (BSM). See Volume III, Section 3.4.6.
- **Media Filter Drain Mix Bed:** The MFD mix is a mixture of crushed rock, dolomite, gypsum, and perlite. The crushed rock provides the support matrix of the medium; the dolomite and gypsum add alkalinity and ion exchange capacity to promote the precipitation and exchange of heavy metals; and the perlite improves moisture retention to promote the formation of biomass within the MFD mix. The combination of physical filtering, precipitation, ion exchange, and biofiltration enhances the water treatment capacity of the mix. The MFD mix

has an estimated initial filtration rate of 50 inches per hour and a long-term filtration rate of 28 inches per hour due to siltation. With an additional safety factor, the rate used to size the length of the MFD should be 10 inches per hour.

- **Planting Considerations:** Landscaping for the grass strip is the same as for biofiltration swales, unless otherwise specified in the special provisions for the project's construction documents.
- **Conveyance System Below Media Filter Drain Mix**
  - The gravel underdrain trench provides hydraulic conveyance when treated runoff needs to be conveyed to a desired location such as a downstream flow control facility or stormwater outfall.
  - In Type C and D soils, an underdrain pipe would help to ensure free flow of the treated runoff through the MFD mix bed. In some Type A and B soils, an underdrain pipe may be unnecessary if most water percolates into subsoil from the underdrain trench. The need for underdrain pipe should be evaluated in all cases. The underdrain trench should be a minimum of 2 feet wide for either the conventional or dual MFD.

The gravel underdrain trench may be eliminated if there is evidence to support that flows can be conveyed laterally to an adjacent ditch or onto a fill slope that is properly vegetated to protect against erosion. The MFD mix should be kept free draining up to the 50-year storm event water surface elevation represented in the downstream ditch.

Materials

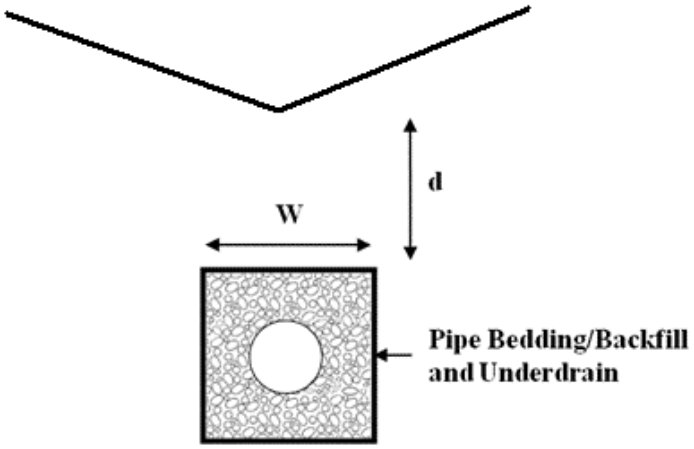
Media Filter Drain Mix

The MFD mix used in the construction of MFDs consists of the amendments listed in Table 7.6 at the end of this chapter. Mixing and transportation must occur in a manner that ensures the materials are thoroughly mixed prior to placement and that separation does not occur during transportation or construction operations.

These materials should be used in accordance with the following *WSDOT Standard Specifications*:

- Gravel Backfill for Drains, 9-03.12(4)
- Underdrain Pipe, 7-01.3(2) (see Figure 7.9)
- Construction Geotextile for Underground Drainage, 9-33.1

Figure 7.9. - Media Filter Drain Underdrain Installation.



Crushed Surfacing Base Course (CSBC)

If the design is configured to allow the MFD to drain laterally into a ditch, the crushed surfacing base course below the MFD should conform to Section 9-03.9(3) of the *Standard Specifications.*

Berms, Baffles, and Slopes

See *Geometry, Components and Sizing Criteria, Cross Section under Media Filter Drain Design Criteria above.*

Construction Criteria

- **Erosion and Sediment Control:** Keep effective erosion and sediment control measures in place until grass strip is established.
- **Traffic Control:** Do not allow vehicles or traffic on the MFD to minimize rutting and maintenance repairs.
- **Signing:** Non-reflective guideposts will delineate the MFD. This practice allows personnel to identify where the system is installed and to make appropriate repairs should damage occur to the system. If the MFD is in a critical aquifer recharge area for drinking water supplies, signage prohibiting the use of pesticides must be provided.

Table 7.6. - Media Filter Drain Mix.

Amendment	Quantity
Mineral aggregate: Aggregate for MFD Mix: Aggregate for MFD Mix shall be manufactured from ledge rock, talus, or gravel in accordance with Section 3-01 of the Standard Specifications for Road, Bridge, and Municipal Construction (2014 or latter), which meets the following test requirements for quality. The use of recycled material is not permitted: Los Angeles Wear, 500 Revolutions 35% max. Degradation Factor 30 min. Aggregate for the MFD Mix shall conform to the following requirements for grading and quality: **Sieve Size** **Percent Passing (by weight):** 1/2" square 100 3/8" square 90-100 U.S. No. 4 30-56 U.S. No. 10 0-10 U.S. No. 200 0-1.5 % fracture, by weight, min. 75 Static stripping test Pass The fracture requirement shall be at least two fractured faces and will apply to material retained on the U.S. No. 10. Aggregate for the MFD shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50% of the surface area of any size between successive laboratory sieves.	3 cubic yards
Perlite: • Horticultural grade, free of any toxic materials) • 0-30% passing US No. 18 Sieve • 0-10% passing US No. 30 Sieve	1 cubic yard per 3 cubic yards of mineral aggregate
Dolomite: CaMg(CO3)2 (calcium magnesium carbonate): • Agricultural grade, free of any toxic materials) • 100% passing US No. 8 Sieve • 0% passing US No. 16 Sieve	10 pounds per cubic yard of perlite
Gypsum: Noncalcined, agricultural gypsum CaSO4•2H2O (hydrated calcium sulfate): • Agricultural grade, free of any toxic materials) • 100% passing US No. 8 Sieve • 0% passing US No. 16 Sieve	1.5 pounds per cubic yard of perlite

Chapter 8. Biofiltration Treatment Facilities

Note: Figures in Chapter 8 are courtesy of King County, except as noted.

8.1 Purpose

This chapter addresses four BMPs that are classified as biofiltration treatment facilities:

- Basic Biofiltration Swale (Section 8.4.1)
- Wet Biofiltration Swale (Section 8.4.2)
- Continuous Inflow Biofiltration Swale (Section 8.4.3)
- Basic Filter Strip (Section 8.4.4).

Biofilters are vegetated treatment systems (typically grass) that remove pollutants by means of sedimentation, filtration, soil sorption, and/or plant uptake. They are typically configured as swales or flat filter strips.

The BMPs discussed in this chapter are designed to remove low concentrations and quantities of total suspended solids, heavy metals, petroleum hydrocarbons, and/or nutrients from stormwater.

8.2 Applications

A biofilter can be used as a basic treatment BMP for contaminated stormwater runoff from roadways, driveways, parking lots, and highly impervious ultra-urban areas, or as the first stage of a treatment train. In cases where hydrocarbons, high total suspended solids, or debris would be present in the runoff, such as high-use sites, a pretreatment system for those components would be necessary. Off-line location is preferred to avoid flattening vegetation and the erosive effects of high flows. Consider biofilters in retrofit situations where appropriate (Center for Watershed Protection 1998).

8.3 Site Suitability

Consider the following factors for determining site suitability:

- Target pollutants are amenable to biofilter treatment
- Accessibility for operation and maintenance
- Suitable growth environment (soil, etc.) for the vegetation
- Adequate siting for a pretreatment facility if high petroleum hydrocarbon levels (oil/grease) or high total suspended solids loads could impair treatment capacity or efficiency
- If the biofilter can be impacted by snowmelts and ice, refer to Caraco and Claytor for additional design criteria (USEPA 1997).

8.4 Best Management Practices

8.4.1 Basic Biofiltration Swale (Ecology BMP T9.10)

Biofiltration swales are typically shaped as a trapezoid or a parabola. See Attachments Section B, Detail 2.0 for typical cross sections.

Limitations

Data suggest that the performance of biofiltration swales is highly variable from storm to storm. It is therefore recommended that treatment methods that perform more consistently, such as sand filters and wet ponds, be considered before using a biofiltration swale. Biofiltration swales downstream of devices of equal or greater effectiveness can convey runoff but should not be expected to offer a treatment benefit (Horner 2000).

Basic Biofiltration Swale Design Criteria

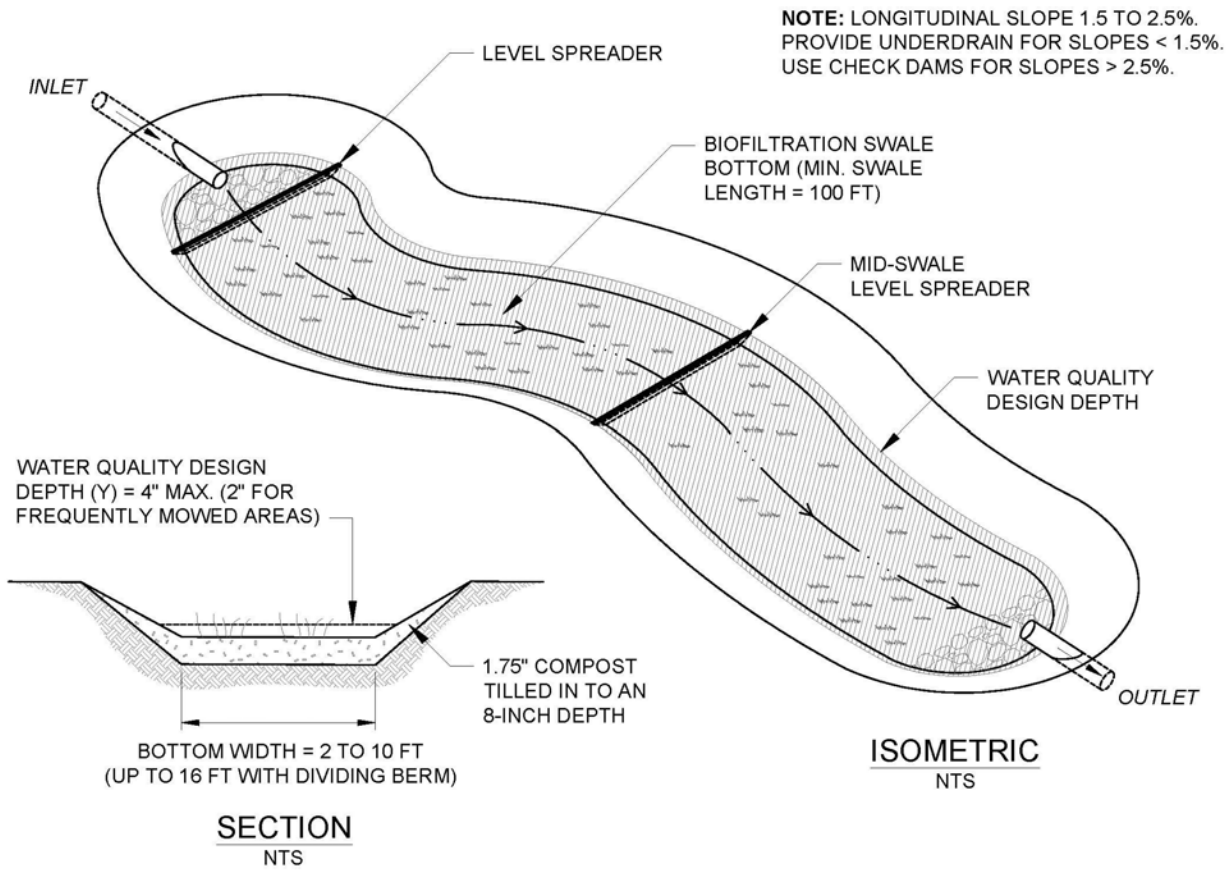
- Design criteria are specified in Table 8.1. A 9minute hydraulic residence time is used at a multiple of the peak 15minute water quality design flow rate (Q) representing 91 percent runoff volume as determined by an approved continuous runoff model (see Volume I).
- Biofiltration swales should be designed as off-line facilities where feasible. For on-line systems, designers must evaluate the hydraulic capacity/stability for inflows greater than design flows. Bypass high flows, or control release rates into the biofilter, if necessary. When designing a swale to be off-line, the stability check is not required.
- Use a wide radius curved path to gain length where land is not adequate for a linear swale. Avoid sharp bends to reduce erosion or provide for erosion protection.
- Install level spreaders (minimum 1-inch gravel) at the head and every 50 feet in swales of ≥4 feet width. Include sediment cleanouts (weir, settling basin, or equivalent) at the head of the biofilter as needed.
- Use energy dissipaters (bioengineered methods or riprap) for increased downslopes.
- Maintain access to biofilter inlet, outlet, and for mowing (Figure 8.1).

Table 8.1. - Sizing Criteria.

Design Parameter	Biofiltration Swale	Filter Strip
Longitudinal slope	0.015 – 0.025[1]	0.01 – 0.33
Maximum velocity	1 ft/sec (@ K multiplied by the water quality design flow rate); for stability, 3 ft/sec max.	0.5 ft/sec (@ K multiplied by the water quality design flow rate)
Maximum water depth[2]	2" – if mowed frequently; 4" if mowed infrequently	1-inch max.
Manning coefficient (22)	(0.2–0.3)[3](0.24 if mowed infrequently)	0.35
Bed width (bottom)	(2–10 ft)[4]	---
Freeboard height	0.5 ft	---
Minimum hydraulic residence time at water quality design flow rate	9 minutes (18 minutes for continuous inflow)	9 minutes
Minimum length	100 ft	Sufficient to achieve hydraulic residence time in the filter strip
Maximum sideslope	3 H:1 V 5H:1V preferred	Inlet edge ≥ 1" lower than contributing paved area
Max. tributary drainage flow path	---	150 ft
Max. longitudinal slope of contributing area	---	0.05 (steeper than 0.05 need upslope flow spreading and energy dissipation)
Max. lateral slope of contributing area	---	0.02 (at the edge of the strip inlet)

1. For swales, if the slope is less than 1.5 percent install an underdrain using a perforated pipe, or equivalent. Amend the soil if necessary to allow effective percolation of water to the underdrain. Install the low-flow drain 6" deep in the soil. Slopes greater than 2.5 percent need check dams (riprap) at vertical drops of 12–15 inches. Underdrains can be made of 6inch Schedule 40 PVC perforated pipe with 6" of drain gravel on the pipe. The gravel and pipe must be enclosed by geotextile fabric (see Figures 8.2 and 8.3).
2. Below the design water depth install an erosion control blanket, at least 4" of topsoil, and the selected biofiltration mix. Above the water line use a straw mulch or sod.
3. This range of Manning's n can be used in the equation; b = Qn/1.49y(1.67) s(0.5) – Zy with wider bottom width b, and lower depth, y, at the same flow. This provides the designer with the option of varying the bottom width of the swale depending on space limitations. Designing at the higher n within this range at the same flow decreases the hydraulic design depth, thus placing the pollutants in closer contact with the vegetation and the soil.
4. For swale widths up to 16 feet the cross-section can be divided with a berm (concrete, plastic, compacted earthfill) using a flow spreader at the inlet (Figure 8.4).

Figure 8.1. - Biofiltration Swale Access Features.



Source: City of Seattle (reproduced with permission)

Guidance for Bypassing Off-Line Facilities

Most biofiltration swales should be designed as off-line facilities. However, an on-line design is possible with approval by Pierce County. Swales designed in an off-line mode should not engage a bypass until the flow rate exceeds a value determined by multiplying Q, the off-line water quality design flow rate predicted by an approved continuous runoff model, by the ratio determined in Figure 8.6b (presented later in this section). This modified design flow rate is an estimate of the design flow rate determined by using Santa Barbara Urban Hydrograph (SBUH) procedures.

Sizing Procedure for Biofiltration Swales

This guide provides biofilter swale design procedures in full detail, along with examples.

Preliminary Steps (P)

P-1 Determine the water quality design flow rate (Q) in 15minute time-steps using an approved continuous runoff model. Use the correct flow rate, off-line or on-line, for the design situation.

P-2 Establish the longitudinal slope of the proposed biofilter.

P-3 Select a vegetation cover suitable for the site. Refer to Tables 8.3, 8.4, and 8.5 (presented later in the text) to select vegetation for western Washington.

Figure 8.2. - Biofiltration Swale Underdrain Detail.

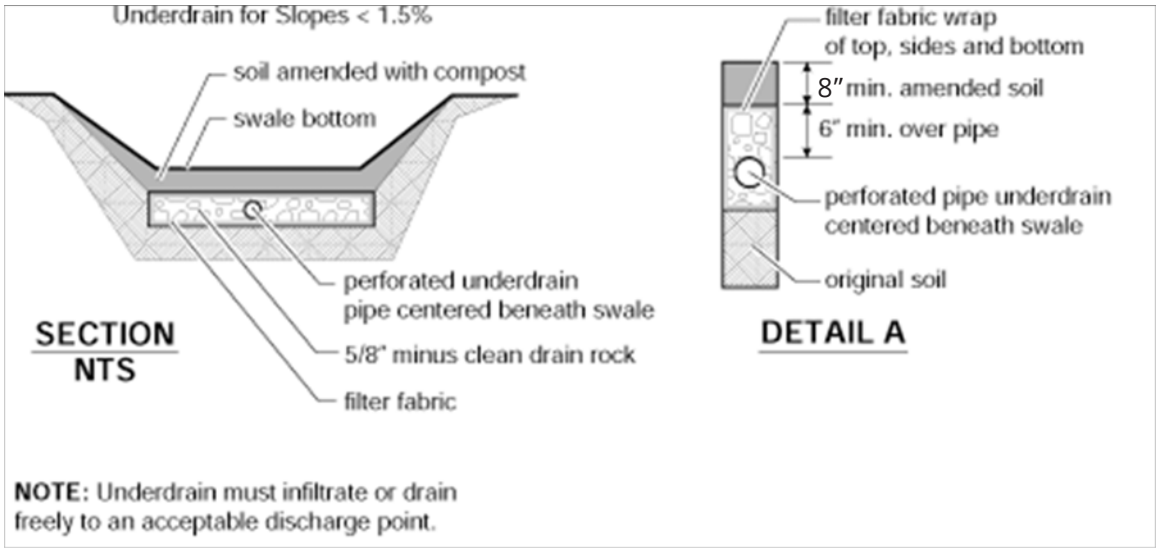


Figure 8.3. - Biofiltration Swale Low-Flow Drain Detail.

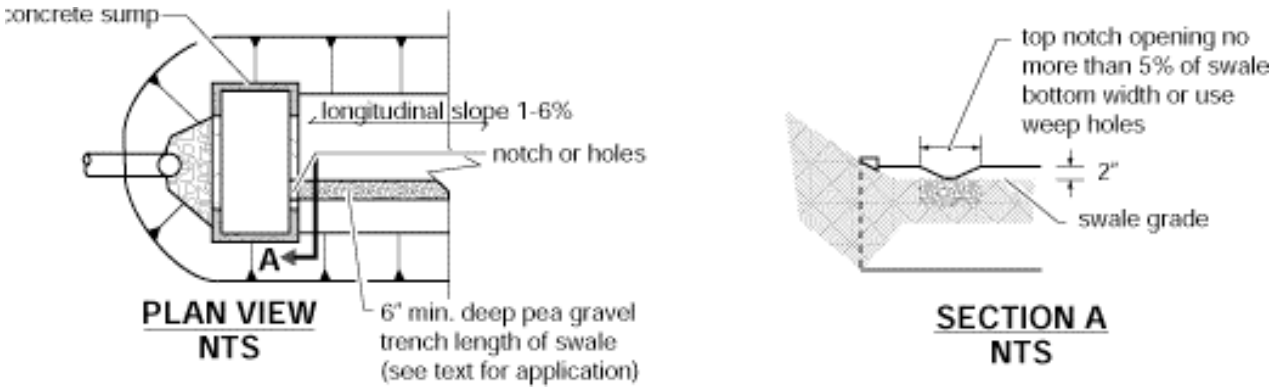
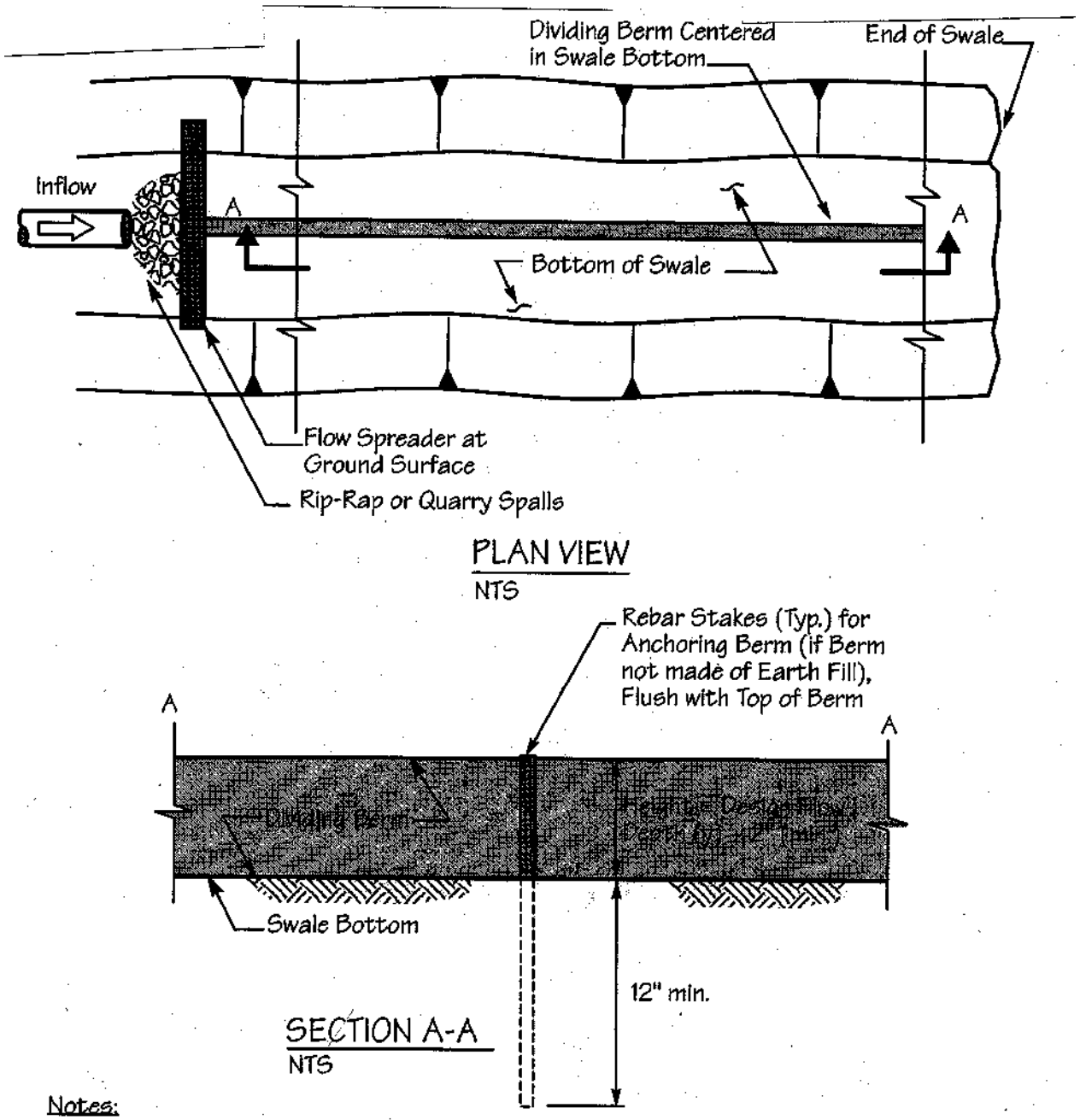


Figure 8.4. - Swale Dividing Berm.



Notes:

1. Berm may be Made of Compacted Earthfill (seeded with grass), Timber, Concrete Plastic, or Similar Weather - Resistant Non - Erodible Material.

2. Rebar Stakes or Similar Berm Anchoring Materials Needed if Berm Made of Timber, Plastic, or Concrete Curbing - Stake Placement Required at Both Ends of Each Individual Member (at a minimum).

Design Calculations for Biofiltration Swale

The procedure recommended here is an adaptation appropriate for biofiltration applications of the type being installed in the Puget Sound region. This procedure reverses Chow's order, designing first for capacity and then for stability. The capacity analysis emphasizes the promotion of biofiltration, rather than transporting flow with the greatest possible hydraulic efficiency. Therefore, it is based on criteria that promote sedimentation, filtration, and other pollutant removal mechanisms. Because these criteria include a lower maximum velocity than permitted for stability, the biofilter dimensions usually do not have to be modified after a stability check.

Design Steps (D):

D-1. Select the type of vegetation, and design depth of flow (based on frequency of mowing and type of vegetation) (Table 8.1).

D-2. Select a value of Manning's n (Table 8.1 with footnote number three).

D-3. Select swale shape;typically trapezoidal or parabolic.

D-4. Use Manning's equation and first approximations relating hydraulic radius and dimensions for the selected swale shape to obtain a working value of a biofilter width dimension:

$$Q = \frac{1.49 A R^{2/3} s^{1/2}}{n} \qquad (1)$$

$$A_{rectangle} = Ty \qquad (2)$$

$$R_{rectangle} = \frac{Ty}{T+2y} \qquad (3)$$

where:

- Q = Water quality design flow rate in 15 minute time steps (feet³/s, cfs)
- n = Manning's n (dimensionless)
- s = Longitudinal slope as a ratio of vertical rise/horizontal run (dimensionless)
- A = Cross-sectional area (feet²)
- R = Hydraulic radius (feet)
- T = top width of trapezoid or width of a rectangle (feet)
- y = depth of flow (feet)
- b = bottom width of trapezoid (feet)

If equations 2 and 3 are substituted into equation 1 and solved for T, complex equations result that are difficult to solve manually. However, approximate solutions can be found by recognizing that $T>>y$ and $Z^2>>1$, and that certain terms are nearly negligible. The approximation solutions for rectangular and trapezoidal shapes are:

$$R_{rectangle} \approx y, \qquad R_{trapezoid} \approx y, \qquad R_{parabolic} \approx 0.67y, \qquad R_v \approx 0.5y$$

Substitute $R_{trapezoid}$ and $A_{trapezoid} = by+Zy^2$ into Equation 1, and solve for the bottom width b (trapezoidal swale):

$$b = \frac{2.5Qn}{1.49y^{1.67}s^{.05}} - Zy$$

For a trapezoid, select a side slope Z of at least 3. Compute b and then top width T, where T = b + 2yZ. (Note: Adjustment factor of 2.5 accounts for the differential between the water quality design flow rate and the SBUH design flow. This equation is used to estimate an initial cross-sectional area. It does not affect the overall biofiltration swale size.)

If b for a swale is greater than 10 feet, either investigate how Q can be reduced, divide the flow by installing a low berm, or arbitrarily set b = 10 feet and continue with the analysis. For other swale shapes, refer to Figure 8.5.

D-5. Compute A:

$$A_{rectangle} = Ty \quad \text{or} \quad A_{trapezoid} = by + Zy^2$$

$$A_{filter\ strip} = Ty$$

D-6. Compute the flow velocity at design flow rate:

$$V = K\frac{Q}{A}$$

K = A ratio of the peak 10minute flow predicted by SBUH to the water quality design flow rate estimated using an approved continuous runoff model. The value of K is determined from Figure 8.6a for on-line facilities, or Figure 8.6b for off-line facilities.

If V > 1.0 feet/sec (or V > 0.5 feet/sec for a filter strip), repeat steps D1 through D6 until the condition is met. A velocity greater than 1.0 feet/sec was found to flatten grasses, thus reducing filtration. A velocity lower than this maximum value will allow a 9minute hydraulic residence time criterion in a shorter biofilter. If the value of V suggests that a longer biofilter will be needed than space permits, investigate how Q can be reduced (e.g., use of low impact development [LID] BMPs), or increase y and/or T (up to the allowable maximum values) and repeat the analysis.

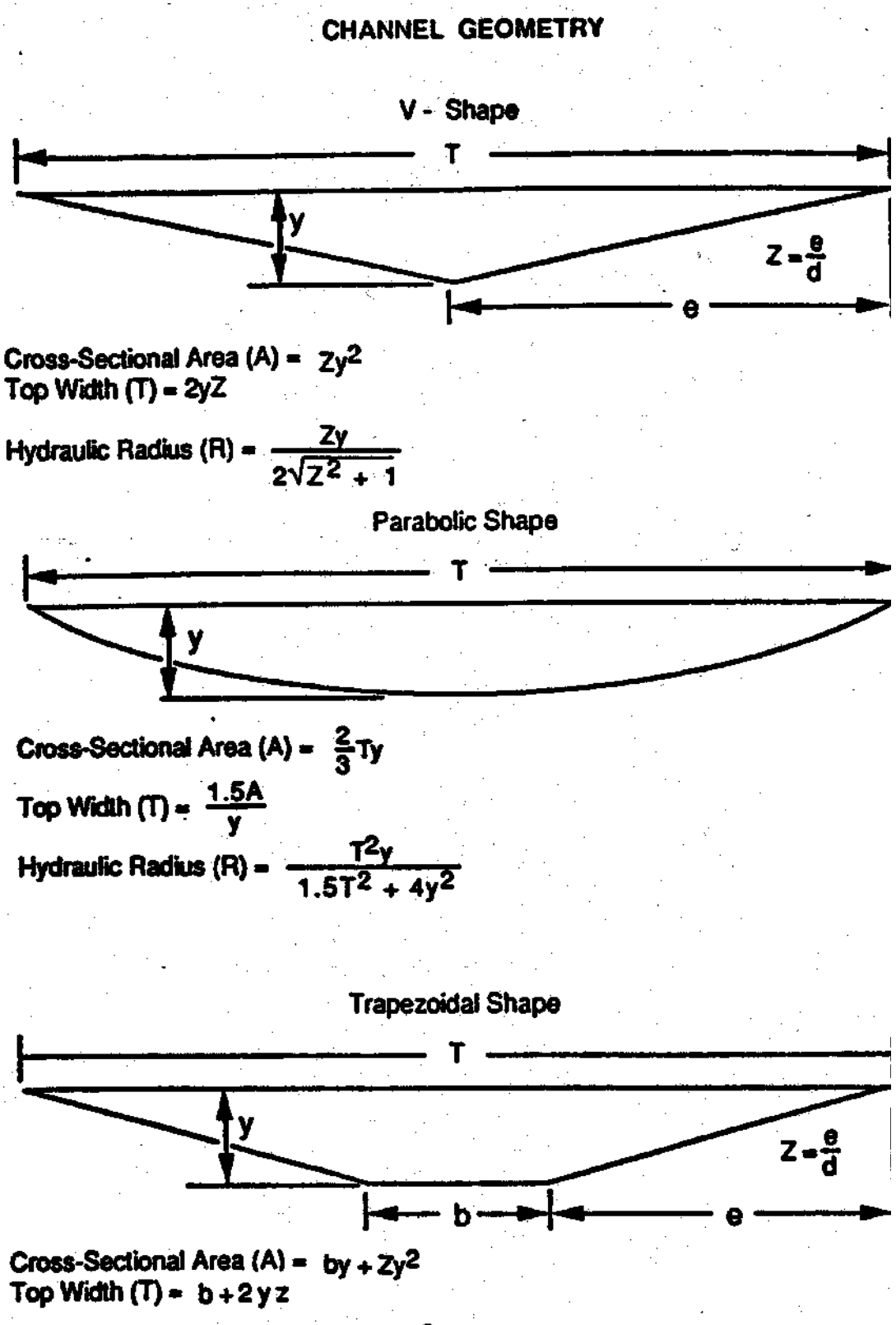
D-7. Compute the swale length (L, feet)

L = Vt (60 sec/min)

Where: t = hydraulic residence time (min)

Use t = 9 minutes for this calculation (use t = 18 minutes for a continuous inflow biofiltration swale). If a biofilter length is greater than the space permits, follow the advice in Step D6.

Figure 8.5. - Geometric Formulas for Common Swale Shapes.



Source: Livingston, et al. 1984

Figure 8.6a. - Ratio of SBUH Peak/Water Quality Flow.

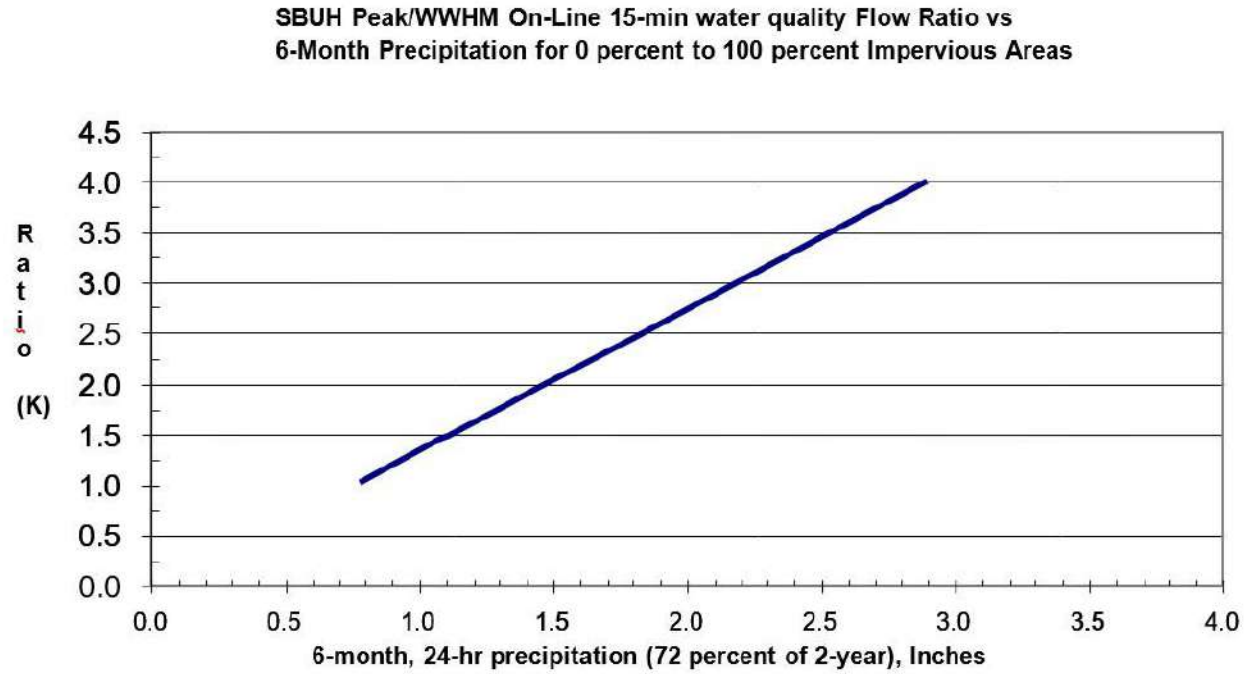
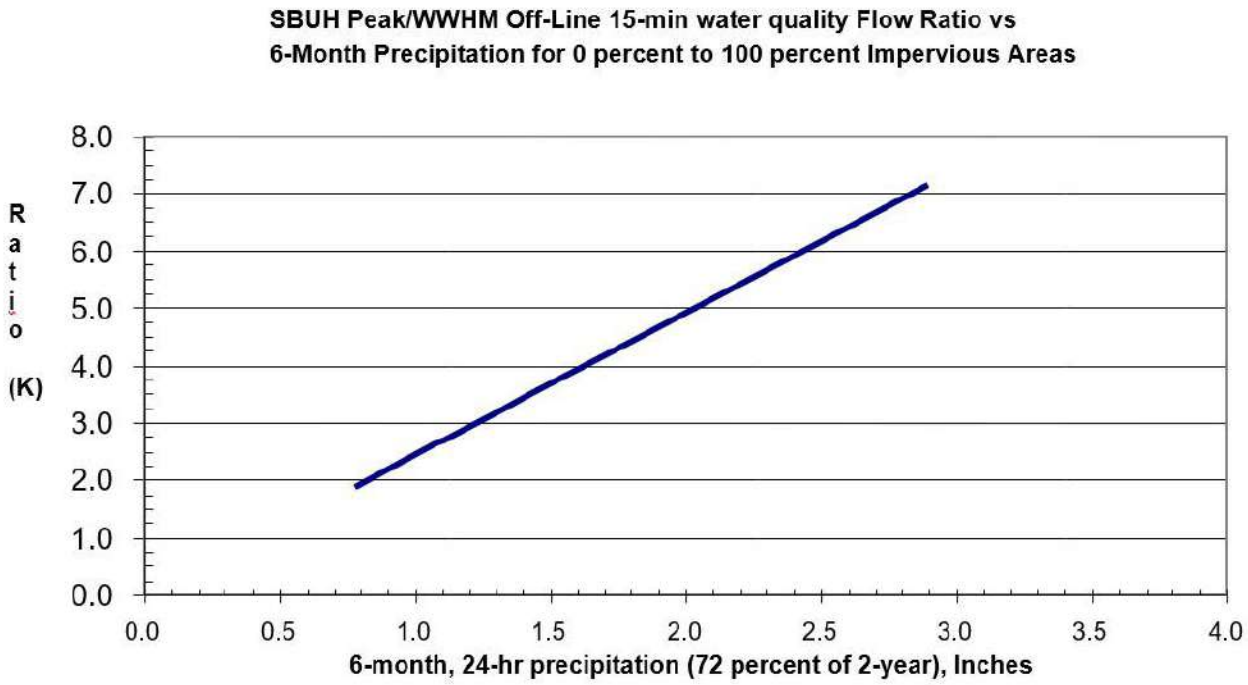


Figure 8.6b. - Ratio of SBUH Peak/Water Quality Flow.



If a length less than 100 feet results from this analysis, increase it to 100 feet, the minimum allowed. In this case, it may be possible to save some space in width and still meet all criteria. This possibility can be checked by computing V in the 100 feet biofilter for t = 9 minutes, recalculating A (if V less than 1 foot/sec) and recalculating T.

D-8. If there is still not sufficient space for the biofilter, Pierce County and the project applicant should consider the following solutions (listed in order of preference):

- Divide the site drainage to flow to multiple biofilters.
- Use infiltration to provide lower discharge rates to the biofilter (only if the infiltration requirements in Volume III, Chapter 2 are met).
- Increase vegetation height and design depth of flow (note: the design must ensure that vegetation remains standing during design flow).
- Reduce the developed surface area to gain space for biofiltration.
- Increase the longitudinal slope.
- Increase the side slopes.
- Nest the biofilter within or around another BMP.

Check for Stability (Minimizing Erosion)

The stability check must be performed for the combination of highest expected flow and least vegetation coverage and height. A check is not required for biofiltration swales that are located "off-line" from the primary conveyance/detention system. Maintain the same units as in the biofiltration capacity analysis.

SC-1. Perform the stability check for the 100year recurrence interval flow using 15minute time steps using an approved continuous runoff model.

SC-2. Estimate the vegetation coverage ("good" or "fair") and height on the first occasion that the biofilter will receive flow, or whenever the coverage and height will be least. Avoid flow introduction during the vegetation establishment period by timing planting or bypassing.

SC-3. Estimate the degree of retardance from Table 8.2. When uncertain, be conservative by selecting a relatively low degree.

The maximum permissible velocity for erosion prevention (Vmax) is 3 feet per second.

Table 8.2. - Guide for Selecting Degree of Retardance.

Coverage	Average Grass Height (inches)	Degree of Retardance[a]
Good	< 2	E. Very Low
	2–6	D. Low
	6–10	C. Moderate
	11–24	B. High
	> 30	A. Very High
Fair	< 2	E. Very Low
	2–6	D. Low
	6–10	D. Low
	11–24	C. Moderate
	> 30	B. High

a See Chow (1959). In addition, Chow recommended selection of retardance C for a grass-legume mixture 6-8 inches high and D for a mixture 4-5 inches high. No retardance recommendations have appeared for emergent wetland species. Therefore, judgment must be used. Since these species generally grow less densely than grasses, using a "fair" coverage would be a reasonable approach.

Stability Check (SC) Steps

SC-4. Select a trial Manning's n for the high flow condition. The minimum value for poor vegetation cover and low height (possibly, knocked from the vertical by high flow) is 0.033. A good initial choice under these conditions is 0.04.

SC-5. Refer to Figure 8.7 to obtain a first approximation for VR of 3 ft/second.

SC-6. Compute hydraulic radius, R, from VR in Figure 8.7 and a Vmax.

SC-7. Use Manning's equation to solve for the actual VR.

SC-8. Compare the actual VR from Step SC-7 and first approximation from Step SC-5. If they do not agree within 5 percent, repeat Steps SC-4 through SC-8 until acceptable agreement is reached. If n < 0.033 is needed to get agreement, set n = 0.033, repeat Step SC-7, and then proceed to Step SC-9.

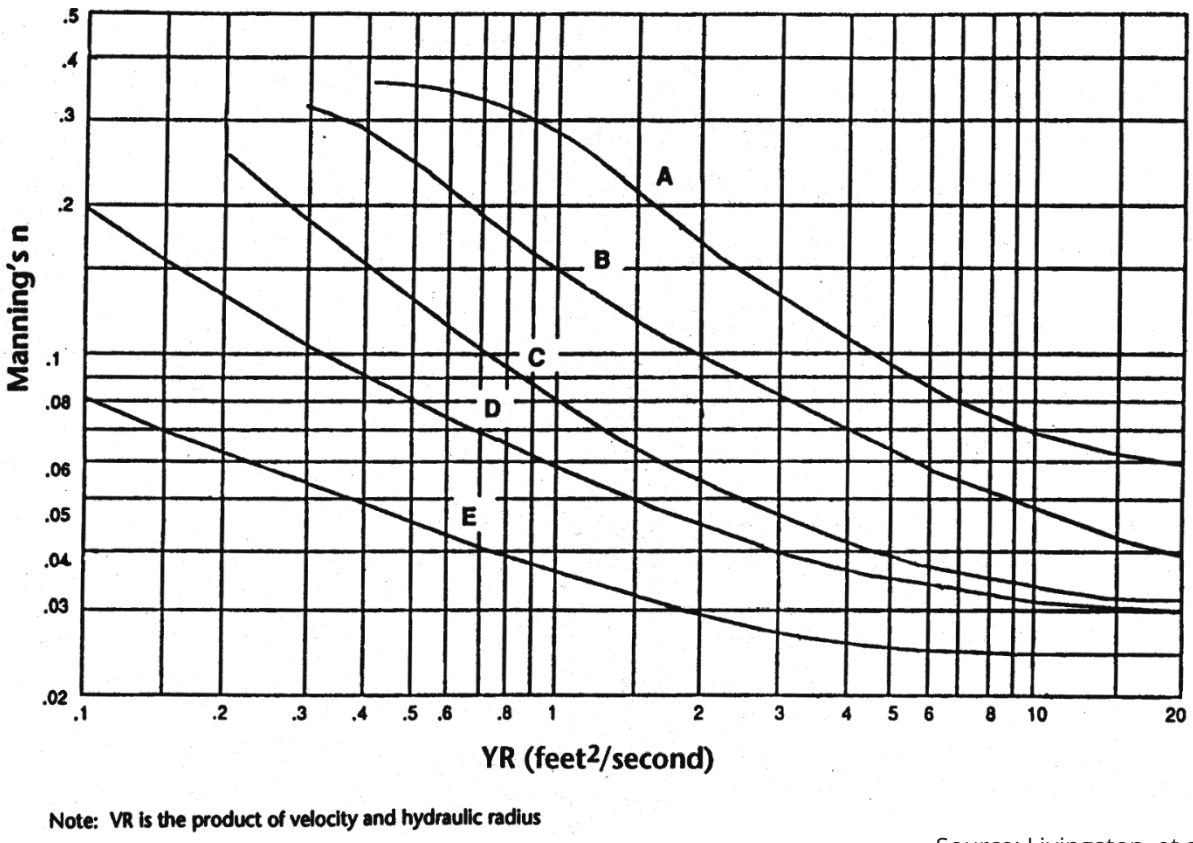
SC-9. Compute the actual V for the final design conditions:

Check to be sure $V < V_{\text{max of 3 ft/second.}}$

SC-10. Compute the required swale cross-sectional area, A, for stability

SC-11. Compare the A, computed in Step SC-10 of the stability analysis, with the A from the biofiltration capacity analysis (Step D-5).

Figure 8.7. - The Relationship of Manning's n with VR for Various Degrees of Flow Retardance (A-E).



Note: VR is the product of velocity and hydraulic radius

Source: Livingston, et al. 1984

If less area is required for stability than is provided for capacity, the capacity design is acceptable. If not, use A from Step SC-10 of the stability analysis and recalculate channel dimensions.

SC-12. Calculate the depth of flow at the stability check design flow rate condition for the final dimensions and use A from Step SC-10.

SC-13. Compare the depth from Step SC-12 to the depth used in the biofiltration capacity design (Step D-1). Use the larger of the two and add 0.5 feet of freeboard to obtain the total depth (yt) of the swale. Calculate the top width for the full depth using the appropriate equation.

SC-14. Recalculate the hydraulic radius: (use b from Step D-4 calculated previously for biofiltration capacity, or Step SC-11, as appropriate, and yt = total depth from Step SC-13).

SC-15. Make a final check for capacity based on the stability check design storm (this check will ensure that capacity is adequate if the largest expected event coincides with the greatest retardance). Use Equation 1, a Manning's n selected in Step D-2, and the calculated channel dimensions, including freeboard, to compute the flow capacity of the channel under these conditions. Use R from Step SC-14, above, and $A = b(yt) + Z(yt)^2$ using b from Step D-4, D-15, or SC-11 as appropriate.

If the flow capacity is less than the stability check design storm flow rate, increase the channel cross-sectional area as needed for this conveyance. Specify the new channel dimensions.

Completion Step (CO)

CO. Review all of the criteria and guidelines for biofilter planning, design, installation, and operation above and specify all of the appropriate features for the application.

Example of Design Calculations for Biofiltration Swales

Preliminary Steps

P-1. Assume that the continuous runoff model based water quality design flow rate in 15minute time-steps, Q, is 0.2 cfs. Assume an on-line facility.

P-2. Assume the slope (s) is 2 percent.

P-3. Assume the vegetation will be a grass-legume mixture and it will be infrequently mowed.

Design for Biofiltration Swale Capacity

D-1. Set winter grass height at 5 inches and the design flow depth (y) at 3 inches.

D-2. Use n = 0.20 to n2 = 0.30

D-3. Base the design on a trapezoidal shape, with a side slope Z = 3.

D-4a. Calculate the bottom width, b;

Where:

$$n = 0.20 \qquad y = 0.25 \text{ ft}$$

$$Q = 0.2 \text{ cfs} \qquad s = 0.02$$

$$Z = 3$$

$$b \approx \frac{2.5Qn}{1.49y^{1.67}s^{0.5}} - Zy$$

$$b \approx 4.0 \text{ ft}$$

$$\text{At } n_2: b_2 = 6.5 \text{ ft}$$

D-4b. Calculate the top width (T)

$$T = b + 2yZ = 4.0 + [2(0.25)(3)] = 5.5 \text{ ft}$$

D-5. Calculate the cross-sectional area (A)

$$A = by + Zy^2 = (4.0)(0.25) + (3)(0.25^2) = 1.19 \text{ft}^2$$

D-6. Calculate the flow velocity (V)

$$V = K\frac{Q}{A} = 0.17 \text{ ft/sec}$$

for $K = 1$. Actual K is determined per Figure 8.6a

$0.17 < 1.0$ ft/sec ∴ OK

D-7. Calculate the Length (L)

$L = Vt\ (60\ \text{sec/min})$

$= 0.17\ (9)(60)$

For $t = 9$ min, $L = 92$ ft. at n; expand to a minimum of 100 foot length per design criterion

At n2; $L = 100$ ft.

Note: Where b is less than the maximum value, it may be possible to reduce L by increasing b, so long as the minimum length (L) is never less than 100 ft.

Check for Channel Stability

SC-1. Base the check on passing the 100-year recurrence interval flow using an approved continuous runoff model with 15-minute time steps through a swale with a mixture of Kentucky bluegrass and tall fescue on loose erodible soil.

SC-2. Base the check on a grass height of 3 inches with "fair" coverage (lowest mowed height and least cover, assuming flow bypasses or does not occur during grass establishment).

SC-3. From Table 8.2, Degree of Retardance = D (low)

$$\text{Set } V_{max} = 3 \text{ ft/sec}$$

SC-4. Select trial Manning's $n=0.04$

SC-5. From Figure 8.7, $VR_{appx} = 3\ ft^2/s$

SC-6. Calculate R

$$R = \frac{VR_{appx}}{V_{max}} = 1.0 \text{ ft}$$

SC-7. Calculate VR_{actual}

$$VR_{actual} = \frac{1.49}{n} R^{1.67} s^{.05} = 5.25 \text{ ft}^2/\text{sec}$$

SC-8. VR_{actual} from Step SC-7 > VR_{appx} from Step SC-5 by > 5 percent.

Select new trial n=0.0475

Figure 8.7: $VR_{appx} = 1.7$ ft^2/s

R = 0.57 ft.

$VR_{actual} = 1.73$ ft^2/s (within 5 percent of $VR_{appx} = 1.7$)

SC-9. Calculate V

$$V = \frac{VR_{actual}}{R} = \frac{1.73}{0.57} = 3 \text{ ft/sec}$$

$V = 3$ ft/sec ≤ 3 ft/sec, V_{max} - OK

SC-10. Calculate Stability Area

$$A_{stability} = \frac{Q}{V} = \frac{1.92}{3} = 0.64 \text{ ft}^2$$

SC-11. Stability Check

$A_{stability} = 0.64$ ft^2 is less than $A_{capacity}$ from Step D-5 ($A_{capacity} = 1.19$ ft^2). ∴OK

If $A_{stability} > A_{capacity}$, it will be necessary to select new trial sizes for width and flow depth (based on space and other considerations), recalculate $A_{capacity}$, and repeat steps SC 10 and SC 11.

SC-12. Calculate depth of flow at the stability design flow rate condition using the quadratic equation solution:

$$y = \frac{-b \pm \sqrt{b^2 - 4Z(-A)}}{2Z}$$

For b=4, y=0.14ft (positive root)

SC-13. Use the greater value of y from SC-12 or that assumed in D-1. In this case, the greater depth is 0.25 foot, which was the basis for the biofiltration capacity design. Add 0.5 ft freeboard to that depth.

Total channel depth = 0.75 ft

Top Width = b + 2yZ

= 4 + (2)(0.75)(3)

= 8.5 ft

SC-14. Recalculate hydraulic radius and flow rate:

For b = 4 ft, y = 0.75 ft

Z = 3, s = 0.02, n = 0.2

$A = by + Zy^2 = 4.68$ ft^2

$$R = \{by + Zy^2\}/\{b + 2y(Z^2 + 1)0.5\} = 0.53 \text{ ft.}$$

SC-15. Calculate Flow Capacity at Greatest Resistance:

$$Q = \frac{1.49AR^{0.67}s^{0.5}}{n} = 3.2 \text{ cfs}$$

$Q = 3.2$ cfs > 1.92 cfs $\therefore$OK

Completion Step

CO-1. Assume 100 ft of swale length is available.

The final channel dimensions are:

Bottom width, $b = 4$ ft

Channel depth $= 0.75$ ft

Top width $= b + 2yZ = 8.5$ ft

No check dams are needed for a 2 percent slope.

Soil Criteria

- The following top soil mix at least 8 inches deep:
  - Sandy loam 60-90 percent
  - Clay 0-10 percent
  - Composted organic matter 10-30 percent (excluding animal waste, toxics)
- Use compost-amended soil where practicable. Composted material shall meet the specifications for compost used in the Bioretention Soil Mix (see Volume III, Section 3.4.6). Note that this excludes the use of biosolids and manures.
- Till to at least an 8inch depth.
- For longitudinal slopes of less than 2 percent use more sand to obtain more infiltration.
- If groundwater contamination is a concern, seal the bed with clay or a treatment liner.

Vegetation Criteria

- See Tables 8.3, 8.4, and 8.5 for recommended grasses, wetland plants, and groundcovers. **The following invasive species shall not be used:** *Phalaris arundinacea* (reed canarygrass), *Lythrum salicaria* (purple loosestrife), *Phragmites* spp. (reeds), *Iris pseudacorus* (yellow iris), and Cattails (*Typha* spp.).
- Select fine, turf-forming, water-resistant grasses where vegetative growth and moisture will be adequate for growth.
- Irrigate if moisture is insufficient during dry weather season.
- Use sod with low clay content and where needed to initiate adequate vegetative growth. Preferably, sod should be laid to a minimum of 1foot vertical depth above the swale bottom.

Recommended Grasses (see Tables 8.3 and 8.4 below)

- Consider sun/shade conditions for adequate vegetative growth and avoid prolonged

shading of any portion not planted with shade tolerant vegetation.

- Stabilize soil areas upslope of the biofilter to prevent erosion.
- Fertilizing a biofilter should be avoided if at all possible in any application where nutrient control is an objective. Test the soil for nitrogen, phosphorous, and potassium, and consult with a landscape professional about the need for fertilizer in relation to soil nutrition and vegetation requirements. If use of a fertilizer cannot be avoided, use a slow-release fertilizer formulation in the least amount needed.

Table 8.3. - Grass Seed Mixes Suitable for Biofiltration Swale Treatment Areas.

Mix 1		**Mix 2**	
75–80%	tall or meadow fescue	60–70%	tall fescue
10–15%	seaside/colonial bentgrass	10–15%	seaside/colonial bentgrass
5–10%	Redtop	10–15%	meadow foxtail
		6–10%	alsike clover
		1–5%	marshfield big trefoil
		1–6%	Redtop

Note: all percentages are by weight. * based on Briargreen, Inc.

Table 8.4. - Groundcovers and Grasses Suitable for the Upper Side Slopes of a Biofiltration Swale in Western Washington.

Groundcovers	
kinnikinnick	*Arctostaphylos uva-ursi*
Epimedium	*Epimedium grandiflorum*
creeping forget-me-not	*Omphalodes verna*
--	*Euonymus lanceolata*
yellow-root	*Xanthorhiza simplissima*
--	*Genista*
white lawn clover	*Trifolium repens*
-------	*Rubus calycinoides*
strawberry	*Fragaria chiloensis*
broadleaf lupine	*Lupinus latifolius*
Grasses (drought-tolerant, minimum mowing)	
dwarf tall fescues	*Festuca* spp. (e.g., Many Mustang, Silverado)
hard fescue	*Festuca ovina duriuscula* (e.g., Reliant, Aurora)
tufted fescue	*Festuca amethystine*
buffalo grass	*Buchloe dactyloides*
red fescue	*Festuca rubra*
tall fescue grass	*Festuca arundinacea*
blue oatgrass	*Helictotrichon sempervirens*

Table 8.5. - Recommended Plants for Wet Biofiltration Swale.

Common Name	**Scientific Name**	**Spacing (on center)**
Shortawn foxtail	*Alopecuris aequalis*	seed
Water foxtail	*Alopecuris geniculatus*	seed
Spike rush	*Eleocharis spp.*	4 inches
Slough sedge*	*Carex obnupta*	6 inches or seed
Sawbeak sedge	*Carex stipata*	6 inches
Sedge	*Carex spp.*	6 inches

Western mannagrass	*Glyceria occidentalis*	seed
Velvetgrass	*Holcus mollis*	seed
Slender rush	*Juncus tenuis*	6 inches
Watercress*	*Rorippa nasturtium-aquaticum*	12 inches
Water parsley*	*Oenanthe sarmentosa*	6 inches
Hardstem bulrush	*Scirpus acutus*	6 inches
Small-fruited bulrush	*Scirpus microcarpus*	12 inches

* Good choices for swales with significant periods of flow, such as those downstream of a detention facility.

Note: Cattail (Typha latifolia) is not appropriate for most wet swales because of its very dense and clumping growth habit which prevents water from filtering through the clump.

Construction Criteria

The biofiltration swale should not be put into operation until areas of exposed soil in the contributing drainage catchment have been sufficiently stabilized. Deposition of eroded soils can impede the growth of grass in the swale and reduce swale treatment effectiveness. Thus, effective erosion and sediment control (ESC) measures should remain in place until the swale vegetation is established (see Volume II for ESC BMPs). Avoid compaction during construction. Grade biofilters to attain uniform longitudinal and lateral slopes.

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

8.4.2 Wet Biofiltration Swale (Ecology BMP T9.20)

A *wet biofiltration swale* is a variation of a basic biofiltration swale for use where the longitudinal slope is slight, water tables are high, or continuous low base flow is likely to result in saturated soil conditions. Where saturation exceeds about 2 weeks, typical grasses will die. Thus, vegetation specifically adapted to saturated soil conditions is needed. Different vegetation in turn requires modification of several of the design parameters for the basic biofiltration swale.

Performance Objectives

To remove low concentrations of pollutants such as total suspended solids, heavy metals, nutrients, and petroleum hydrocarbons.

Applications and Limitations

Wet biofiltration swales are applied where a basic biofiltration swale is desired but not allowed or advisable because one or more of the following conditions exist:

- The swale is on till soils and is downstream of a detention pond providing flow control.
- Saturated soil conditions are likely because of seeps or base flows on the site.
- Longitudinal slopes are slight (generally less than 2 percent).

Wet Biofiltration Swale Design Criteria

Use the same design approach as for basic biofiltration swales except to add the following:

Adjust for extended wet season flow. If the swale will be downstream of a detention pond

providing flow control, multiply the treatment area (bottom width times length) of the swale by 2, and readjust the swale length, if desired. Maintain a 5:1 length to width ratio.

Intent: An increase in the treatment area of swales following detention ponds is required because of the differences in vegetation established in a constant flow environment. Flows following detention are much more prolonged. These prolonged flows result in more stream-like conditions than are typical for other wet biofilter situations. Since vegetation growing in streams is often less dense, this increase in treatment area is needed to ensure that equivalent pollutant removal is achieved in extended flow situations.

Swale Geometry: Same as specified for basic biofiltration swales except for the following modifications:

- ***Criterion 1:*** The bottom width may be increased to 25 feet maximum, but a minimum length-to-width ratio of 5:1 must be provided. No longitudinal dividing berm is needed. Note: The minimum swale length is still 100 feet.
- ***Criterion 2:*** If longitudinal slopes are greater than 2 percent, the wet swale must be stepped so that the slope within the stepped sections averages 2 percent. Steps may be made of retaining walls, log check dams, or short riprap sections. **No underdrain or low-flow drain is required.**

High-Flow Bypass: A high-flow bypass (i.e., an off-line design) is required for flows greater than the off-line water quality design flow that has been increased by the ratio indicated in Figure 8.6b. The bypass is necessary to protect wetland vegetation from damage. Unlike grass, wetland vegetation will not quickly regain an upright attitude after being laid down by high flows. New growth, usually from the base of the plant, often taking several weeks, is required to regain its upright form. The bypass may be an open channel parallel to the wet biofiltration swale.

Water Depth and Base Flow: Same as for basic biofiltration swales except the design water depth shall be 4 inches for all wetland vegetation selections, and **no underdrains or low-flow drains are required.**

Flow Velocity, Energy Dissipation, and Flow Spreading: Same as for basic biofiltration swales except no flow spreader is needed.

Access: Same as for basic biofiltration swales except access is only required to the inflow and the outflow of the swale; access along the length of the swale is not required. Also, wheel strips may not be used for access in the swale.

Intent: An access road is not required along the length of a wet swale because of infrequent access needs. Frequent mowing or harvesting is not desirable. In addition, wetland plants are fairly resilient to sediment-induced changes in water depth, so the need for access should be infrequent.

Soil Amendment: Same as for basic biofiltration swales.

Planting Requirements: Same as for basic biofiltration swales except for the following modifications:

- A list of acceptable plants and recommended spacing is shown in Table 8.5. In general, it is best to plant several species to increase the likelihood that at least some of the selected species will find growing conditions favorable.
- A wetland seed mix may be applied by hydroseeding, but if coverage is poor, planting of rootstock or nursery stock is required. Poor coverage is considered to be more than

30 percent bare area through the upper two-thirds of the swale after 4 weeks.

Recommended Design Features: Same as for basic biofiltration swales.

Construction Criteria: Same as for basic biofiltration swales.

Operations and Maintenance Criteria: Same as for basic biofiltration swales.

8.4.3 Continuous Inflow Biofiltration Swale (Ecology BMP T9.30)

In situations where water enters a biofiltration swale continuously along the side slope rather than discretely at the head, a different design approach, the continuous inflow biofiltration swale, is needed. The basic swale design is modified by increasing swale length to achieve an equivalent average residence time.

Applications and Limitations

A continuous inflow biofiltration swale is to be **used when inflows are not concentrated**, such as locations along the shoulder of a road without curbs. This design may also be **used where frequent, small point flows enter a swale**, such as through curb inlet ports spaced at intervals along a road, or from a parking lot with frequent curb cuts. In general, no inlet port should carry more than about 10 percent of the flow.

A continuous inflow swale is not appropriate for a situation in which significant lateral flows enter a swale at some point downstream from the head of the swale. In this situation, the swale width and length must be recalculated from the point of confluence to the swale outlet in order to provide adequate treatment for the increased flows.

Continuous Inflow Biofiltration Swale Design Criteria

Same as specified for **basic biofiltration swale** except for the following:

- The design flow for continuous inflow swales must include runoff from the pervious side slopes draining to the swale along the entire swale length. Therefore, they must be on-line facilities.
- If only a single design flow is used, the flow rate at the outlet should be used. The goal is to achieve an average residence time through the swale of 9 minutes as calculated using the on-line water quality design flow rate multiplied by the ratio, K, in Figure 8.6a. Assuming an even distribution of inflow into the side of the swale, double the hydraulic residence time to a minimum of 18 minutes.
- For continuous inflow biofiltration swales, interior side slopes above the water quality design treatment elevation shall be planted in grass. A typical lawn seed mix or the biofiltration seed mixes are acceptable. Landscape plants or groundcovers other than grass may not be used anywhere between the runoff inflow elevation and the bottom of the swale. Intent: The use of grass on interior side slopes reduces the chance of soil erosion and transfer of pollutants from landscape areas to the biofiltration treatment area.

Construction Criteria

Same as for basic biofiltration swales.

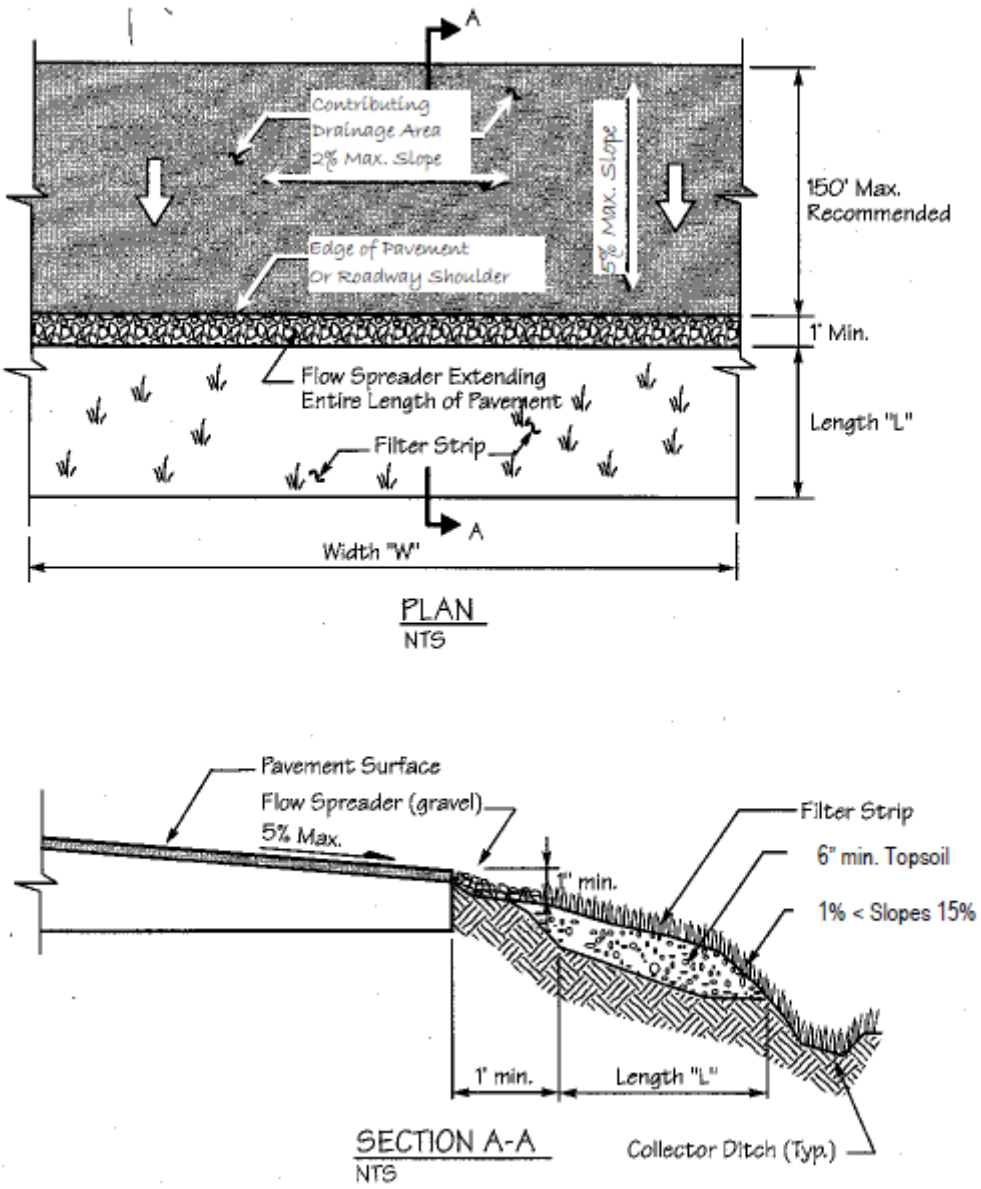
Operations and Maintenance Criteria

Same as for basic biofiltration swales.

8.4.4 Basic Filter Strip (Ecology BMP T9.40)

A basic filter strip is flat with no side slopes (Figure 8.8). Contaminated stormwater is distributed as sheet flow across the inlet width of a biofilter strip. Treatment is by passage of water over the surface, and through grass.

Figure 8.8. - Typical Filter Strip.



Applications and Limitations

The basic filter strip is typically used on-line and adjacent and parallel to a paved area such as parking lots, driveways, and roadways.

Filter Strip Design Criteria

- Use the design criteria specified in Table 8.1.
- If groundwater contamination is a concern, seal the bed with clay or a treatment liner.
- Filter strips should only receive sheet flow.
- For roadways with curbs, curb cuts along roadsides shall include a metal cap on top of the curb per Attachments Section A, Detail 26.3 to prevent vehicle launching. Use curb cuts ≥

12inch wide and 1inch above the filter strip inlet. Curb cuts should be spaced at 10 feet, maximum.

Calculate the design flow depth using Manning's equation as follows:

$$KQ = (1.49A\ R^{0.67}\ s^{0.5})/n$$

Substituting for AR:

$$KQ = (1.49Ty^{1.67}\ s^{0.5})/n$$

Where:

$Ty = A_{rectangle}$, ft^2

$y \approx R_{rectangle}$, design depth of flow, ft. (1 inch maximum)

$Q =$ Peak water quality design flow rate based on an approved continuous runoff model, ft^3/sec

$K =$ The ratio determined by using Figure 8.6a

$n =$ Manning's roughness coefficient

$s =$ Longitudinal slope of filter strip parallel to direction of flow

$T =$ Width of filter strip perpendicular to the direction of flow, ft.

$A =$ Filter strip inlet cross-sectional flow area (rectangular), ft2

$R =$ Hydraulic radius, ft.

Rearranging for y:

$$y = [KQn/1.49Ts^{0.5}]^{0.6}$$

y must not exceed 1 inch

Note: As in swale, design an adjustment factor of K accounts for the differential between the WWHM water quality design flow rate and the SBUH design flow.

Calculate the design flow velocity V, ft./sec., through the filter strip:

$$V = KQ/Ty$$

V must not exceed 0.5 ft./sec

Calculate required length, in feet, of the filter strip at the minimum hydraulic residence time, t, of 9 minutes:

$$L = tV = 540V$$

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

Chapter 9. Wet Pool Facilities

Note: Figures in Chapter 9 are from the King County Surface Water Design Manual

9.1 Purpose

This chapter presents the methods, criteria, and details for analysis and design of wet ponds, wet vaults, and stormwater wetlands. These facilities have as a common element a permanent pool of water – the wet pool. Each of the wet pool facilities can be combined with a detention or flow control pond in a combined facility. This chapter addresses four BMPs that are classified as wet pool facilities:

- Wet ponds, Basic and Large (Section 9.3.1)
- Wet Vaults (Section 9.3.2)
- Stormwater Treatment Wetlands (Section 9.3.3)
- Combined Detention and Wet Pool Facilities (Section 9.3.4).

9.2 Applications

The wet pool facility designs described for the four BMPs in this chapter will achieve the performance objectives cited in Chapter 3 for specific treatment menus.

9.3 Best Management Practices for Wet Pool Facilities

9.3.1 Wet Ponds – Basic and Large (Ecology BMP T10.10)

A wet pond is a constructed stormwater pond that retains a permanent pool of water ("wet pool") at least during the wet season. The volume of the wet pool is related to the effectiveness of the pond in settling particulate pollutants. As an option, a shallow marsh area can be created within the permanent pool volume to provide additional treatment for nutrient removal. Peak flow control can be provided in the "live storage" area above the permanent pool. Attachments Section B, Detail 2.0 illustrates a typical wet pond BMP.

The following design criteria cover two wet pond applications – the basic wet pond and the large wet pond. Large wet ponds are designed for higher levels of pollutant removal. As with other similar BMPs, wet ponds may be used as sedimentation ponds during construction. However, any sediment that has accumulated in the pond must be removed after construction is complete and before the pond is permanently on-line.

Applications and Limitations

A wet pond requires a larger area than a biofiltration swale or a sand filter, but it can be integrated to the contours of a site fairly easily. Wet ponds are designed to hold a permanent pool of water, therefore, the first cell of the wet pond must be lined with a treatment liner or low permeability liner (see Section 4.3). Although high groundwater levels must be avoided for most stormwater facilities (due to buoyancy concerns), the standing water in a wet pond will neutralize any buoyancy effects from high groundwater. Thus, the wet pool storage of wet ponds may be provided below the groundwater level without interfering unduly with treatment effectiveness. However, if combined with a detention function, the live storage must be above the seasonal high groundwater level.

Wet ponds may be single-purpose facilities, providing only runoff treatment, or they may be combined with a detention pond to also provide flow control. If combined, the wet pond can often be stacked under the detention pond with little further loss of development area. See Section 9.3.4 for a description of combined detention and wet pool facilities.

Wet Pond Design Criteria

The primary design factor that determines a wet pond's treatment efficiency is the volume of the wet pool. The larger the wet pool volume, the greater the potential for pollutant removal. For a basic wet pond, the wet pool volume provided shall be equal to or greater than the water quality design storm volume. **This volume is equal to the simulated daily volume that represents the upper limit of the range of daily volumes that accounts for 91 percent of the entire runoff volume over a multi-decade period of record.** The WWHM identify this volume for you.

A large wet pond requires a wet pool volume at least 1.5 times larger than the water quality design storm volume. Also important are the avoidance of short-circuiting and the promotion of plug flow. *Plug flow* describes the hypothetical condition of stormwater moving through the pond as a unit, displacing the "old" water in the pond with incoming flows. To prevent short-circuiting, water is forced to flow, to the extent practical, to all potentially available flow routes, avoiding "dead zones" and maximizing the time water stays in the pond during the active part of a storm.

Design features that encourage plug flow and avoid dead zones are:

Dissipating energy at the inlet.

Providing a large length-to-width ratio.

Providing a broad surface for water exchange using a berm designed as a broad-crested weir to divide the wet pond into two cells rather than a constricted area such as a pipe.

Maximizing the flow path between inlet and outlet, including the vertical path, also enhances treatment by increasing residence time.

Sizing Procedure

Procedures for determining a wet pond's dimensions and volume are outlined below.

Step 1: Identify required wet pool volume using an approved continuous runoff model – water quality design storm volume. A large wet pond requires a volume at least 1.5 times the water quality design storm volume.

Step 2: Determine wet pool dimensions. Determine the wet pool dimensions satisfying the design criteria outlined below and illustrated in Attachments Section B, Detail 2.0. A simple way to check the volume of each wet pool cell is to use the following equation:

$$V = \frac{h(A_1 + A_2)}{2}$$

Where V = wet pool volume (cf)

h = wet pool average depth (ft)

A_1 = water quality design surface area of wet pool (sf)

A_2 = bottom area of wet pool (sf)

Step 3: Design pond outlet pipe and determine primary overflow water surface. The pond outlet

pipe shall be placed on a reverse grade from the pond's wet pool to the outlet structure. Use the following procedure to design the pond outlet pipe and determine the primary overflow water surface elevation:

- Use the nomographs in Volume III, Appendix IIIC to select a trial size for the pond outlet pipe sufficient to pass the on-line water quality design flow, Q_{wq} indicated by an approved continuous runoff model.
- Use the nomographs in Volume III, Appendix IIIC to determine the critical depth d_c at the outflow end of the pipe for Q_{wq}.
- Use the nomographs in Volume III, Appendix IIIC to determine the flow area A_c at critical depth.
- Calculate the flow velocity at critical depth using continuity equation ($Vc = Q_{wq} / A_c$).
- Calculate the velocity head V_H ($V_H = V_c^2 / 2g$, where g is the gravitational constant, 32.2 feet per second).
- Determine the primary overflow water surface elevation by adding the velocity head and critical depth to the invert elevation at the outflow end of the pond outlet pipe (i.e., overflow water surface elevation = outflow invert + d_c + V_H).
- Adjust outlet pipe diameter as needed and repeat steps (a) through (e).

Step 4: Determine wet pond dimensions. General wet pond design criteria and concepts are shown in Attachments Section B, Detail 2.0.

Wet Pool Geometry

- The wet pool shall be divided into two cells separated by a baffle or berm. The first cell shall contain between 25 to 35 percent of the total wet pool volume. Both cells must have level pond bottoms.
- The baffle or berm volume shall not count as part of the total wet pool volume. The term baffle means a vertical divider placed across the entire width of the pond, stopping short of the bottom. A berm is a vertical divider typically built up from the bottom, or if in a vault, connects all the way to the bottom.

  Intent: The full-length berm or baffle promotes plug flow and enhances quiescence and laminar flow through as much of the entire water volume as possible. Alternative methods to the full-length berm or baffle that provide equivalent flow characteristics may be approved on a case-by-case basis by Pierce County.
- Sediment storage shall be provided in the first cell. The sediment storage shall have a minimum depth of 1 foot. A fixed sediment depth monitor should be installed in the first cell to gauge sediment accumulation unless an alternative gauging method is proposed.
- The minimum depth of the first cell shall be 4 feet, exclusive of sediment storage requirements. The depth of the first cell may be greater than the depth of the second cell.
- The maximum depth of each cell shall not exceed 8 feet (exclusive of sediment storage in the first cell). Pool depths of 3 feet or shallower (second cell) shall be planted with emergent wetland vegetation (see Planting Requirements).
- Inlets and outlets shall be placed to maximize the flow path through the facility. The ratio of flow path length to width from the inlet to the outlet shall be at least 3:1. The ***flow path***

length is defined as the distance from the inlet to the outlet, as measured at mid-depth. The ***width*** at mid-depth can be found as follows: width = (average top width + average bottom width)/2.

- Wet ponds with wet pool volumes less than or equal to 4,000 cubic feet may be single celled (i.e., no baffle or berm is required). However, it is especially important in this case that the flow path length be maximized. The ratio of flow path length to width shall be at least 4:1 in single celled wet ponds, but should preferably be 5:1.
- All inlets shall enter the first cell. If there are multiple inlets, the length-to-width ratio shall be based on the average flow path length for all inlets.
- The wet pool cells shall be lined per the liner requirements outlined in Section 4.3.

Berms, Baffles, and Slopes

- A berm or baffle shall extend across the full width of the wet pool, and tie into the wet pond side slopes. If the berm embankments are greater than 4 feet in height, the berm must be constructed by excavating a key equal to 50 percent of the embankment cross-sectional height and width. This requirement may be waived if recommended by a geotechnical engineer for specific site conditions. The geotechnical analysis shall address situations in which one of the two cells is empty while the other remains full of water.
- The top of the berm may extend to the water quality design water surface or be 1 foot below the water quality design water surface. If at the water quality design water surface, berm side slopes should be 3H:1V. Berm side slopes may be steeper (up to 2:1) if the berm is submerged 1 foot.

  Intent: Submerging the berm is intended to enhance safety by discouraging pedestrian access when side slopes are steeper than 3H:1V. An alternative to the submerged berm design is the use of barrier planting to prevent easy access to the divider berm in an unfenced wet pond.
- If good vegetation cover is not established on the berm, erosion control measures should be used to prevent erosion of the berm back-slope when the pond is initially filled.
- The interior berm or baffle may be a retaining wall provided that the design is prepared and stamped by a licensed civil engineer. If a baffle or retaining wall is used, it should be submerged 1 foot below the design water surface to discourage access by pedestrians.
- Note that wet ponds can also be designed to include oil containment booms at locations where oil control is required. Design guidelines for oil containment booms are not included in this volume, but can be found in the 2014 WSDOT Highway Runoff Manual, Chapter 5, BMP RT.22.
- Requirements for wet pond side slopes are the same as for detention ponds (see Volume III, Section 3.12.1).

Embankments

Embankments that impound water must comply with the Washington State Dam Safety Regulations (Chapter 173175 WAC). If the impoundment has a storage capacity (including both water and sediment storage volumes) greater than 10 acre-feet (435,600 cubic feet or 3.26 million gallons) above natural ground level, then dam safety design and review are required by Ecology. See Volume III, Section 3.12.1 for additional requirements.

Inlet and Outlet

See Attachments Section B, Detail 2.0 for details on the following requirements:

- The inlet to the wet pond shall be submerged with the inlet pipe invert a minimum of 2 feet from the pond bottom (not including sediment storage). The top of the inlet pipe should be submerged at least 1 foot, if possible. Conveyance modeling for the stormwater system leading to the wet pond must be shown to include consideration of the backwater effects of the submerged inlet.

  Intent: The inlet is submerged to dissipate energy of the incoming flow. The distance from the bottom is set to minimize resuspension of settled sediments. Alternative inlet designs that accomplish these objectives are acceptable.

- The runoff shall be discharged uniformly and at a velocity below 3 feet per second in Type A and B soils, and 5 feet per second in Type C and D soils or as necessary to prevent erosion and to insure quiescent conditions within the BMP.
- An outlet structure shall be provided. Either a Type 2 catch basin with a grated opening (jail house window) or a manhole with a cone grate (birdcage) may be used (see Attachments Section A, Detail 16.0 for an illustration). The outlet structure receives flow from the pond outlet pipe. The grate or birdcage openings provide an overflow route should the pond outlet pipe become clogged. The overflow criteria provided below specifies the sizing and position of the grate opening.
- The pond outlet pipe (as opposed to the manhole or Type 2 catch basin outlet pipe) shall be back-sloped or have a turn-down elbow, and extend 1 foot below the water quality design water surface. Note: A floating outlet, set to draw water from 1 foot below the water surface, is also acceptable if vandalism concerns are adequately addressed.

  Intent: The inverted outlet pipe provides for trapping of oils and floatables in the wet pond.

- The pond outlet pipe shall be sized, at a minimum, to pass the on-line water quality design flow. Note: The highest invert of the outlet pipe sets the water quality design water surface elevation.
- The overflow criteria for single-purpose (treatment only, not combined with flow control) wet ponds are as follows:
  - The requirement for primary overflow is satisfied by either the grated inlet to the outlet structure or by a birdcage above the pond outlet structure.
  - The bottom of the grate opening in the outlet structure shall be set at or above the height needed to pass the water quality design flow through the pond outlet pipe. *Note: The grate invert elevation sets the overflow water surface elevation.*
  - The grated opening should be sized to pass the 100year recurrence interval design flow. The capacity of the outlet system should be sized to pass the peak flow for the conveyance requirements.
- An emergency spillway shall be provided and designed according to the requirements for detention ponds (see Volume III, Section 3.12.1).
- The County may require a bypass/shutoff valve to enable the pond to be taken off-line for maintenance purposes.
- A gravity drain for maintenance is required where feasible. The engineer must demonstrate

why a drain is not feasible and show in the Maintenance and Source Control Manual how to drain the pond.

Intent: It is anticipated that sediment removal will only be needed for the first cell in the majority of cases. The gravity drain is intended to allow water from the first cell to be drained to the second cell when the first cell is pumped dry for cleaning.

- The drain invert shall be at least 6 inches below the top elevation of the dividing berm or baffle. Deeper drains are encouraged where feasible, but must be no deeper than 18 inches above the pond bottom.

  Intent: To prevent highly sediment-laden water from escaping the pond when drained for maintenance.

- The drain shall be at least 8 inches (minimum) diameter and shall be controlled by a valve. Use of a shear gate is allowed only at the inlet end of a pipe located within an approved structure.

  Intent: Shear gates often leak if water pressure pushes on the side of the gate opposite the seal. The gate should be situated so that water pressure pushes toward the seal.

- Operational access to the valve shall be provided to the finished ground surface.
- The valve location shall be accessible and well-marked with 1 foot of paving placed around the box. It must also be protected from damage and unauthorized operation.
- A valve box is allowed to a maximum depth of 5 feet without an access manhole. If over 5 feet deep, an access manhole or vault is required.
- All metal parts shall be corrosion-resistant. Galvanized materials should not be used unless unavoidable.

  Intent: Galvanized metal contributes zinc to stormwater, sometimes in very high concentrations.

Access and Setbacks

- All facilities shall be a minimum of 20 feet from any structure, property line, and any vegetative buffer required by Pierce County, and 100 feet from any septic tank/drainfield.
- All facilities shall be a minimum of 50 feet from any steep (greater than 15 percent) slope. A geotechnical assessment must address the potential impact of a wet pond on a steep slope.
- Access and maintenance roads shall be provided and designed according to the requirements for detention ponds (see Volume III, Section 3.12.1). Access and maintenance roads shall extend to both the wet pond inlet and outlet structures. An access ramp shall be provided to the bottom of all cells, unless a trackhoe (maximum reach of 20 feet) can reach all portions of the cell and can load a truck parked at the pond edge or on the internal berm of a wet pond or combined pond.
- If the dividing berm is also used for access, it should be built to sustain loads of up to 80,000 pounds.

Signage

- See the signage requirements in Volume III, Section 3.12.1 for wet pond sign requirements.

Planting Requirements

Planting requirements for detention ponds also apply to wet ponds.

- Large wet ponds intended for phosphorus control should not be planted within the cells, as the plants will release phosphorus in the winter when they die off.
- If the second cell of a basic wet pond is 3 feet or shallower, the bottom area shall be planted with emergent wetland vegetation. See Table 9.1 for recommended emergent wetland plant species for wet ponds.

  Intent: Planting of shallow pond areas helps to stabilize settled sediment and prevent resuspension.
- Cattails (*Typha latifolia*) are not recommended because they tend to crowd out other species and will typically establish themselves anyway.
- If the wet pond discharges to a phosphorus-sensitive lake or wetland, shrubs that form a dense cover should be planted on slopes above the water quality design water surface on at least three sides. For banks that are berms, no planting is allowed if the berm is regulated by dam safety requirements. The purpose of planting is to discourage waterfowl use of the pond and to provide shading. Some suitable trees and shrubs include vine maple (*Acer circinatum*), wild cherry (*Prunus emarginata*), red osier dogwood (*Cornus stolonifera*), California myrtle (*Myrica californica*), Indian plum (*Oemleria cerasiformis*), and Pacific yew (*Taxus brevifolia*) as well as numerous ornamental species.

Construction Criteria

Sediment that has accumulated in the pond must be removed after construction in the drainage area is complete (unless used as part of a low permeability liner; see Section 4.3).

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

Table 9.1. - Emergent Wetland Plant Species Recommended for Wet Ponds.

Species	Common Name	Notes	Max. Depth
Agrostis exarata[1]	Spike bent grass	Prairie to coast	to 2 feet
Carex stipata	Sawbeak sedge	Wet ground	
Eleocharis palustris	Spike rush	Margins of ponds, wet meadows	to 2 feet
Glyceria occidentalis	Western mannagrass	Marshes, pond margins	to 2 feet
Juncus tenuis	Slender rush	Wet soils, wetland margins	
Oenanthe sarmentosa	Water parsley	Shallow water along stream and pond margins; needs saturated soils all summer	
Scirpus atrocinctus (formerly S. cyperinus)	Woolgrass	Tolerates shallow water; tall clumps	
Scirpus microcarpus	Small-fruited bulrush	Wet ground to 18 inches depth	18 inches
Sagittaria latifolia	Arrowhead		
INUNDATION 1 TO 2 FEET			
Agrostis exarata[1]	Spike bent grass	Prairie to coast	
Alisma plantago-aquatica	Water plantain		
Eleocharis palustris	Spike rush	Margins of ponds, wet meadows	
Glyceria occidentalis	Western mannagrass	Marshes, pond margins	
Juncus effusus	Soft rush	Wet meadows, pastures, wetland margins	
Scirpus microcarpus	Small-fruited bulrush	Wet ground to 18 inches depth	18 inches
Sparganium emmersum	Bur reed	Shallow standing water, saturated soils	
Inundation 1 to 3 feet			
Carex obnupta	Slough sedge	Wet ground or standing water	1.5 to 3 feet
Beckmannia syzigachne[1]	Western sloughgrass	Wet prairie to pond margins	
Scirpus acutus[2]	Hardstem bulrush	Single tall stems, not clumping	to 3 feet
Scirpus validus[2]	Softstem bulrush		
INUNDATION GREATER THAN 3 FEET			
Nuphar polysepalum	Spatterdock	Deep water	3 to 7.5 feet
Nymphaea odorata(1)	White waterlily	Shallow to deep ponds	to 6 feet

Notes:

(1) Nonnative species. Beckmannia syzigachne is native to Oregon. Native species are preferred.

(2) Scirpus tubers must be planted shallower for establishment, and protected from foraging waterfowl until established. Emerging aerial stems should project above water surface to allow oxygen transport to the roots.

Primary sources: Municipality of Metropolitan Seattle, Water Pollution Control Aspects of Aquatic Plants 1990. Hortus Northwest, Wetland Plants for Western Oregon, Issue 2, 1991. Hitchcock and Cronquist, Flora of the Pacific Northwest 1973.

Note: The recommendations in Table 9.1 are for western Washington only. Local knowledge should be used to adapt this information if used in other areas.

9.3.2 Wet Vaults (Ecology BMP T10.20)

A wet vault is an underground structure similar in appearance to a detention vault, except that a wet vault has a permanent pool of water (wet pool) which dissipates energy and improves the settling of particulate pollutants (see the wet vault details in Figure 9.1). Being underground, the wet vault lacks the biological pollutant removal mechanisms, such as algae uptake, present in surface wet ponds.

Applications and Limitations

A wet vault may be used for commercial, industrial, or roadway projects if there are space limitations precluding the use of other treatment BMPs. The use of **wet vaults for residential development is highly discouraged**. Combined detention and wet vaults are allowed; see Section 9.3.4.

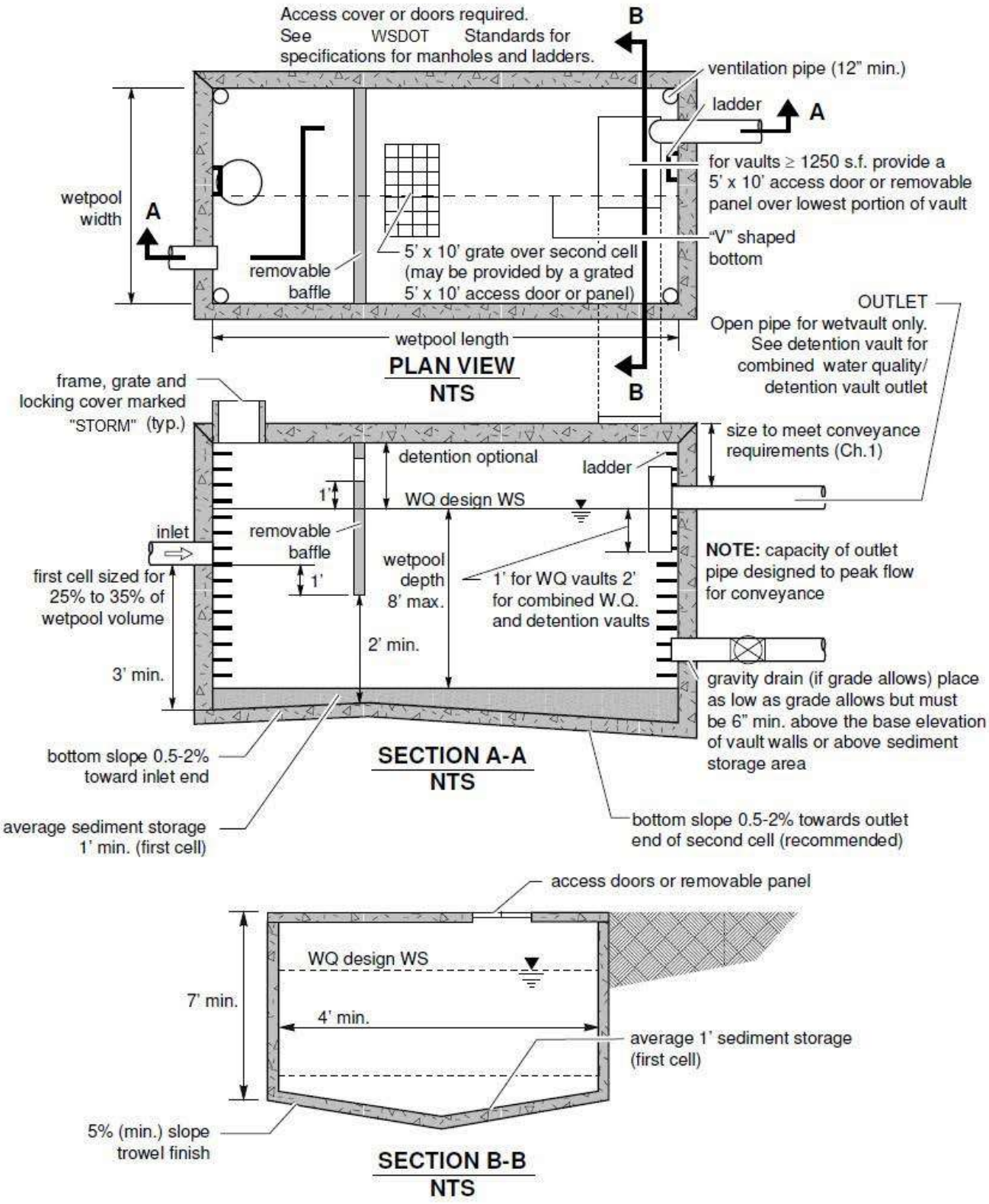
A wet vault is believed to be ineffective in removing dissolved pollutants such as soluble phosphorus or metals such as copper. There is also concern that oxygen levels will decline, especially in warm summer months, because of limited contact with air and wind. However, the extent to which this potential problem occurs has not been documented.

Below-ground structures like wet vaults are relatively difficult and expensive to maintain. The need for maintenance is often not seen and as a result routine maintenance does not occur. Therefore, wet vaults **shall only be permitted after it has been demonstrated to the satisfaction of the County that more desirable BMPs are not practicable**.

If a wet vault/tank is designed to provide runoff treatment but not runoff quantity control, it must be located “off-line” from the primary conveyance/detention system. Flows above the peak flow for the water quality design storm (see Sizing Procedure below) must bypass the facility in a separate conveyance to the point of discharge. A mechanism must also be provided at the bypass point to take the facility “off-line” for maintenance purposes.

If oil control is required for a project, a wet vault may be combined with an API oil/water separator.

Figure 9.1. - Wet Vault Geometry.



Wet Vault Design Criteria

Sizing Procedure

As with wet ponds, the primary design factor that determines the removal efficiency of a wet vault is the volume of the wet pool. The larger the volume, the higher the potential for pollutant removal. Performance is also improved by avoiding dead zones (like corners) where little exchange occurs, using large length-to-width ratios, dissipating energy at the inlet, and ensuring that flow rates are uniform to the extent possible and not increased between cells.

The sizing procedure for a wet vault is identical to the sizing procedure for a wet pond. The wet pool volume for the wet vault shall be equal to or greater than the water quality design storm volume estimated by an approved continuous runoff model. In addition, because wet vaults are designed to be off-line, the facility must be designed with a flow splitter that can engage a bypass when the flow rate exceeds the water quality design flow rate.

Typical design details and concepts for the wet vault are shown in Figure 9.1.

Wet Pool Geometry

Same as specified for wet ponds (see Section 9.3.1) except for the following two modifications:

- The sediment storage in the first cell shall be an average of 1-foot. Because of the V-shaped bottom, the depth of sediment storage needed above the bottom of the side wall is roughly proportional to vault width according to the schedule below:
- The second cell shall be a minimum of 3 feet deep since planting cannot be used to prevent resuspension of sediment in shallow water, as it can in open ponds.

Vault Structure

- The vault shall be separated into two cells by a wall or a removable baffle. If a wall is used, a 5foot by 10foot removable maintenance access must be provided for both cells. If a removable baffle is used, the following criteria apply:
    - The baffle shall extend from a minimum of 1 foot above the water quality design water surface to a minimum of 1 foot below the invert elevation of the inlet pipe.
    - The lowest point of the baffle shall be a minimum of 2 feet from the bottom of the vault, and greater if feasible.
- If the vault is less than 2,000 cubic feet (inside dimensions), or if the length-to-width ratio of the vault pool is 5:1 or greater, the baffle or wall may be omitted and the vault may be one-celled.
- The two cells of a wet vault should not be divided into additional subcells by internal walls. If internal structural support is needed, it is preferred that post and pier construction be used to support the vault lid rather than walls. Any walls used within cells must be positioned so as to lengthen, rather than divide, the flow path.

  Intent: Treatment effectiveness in wet pool facilities is related to the extent to which plug flow is achieved and short-circuiting and dead zones are avoided. Structural walls placed within the cells can interfere with plug flow and create significant dead zones, reducing treatment effectiveness.
- The bottom of the first cell shall be sloped toward the access opening. Slope should be between 0.5 percent (minimum) and 2 percent (maximum). The second cell may be level (longitudinally) sloped toward the outlet, with a high point between the first and second

cells. The intent of sloping the bottom is to direct the sediment accumulation to the closest access point for maintenance purposes. Sloping the second cell towards the access opening for the first cell is also acceptable.

- The vault bottom shall slope laterally a minimum of 5 percent from each side towards the center, forming a broad "V" to facilitate sediment removal. Note: More than one "V" may be used to minimize vault depth.

  Exception: Pierce County may allow the vault bottom to be flat if removable panels are provided over the entire vault. Removable panels should be at grade, have stainless steel lifting eyes, and weigh no more than 5 tons per panel.

- The highest point of a vault bottom must be at least 6 inches below the outlet elevation to provide for sediment storage over the entire bottom.
- Provision for passage of flows should the outlet plug shall be provided.
- Wet vaults may be constructed using arch culvert sections, provided the top area at the water quality design water surface is, at a minimum, equal to that of a vault with vertical walls designed with an average depth of 6 feet.

  Intent: To prevent decreasing the surface area available for oxygen exchange.

- Wet vaults shall conform to the "Materials" and "Structural Stability" criteria specified for detention vaults in Volume III, Section 3.12.3.
- Where pipes enter and leave the vault below the water quality design water surface, they shall be sealed using a non-porous, non-shrinking grout.

Inlet and Outlet

- The inlet to the wet vault shall be submerged with the inlet pipe invert a minimum of 3 feet from the vault bottom. The top of the inlet pipe shall be submerged at least 1 foot.
  - The inlet pipe must also maintain a flow rate of 2 ft/s under the design water quality storm event to minimize sediment settling in the pipe.
  - Conveyance modeling for the stormwater system leading to the vault must be shown to include consideration of the backwater effects of the submerged vault inlet. Additional information on backwater analyses is provided in Volume III, Chapter 4.

    Intent: The submerged inlet is to dissipate energy of the incoming flow. The distance from the bottom is to minimize resuspension of settled sediments. Alternative inlet designs that accomplish these objectives are acceptable.

- The capacity of the outlet pipe and available head above the outlet pipe should be designed to convey the 100year recurrence interval design flow for developed site conditions without overtopping the vault. The available head above the outlet pipe must be a minimum of 6 inches.
- The flow path length should be maximized from inlet to outlet for all inlets to the vault.
- The outlet pipe shall be back-sloped or have a tee section, the lower arm of which should extend 1 foot below the water quality design water surface to provide for trapping of oils and floatables in the vault.
- Pierce County may require a bypass/shutoff valve to enable the vault to be taken off-line for maintenance.

Access Requirements

Same as for detention vaults (see Volume III, Section 3.12.3) except for the following additional requirement for wet vaults:

- A minimum of 50 square feet of grate should be provided over the second cell. For vaults in which the surface area of the second cell is greater than 1,250 square feet, 4 percent of the top should be grated. This requirement may be met by one grate or by many smaller grates distributed over the second cell area. *Note: A grated access door can be used to meet this requirement.*

  Intent: The grate allows air contact with the wet pool in order to minimize stagnant conditions which can result in oxygen depletion, especially in warm weather.

Access Roads, Right-of-Way, and Setbacks

Same as for detention vaults (see Volume III, Section 3.12.3).

Construction Criteria

Sediment that has accumulated in the vault must be removed after construction in the drainage area is complete.

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

Modifications for Combining with a Baffle Oil/Water Separator

If the project site is a high-use site and a wet vault is proposed, the vault may be combined with a baffle oil/water separator to meet the runoff treatment requirements with one facility rather than two. Structural modifications and added design criteria are given below. However, the maintenance requirements for baffle oil/water separators must be adhered to, in addition to those for a wet vault. This will result in more frequent inspection and cleaning than for a wet vault used only for total suspended solids removal. See Chapter 10 for information on maintenance of baffle oil/water separators.

- The sizing procedures for the baffle oil/water separator (Chapter 10) should be run as a check to ensure the vault is large enough. If the oil/water separator sizing procedures result in a larger vault size, increase the wet vault size to match.
- An oil retaining baffle shall be provided in the second cell near the vault outlet. The baffle should not contain a high-flow overflow, or else the retained oil will be washed out of the vault during large storms.
- The vault shall have a minimum length-to-width ratio of 5:1.
- The vault shall have a design water depth-to-width ratio of between 1:3 and 1:2.
- The vault shall be watertight and shall be coated to protect from corrosion.
- Separator vaults shall have a shutoff mechanism on the outlet pipe to prevent oil discharges during maintenance and to provide emergency shut-off capability in case of a spill. A valve box and riser shall also be provided and accessible.

- Wet vaults used as oil/water separators must be off-line and must bypass flows greater than the off-line water quality design flow multiplied by the offline ratio indicated in Figure 8.6b.

  Intent: This design minimizes the entrainment and/or emulsification of previously captured oil during very high flow events.

9.3.3 Stormwater Treatment Wetlands (Ecology BMP T10.30)

Stormwater treatment wetlands are shallow man-made ponds that are designed to treat stormwater through the biological processes associated with emergent aquatic plants (see the stormwater wetland details in Figures 9.2 and 9.3). Wetlands created to mitigate disturbance impacts, such as filling, may not also be used as stormwater treatment facilities.

In general, stormwater wetlands perform well to remove sediment, metals, and pollutants that bind to humic or organic acids. Phosphorus removal in stormwater wetlands is highly variable.

Applications and Limitations

This stormwater wetland design occupies about the same surface area as wet ponds, but has the potential to be better integrated aesthetically into a site because of the abundance of emergent aquatic vegetation. The most critical factor for a successful design is the provision of an adequate supply of water for most of the year. Careful planning is needed to be sure sufficient water will be retained to sustain good wetland plant growth. Since water depths are shallower than in wet ponds, water loss by evaporation is an important concern. Stormwater wetlands are a good water quality facility choice in areas with high winter groundwater levels.

Stormwater Treatment Wetland Design Criteria

When used for stormwater treatment, stormwater wetlands employ some of the same design features as wet ponds. However, instead of gravity settling being the dominant treatment process, pollutant removal mediated by aquatic vegetation and the microbiological community associated with that vegetation becomes the dominant treatment process. Thus, when designing wetlands, water volume is not the dominant design criteria. Rather, factors which affect plant vigor and biomass are the primary concerns.

Sizing Procedure

Step 1: The volume of a basic wet pond is used as a template for sizing the stormwater wetland. The design volume is the water quality design storm volume estimated by an approved continuous runoff model.

Step 2: Calculate the surface area of the stormwater wetland. The surface area of the wetland shall be the same as the top area of a wet pond sized for the same site conditions. Calculate the surface area of the stormwater wetland by using the volume from Step 1 and dividing by the average water depth (use 3 feet).

Step 3: Determine the surface area of the first cell of the stormwater wetland. Use the volume determined from Criterion 2 under "Wetland Geometry," and the actual depth of the first cell.

Step 4: Determine the surface area of the wetland cell. Subtract the surface area of the first cell (Step 3) from the total surface area (Step 2).

Step 5: Determine water depth distribution in the second cell. Decide if the top of the dividing berm will be at the surface or submerged (designer's choice). Adjust the distribution of water

depths in the second cell according to Criterion 8 under "Wetland Geometry" below. Note: This will result in a facility that holds less volume than that determined in Step 1 above. This is acceptable.

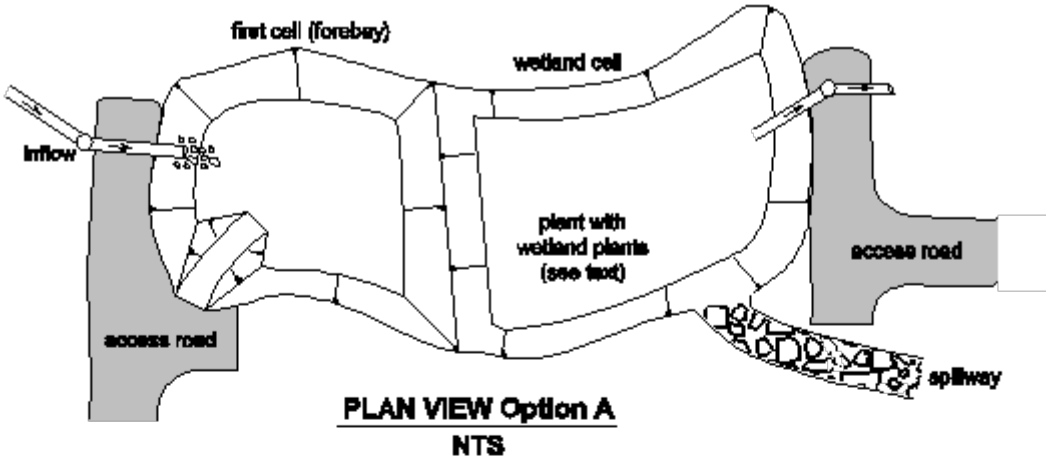
> **Intent:** The surface area of the stormwater wetland is set to be roughly equivalent to that of a wet pond designed for the same site so as not to discourage use of this option.

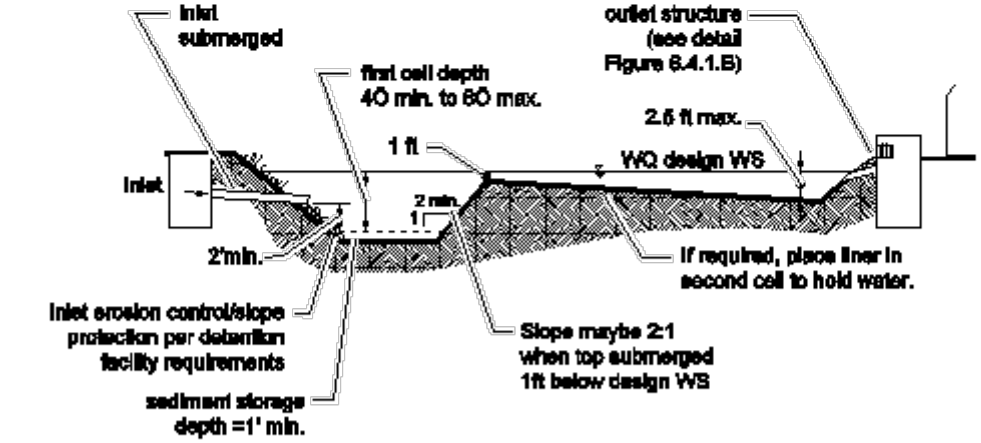
Step 6: Choose plants. See Table 9.1 for a list of plants recommended for wet pond water depth zones, or consult a wetland scientist.

Wetland Geometry

1. Stormwater wetlands shall consist of two cells, a presettling cell and a wetland cell.
2. The presettling cell shall contain approximately 33 percent of the wet pool volume calculated in Step 1 above.
3. The depth of the presettling cell shall be between 4 feet (minimum) and 8 feet (maximum), excluding sediment storage.
4. One foot of sediment storage shall be provided in the presettling cell.
5. The presettling cell must include a gravity drain for maintenance.
6. The wetland cell shall have an average water depth of about 1.5 feet (plus or minus 3 inches).
7. The "berm" separating the two cells shall be shaped such that its downstream side gradually slopes to form the second shallow wetland cell (see the section view in Figure 9.2). Alternatively, the second cell may be graded naturalistically from the top of the dividing berm (see Criterion 8 below).

Figure 9.2. - Stormwater Wetland – Option One.





Note: See detention facility requirements for location and setback requirements.

8. The top of berm shall be either at the water quality design water surface or submerged 1 foot below the water quality design water surface, as with wet ponds. Correspondingly, the side slopes of the berm must meet the following criteria:
    - If the top of berm is at the water quality design water surface, the berm side slopes shall be no steeper than 3H:1V.
    - If the top of berm is submerged 1 foot, the upstream side slope may be up to 2H:1V. If the berm is at the water surface, then for safety reasons, its slope should be not greater than 3:1, just as the pond banks should not be greater than 3:1 if the pond is not fenced. A steeper slope (2:1 rather than 3:1) is allowable if the berm is submerged in 1 foot of water. If submerged, the berm is not considered accessible, and the steeper

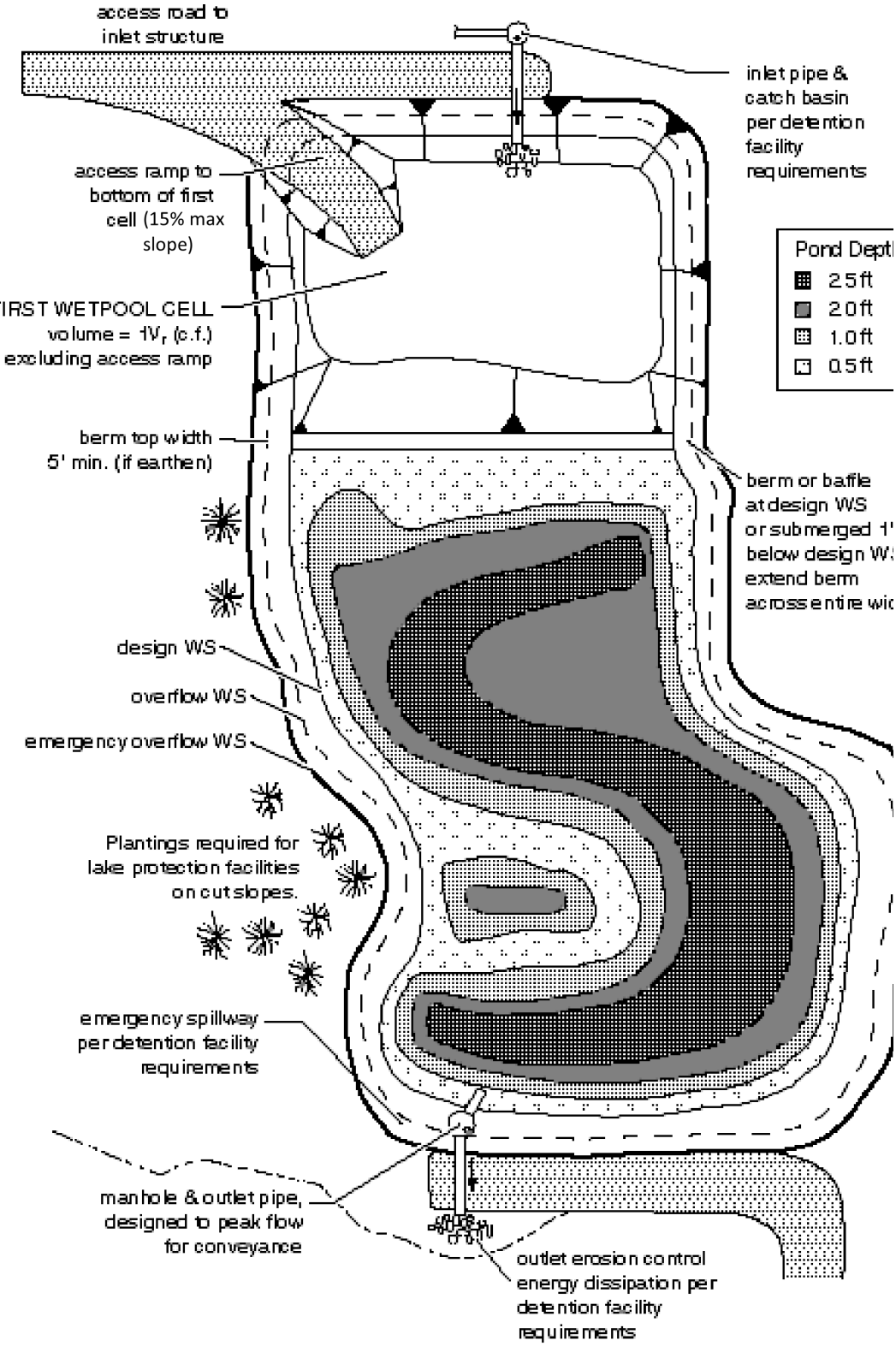
slope is allowable.

9. Two examples are provided for grading the bottom of the wetland cell. One example is a shallow, evenly graded slope from the upstream to the downstream edge of the wetland cell (see Figure 9.2). The second example is a "naturalistic" alternative, with the specified range of depths intermixed throughout the second cell (see Figure 9.3). A distribution of depths shall be provided in the wetland cell depending on whether the dividing berm is at the water surface or submerged (see Table 9.2 below). The maximum depth is 2.5 feet in either configuration. Other configurations within the wetland geometry constraints listed above may be approved by Pierce County.
10. Construction of the naturalistic alternative (example 2 above) can be easily accomplished by first excavating the entire area to the 1.5foot average depth. Then soil subsequently excavated to form deeper areas can be deposited to raise other areas until the distribution of depths indicated in the design is achieved.
11. To the extent possible create a complex microtopography within the wetland.
12. Design the flow path to maximize sinuous flow between wetland cells.

Table 9.2. - Distribution of Depths in Wetland Cell.

Dividing Berm at Water Quality Design Water Surface		Dividing Berm Submerged 1 Foot	
Depth Range (ft)	**Percent**	**Depth Range (ft)**	**Percent**
0.1 to 1	25	1 to 1.5	40
1 to 2	55	1.5 to 2	40
2 to 2.5	20	2 to 2.5	20

Figure 9.3. - Stormwater Wetland – Option Two.



Lining Requirements

Constructed wetlands are not intended to infiltrate. Many wetland plants can adapt to periods of summer drought, however the stormwater wetland design should maximize the duration of wet conditions to the extent possible. Therefore, both cells of the stormwater wetland shall be lined with a low-permeability liner. The criteria for liners given in Section 4.3 must be observed. A minimum of 18 inches of native soil amended with topsoil or compost (one part compost mixed with three parts native soil) must be placed over the liner. For geomembrane liners, a soil depth of 3 feet is recommended to prevent damage to the liner during planting. A liner is not required in hydric soils.

Inlet and Outlet

Inlets and outlets shall be configured in accordance with the requirements of wet ponds, see BMP 9.10.

Access and Setbacks

- Location of the stormwater wetland relative to site constraints (e.g., buildings, property lines, etc.) shall be the same as for detention ponds (see Volume III, Section 3.12.1).
- Access and maintenance roads shall be provided and designed according to the requirements for detention ponds (see Volume III, Section 3.12.1). Access and maintenance roads shall extend to both the wetland inlet and outlet structures. An access ramp shall be provided to the bottom of the first cell unless all portions of the cell can be reached and sediment loaded from the top of the wetland side slopes.

Planting Requirements

The wetland cell shall be planted with emergent wetland plants following the recommendations given in Table 9.1 or the recommendations of a wetland specialist.

Note: Cattails (Typha latifolia) are not recommended. They tend to escape to natural wetlands and crowd out other species. In addition, the shoots die back each fall and will result in oxygen depletion in the wet pool unless they are removed.

Construction Criteria

Sediment that has accumulated in the pond must be removed after construction in the drainage area is complete (unless used as part of a low permeability liner; see Section 4.3).

Operations and Maintenance Criteria

See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

9.3.4 Combined Detention and Wet Pool Facilities (Ecology BMP T10.40)

Combined detention and water quality wet pool facilities have the appearance of a detention facility but contain a permanent pool of water as well. The following design procedures, requirements, and recommendations cover differences in the design of the stand-alone water quality facility when combined with detention storage. The following combined facilities are addressed:

- Detention/wet pond (basic and large)
- Detention/wet vault

- Detention/stormwater wetland.

There are two sizes of the combined wet pond, a basic and a large, but only a basic size for the combined wet vault and combined stormwater wetland. The facility sizes (basic and large) are related to the pollutant removal goals. See Chapter 3 for more information about treatment performance goals.

Applications and Limitations

Combined detention and water quality facilities are very efficient for sites that also have detention requirements. The water quality facility may often be placed beneath the detention facility without increasing the facility surface area. However, the fluctuating water surface of the live storage will create unique challenges for plant growth and for aesthetics alike.

The basis for pollutant removal in combined facilities is the same as in the stand-alone water quality facilities. However, in the combined facility, the detention function creates fluctuating water levels and added turbulence. For simplicity, the positive effect of the extra live storage volume and the negative effect of increased turbulence are assumed to balance, and are thus ignored when sizing the wet pool volume. For the combined detention/stormwater wetland, criteria that limit the extent of water level fluctuation are specified to better ensure survival of the wetland plants.

Unlike the wet pool volume, the live storage component of the facility should be provided above the seasonal high water table.

Construction, and Operations and Maintenance Criteria

Construction, and operations and maintenance criteria for combined facilities are the same as those outlined for each individual detention and treatment facility (i.e., as outlined in Volume III, and in the previous sections of this volume).

Combined Detention and Wet Pond (Basic and Large)

Typical design details and concepts for a combined detention and wet pond are shown in Figures 9.4a and 9.4b. The detention portion of the facility shall meet the design criteria and sizing procedures set forth in Volume III.

Sizing Procedure

The sizing procedure for combined detention and wet ponds are identical to those outlined for wet ponds and for detention facilities. The wet pool volume for a combined facility shall be equal to or greater than the water quality design storm volume estimated by an approved continuous runoff model. Follow the standard procedure specified in Volume III and guidance documents for use of an approved continuous runoff model to size the detention portion of the pond.

Detention and Wet Pond Geometry

- The wet pool and sediment storage volumes shall not be included in the required detention volume.
- The “Wet Pool Geometry” criteria for wet ponds (see Section 9.3.1) shall apply with the following modifications/clarifications:
    - Criterion 1: The permanent pool may be made shallower to take up most of the pond bottom, or deeper and positioned to take up only a limited portion of the bottom. Note, however, that having the first wet pool cell at the inlet allows for more efficient

sediment management than if the cell is moved away from the inlet. Wet pond criteria governing water depth must, however, still be met. See Figure 9.5 for two possibilities for wet pool cell placement.

Intent: This flexibility in positioning cells is provided to allow for multiple use options, such as volleyball courts in live storage areas in the drier months.

- Criterion 2: The minimum sediment storage depth in the first cell is 1 foot. The 6 inches of sediment storage required for detention ponds do not need to be added to this, but 6 inches of sediment storage must be added to the second cell to comply with the detention sediment storage requirement.

Berms, Baffles, and Slopes

Same as for wet ponds (see Section 9.3.1).

Inlet and Outlet

The "Inlet and Outlet" criteria for wet ponds shall apply with the following modifications:

- A sump must be provided in the outlet structure of combined ponds.
- The detention flow restrictor and its outlet pipe shall be designed according to the requirements for detention ponds (see Volume III, Section 3.12.1).

Access and Setbacks

Same as for wet ponds.

Planting Requirements

Same as for wet ponds.

Figure 9.4a. - Combined Detention and Wet Pond.

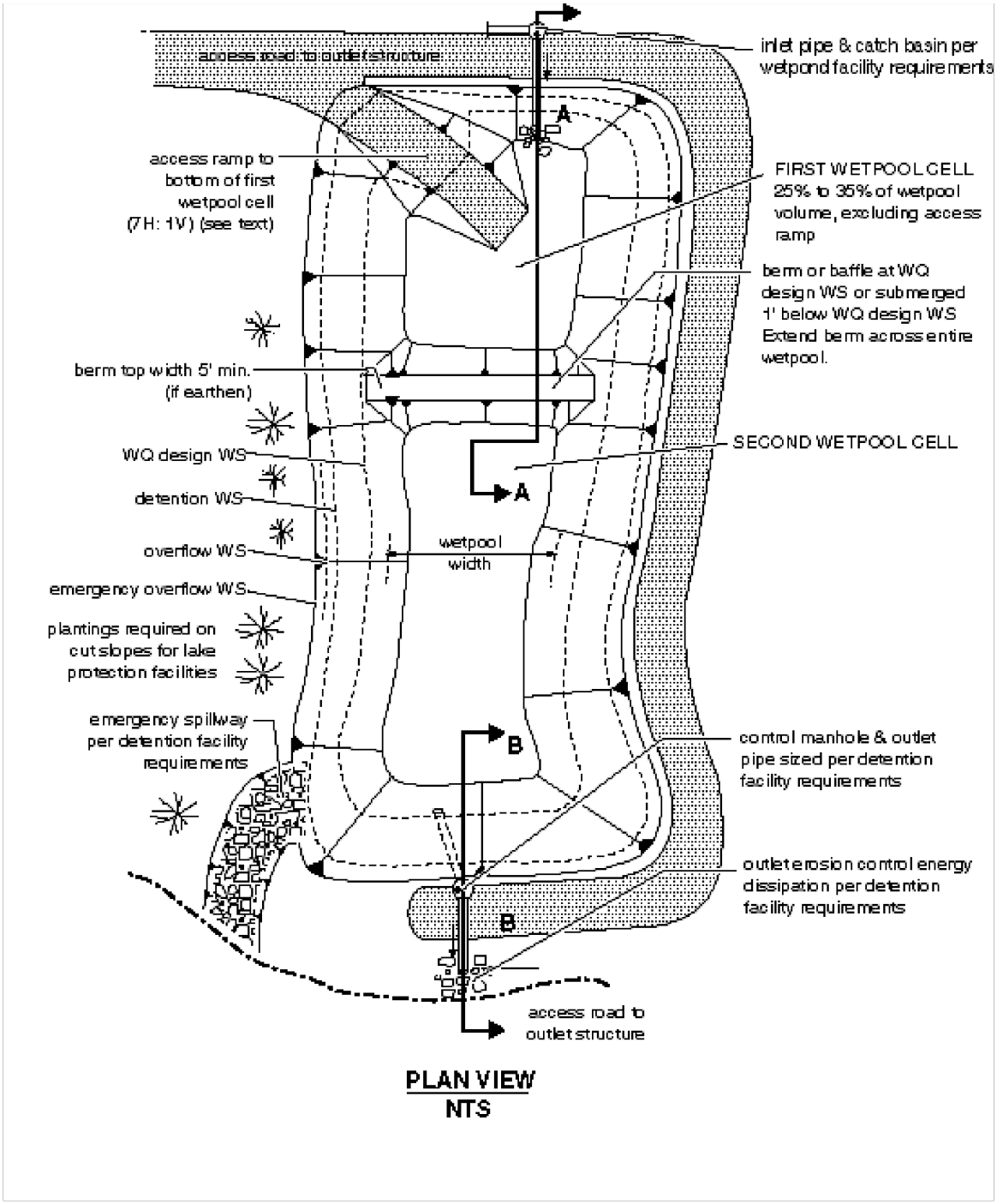


Figure 9.4b. - Combined Detention and Wet Pond (continued).

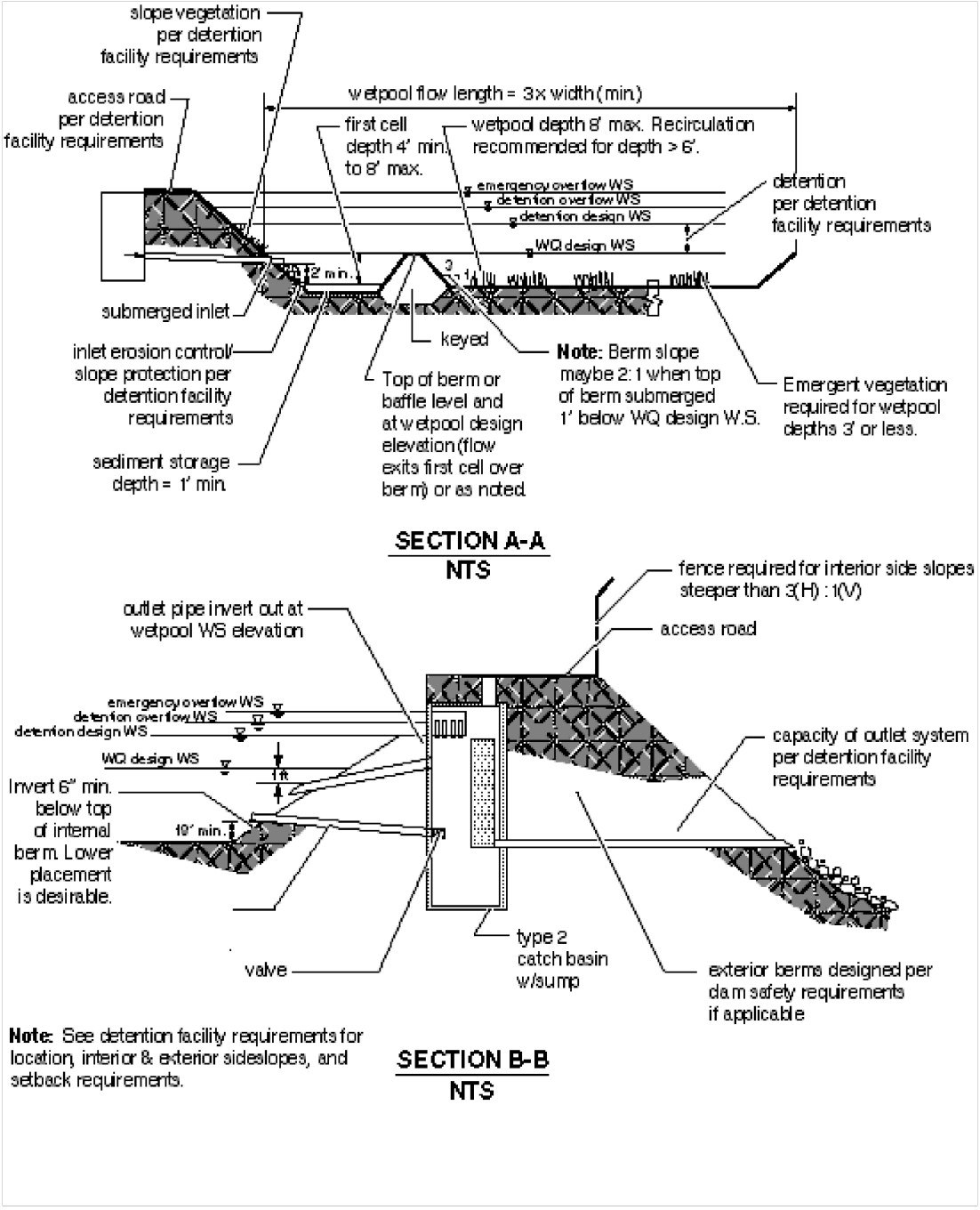
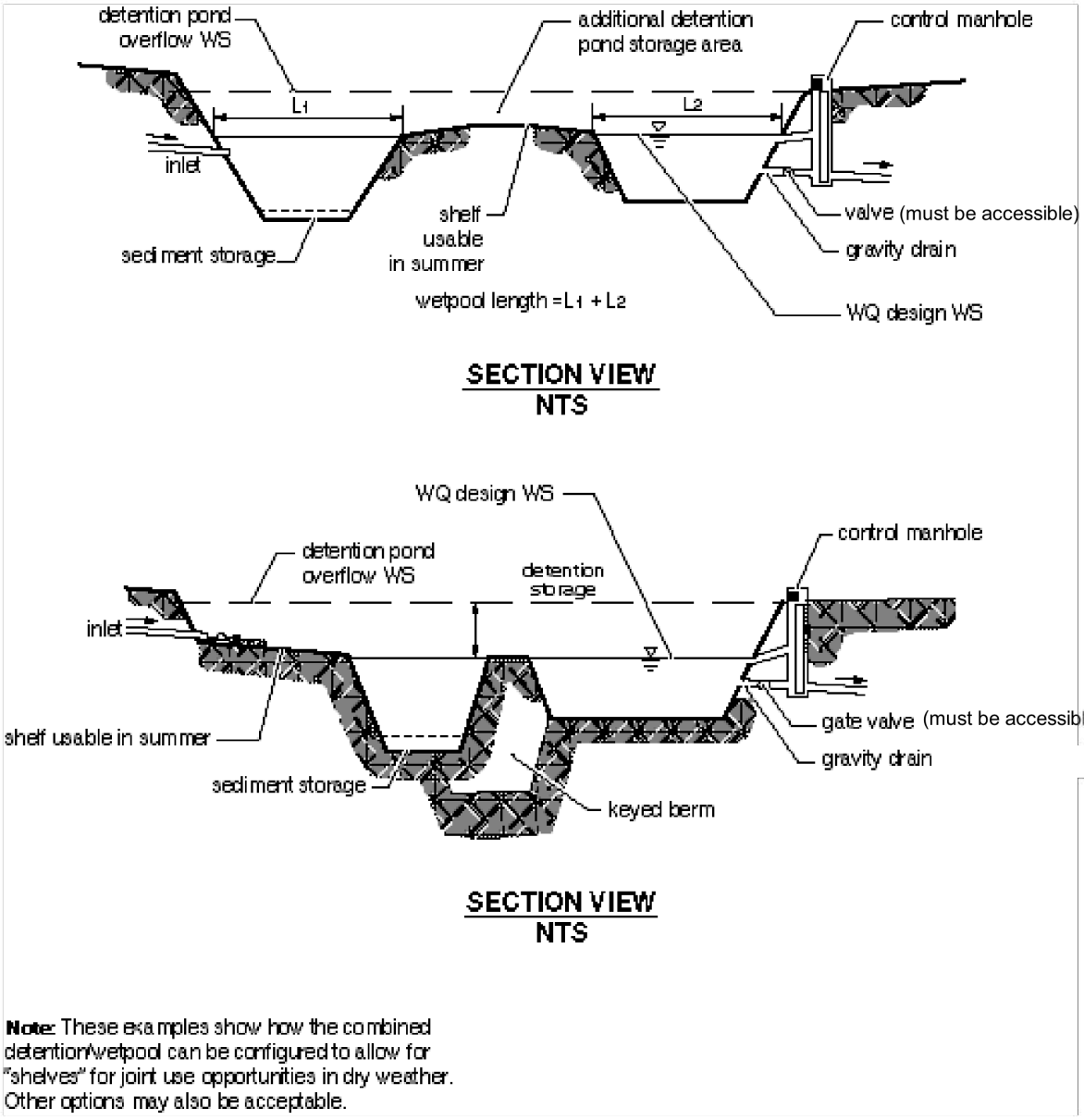


Figure 9.5. - Alternative Configurations of Detention and Wet Pool Areas.



Combined Detention and Wet Vault

Sizing Procedure

The sizing procedure for combined detention and wet vaults is identical to those outlined for wet vaults and for detention facilities. The wet vault volume for a combined facility shall be equal to or greater than the water quality design storm volume estimated by an approved continuous runoff model. Follow the standard procedure specified in Volume III to size the detention portion of the vault.

Detention and Wet Vault Geometry

The design criteria for detention vaults and wet vaults must both be met, except for the following modifications:

The minimum sediment storage depth in the first cell shall average 1 foot. The 6 inches of sediment storage required for detention vaults does not need to be added to this, but 6 inches of sediment storage must be added to the second cell to comply with detention vault sediment storage requirements.

Berms, Baffles, and Slopes

The design criteria for detention vaults and wet vaults must both be met, except for the following modifications:

The oil retaining baffle shall extend a minimum of 2 feet below the water quality design water surface.

> **Intent:** The greater depth of the baffle in relation to the water quality design water surface compensates for the greater water level fluctuations experienced in the combined vault.

Note: If a vault is used for detention as well as water quality control, the facility may not be modified to function as a baffle oil/water separator as allowed for wet vaults. This is because the added pool fluctuation in the combined vault does not allow for the quiescent conditions needed for oil separation.

Inlet and Outlet

Same as for wet vaults.

Access and Setbacks

Same as for wet vaults.

Combined Detention and Stormwater Wetland

Sizing Procedure

The sizing procedure for combined detention and stormwater wetlands is identical to those outlined for stormwater wetlands and for detention facilities. Follow the procedure specified for stormwater treatment wetlands in Section 9.3.3 to determine the stormwater wetland size. Follow the standard procedure specified in Volume III to size the detention portion of the wetland.

Detention and Wetland Geometry

The design criteria for detention ponds and stormwater wetlands must both be met, except for the following modifications:

- Water Level Fluctuation Restrictions: The difference between the water quality design water surface and the maximum water surface associated with the 2year recurrence interval runoff shall not be greater than 3 feet. If this restriction cannot be met, the size of the

stormwater wetland must be increased. The additional area may be placed in the first cell, second cell, or both. If placed in the second cell, the additional area need not be planted with wetland vegetation or counted in calculating the average depth.

Intent: This criterion is designed to dampen the most extreme water level fluctuations expected in combined facilities to better ensure that fluctuationtolerant wetland plants will be able to survive in the facility. It is not intended to protect native wetland plant communities and is not to be applied to natural wetlands.

- The "Wetland Geometry" criteria for stormwater wetlands (see Section 9.3.3) must be modified such that the minimum sediment storage depth in the first cell is 1 foot. The 6 inches of sediment storage required for detention ponds does not need to be added to this, nor does the 6 inches of sediment storage in the second cell of detention pond.

  Intent: Since emergent plants are limited to shallower water depths, the deeper water created before sediments accumulate is considered detrimental to robust emergent growth. Therefore, sediment storage is confined to the first cell which functions as a presettling cell.

The "Inlet and Outlet" criteria for wet ponds shall apply with the following modifications:

- A sump must be provided in the outlet structure of combined facilities.
- The detention flow restrictor and its outlet pipe shall be designed according to the requirements for detention ponds (see Volume III, Section 3.2.1).

  The "Planting Requirements" for stormwater wetlands are modified to use the following plants which are better adapted to water level fluctuations:

  - *Scirpus acutus* (hardstem bulrush) 2–6' depth
  - *Scirpus microcarpus* (small-fruited bulrush) 1–2.5' depth
  - *Sparganium emersum* (burreed) 1–2' depth
  - *Sparganium eurycarpum* (burreed) 1–2' depth
  - *Veronica sp.* (marsh speedwell) 0–1' depth

In addition, the shrub *Spirea douglasii* (Douglas spirea) may be used in combined facilities.

Chapter 10. Oil and Water Separators

10.1 Purpose

This chapter provides a discussion of oil and water separators, including their application and design criteria. Oil and water separators remove oil and other water-insoluble hydrocarbons, and settleable solids from stormwater runoff.

BMPs are described for baffle type and coalescing plate separators. In addition to the oil and water separators outlined in this volume, Pierce County will also permit the use of oil control booms for oil control when designed in accordance with the requirements outlined in the 2014 WSDOT Highway Runoff Manual, Chapter 5, BMP RT.22 (or subsequent updates as approved by Ecology and Pierce County).

10.2 Description

Oil and water separators are typically the API, also called baffle type (American Petroleum Institute 1990) or the coalescing plate (CP) type using a gravity mechanism for separation. See Figures 10.1 and 10.2. Oil removal separators typically consist of three bays; forebay, separator section, and the afterbay. The CP separators need considerably less space for separation of the floating oil due to the shorter travel distances between parallel plates. A spill control separator (Figure 10.3) is a simple catch basin with a Tinlet for temporarily trapping small volumes of oil. The spill control separator is included here for comparison only and is not designed for, or to be used for treatment purposes.

10.3 Performance Objectives

Oil and water separators are expected to remove oil and TPH down to 15 mg/L at any time and 10 mg/L on a 24hour average, and produce a discharge that does not cause an ongoing or recurring visible sheen in the stormwater discharge, or in the receiving water (see also Chapter 3).

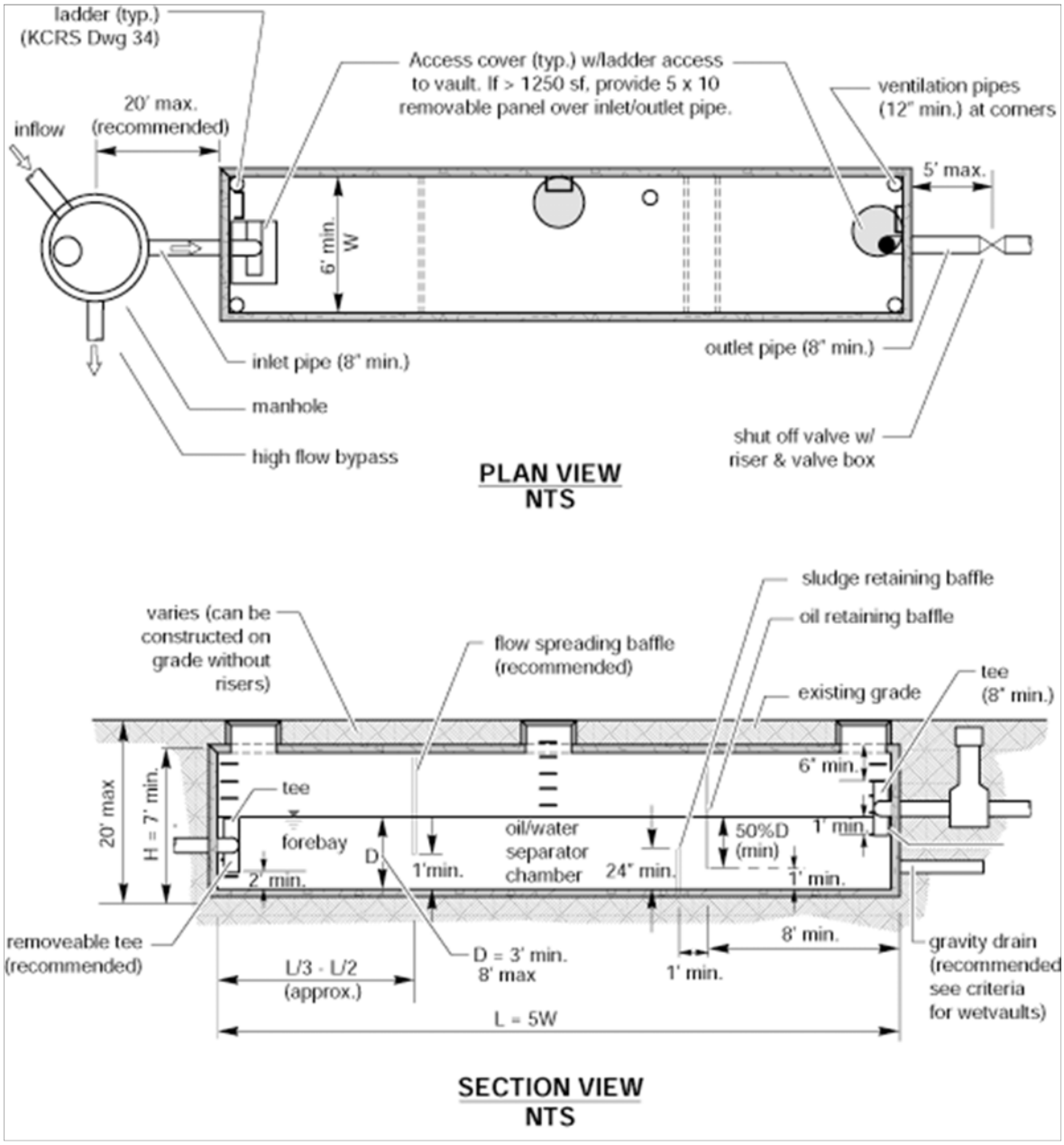
Without intense maintenance, oil/water separators may not be sufficiently effective in achieving oil and TPH removal down to required levels. See Minimum Requirement #9 in Volume I; Volume I, Section 3.3.6; and Volume I, Appendix IA for information on maintenance requirements.

10.4 Site Suitability

Consider the following site characteristics:

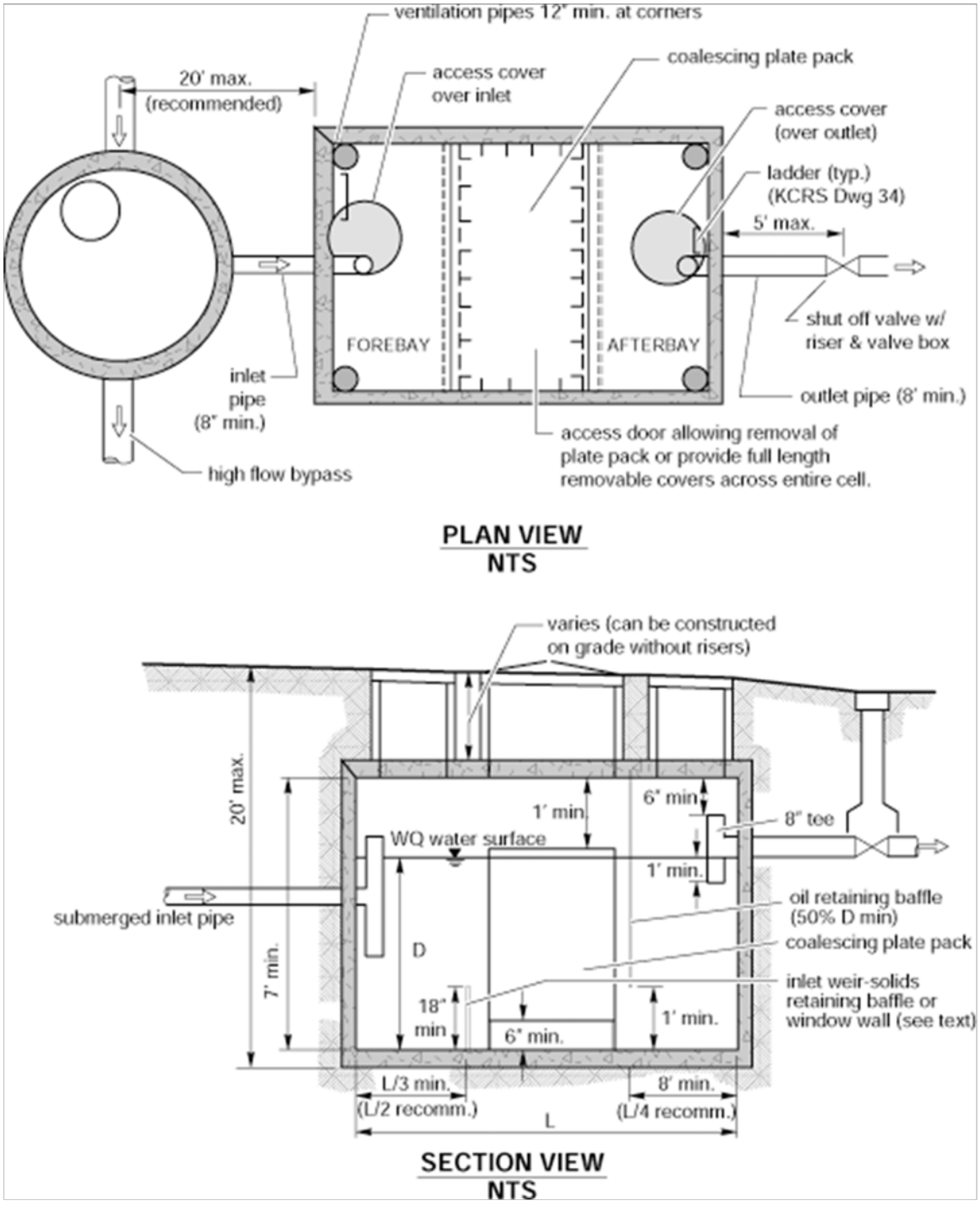
- Sufficient land area
- Adequate total suspended solids control or pretreatment capability
- Compliance with environmental objectives
- Adequate influent flow attenuation and/or bypass capability
- Sufficient access for operation and maintenance (O&M).

Figure 10.1. - API (baffle type) Separator.



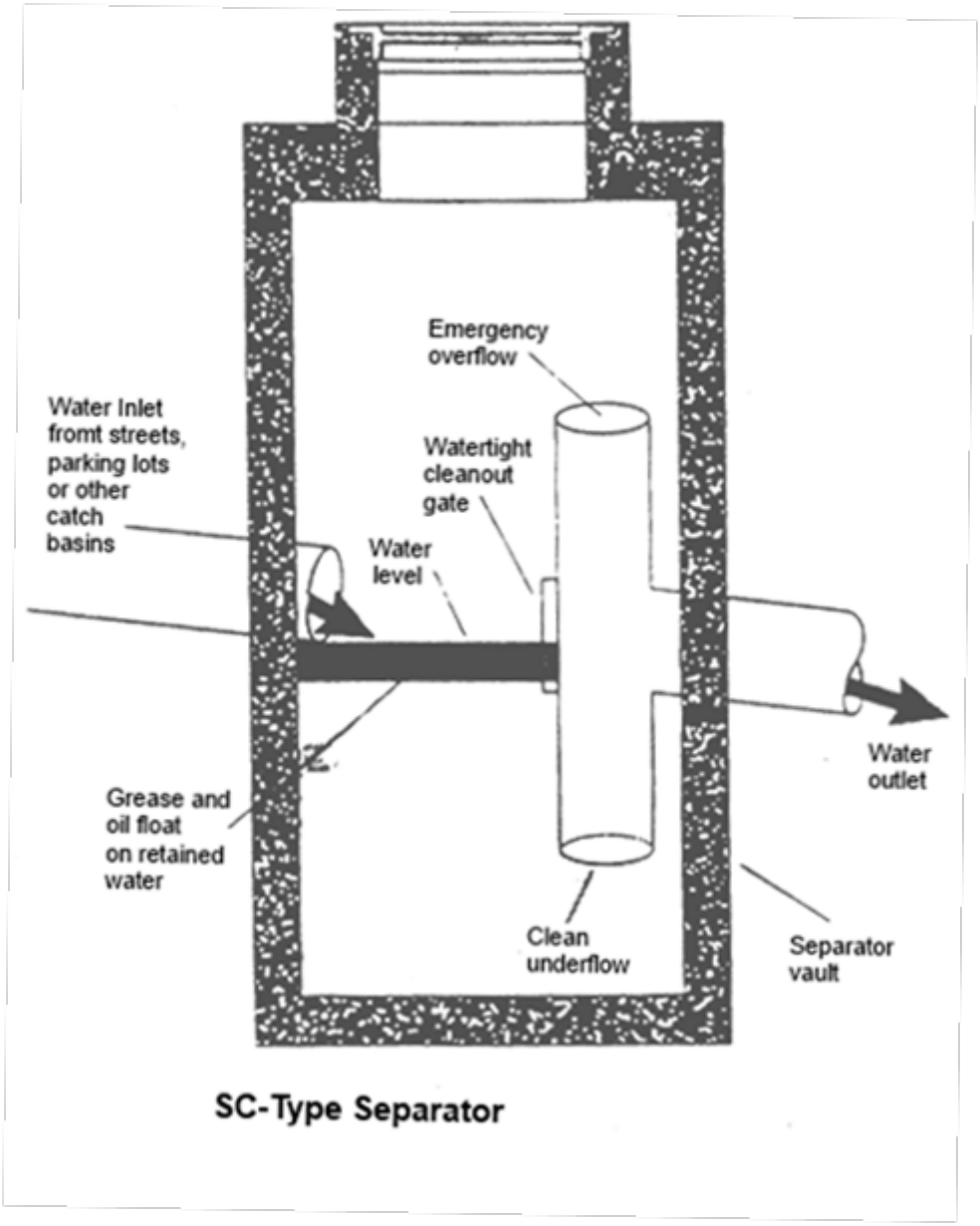
Source: King County (reproduced with permission)

Figure 10.2. - Coalescing Plate Separator.



Source: King County (reproduced with permission)

Figure 10.3. - Spill Control Separator (not for oil treatment).



Source: 1992 Ecology Manual

10.5 Design Criteria – General Considerations

There is concern that oil/water separators used for stormwater treatment have not performed to expectations (Watershed Protection Techniques 1994; Schueler 1992). Therefore, emphasis should be given to proper application, design, O&M, (particularly sludge and oil removal) and prevention of CP fouling and plugging (U.S. Army Corps of Engineers 1994). Other treatment systems, such as sand filters and emerging technologies, should be considered for the removal of insoluble oil and TPH.

The following are design criteria applicable to API and CP oil/water separators:

- Locate the separator off-line and bypass the incremental portion of flows that exceed the off-line 15minute, Water Quality design flow rate multiplied by the ratio indicated in

Figure 8.6b of this volume. If it is necessary to locate the separator on-line, try to minimize the size of the area needing oil control, and use the on-line water quality design flow rate multiplied by the ratio indicated in Figure 8.6a.

- As feasible, determine oil/grease (or TPH) and TSS concentrations, lowest temperature, pH; and empirical oil rise rates in the runoff, and the viscosity, and specific gravity of the oil. Determine whether the oil is emulsified or dissolved and do not use oil/water separators for the removal of dissolved or emulsified oils such as coolants, soluble lubricants, glycols, and alcohols.
- Use only impervious conveyances for oil contaminated stormwater.
- Add pretreatment for total suspended solids that could cause clogging of the CP separator, or otherwise impair the long-term effectiveness of the separator.
- Include roughing screens for the forebay or upstream of the separator to remove debris. Screen openings should be about three-fourths inch.

10.5.1 Criteria for Separator Bays

- Size the separator bay for the Water Quality design flow rate (15minute time step) x a correction factor ratio indicated in Figure 8.6b of this volume (assuming an off-line facility). (See Chapter 4 for a definition of the Water Quality Design Flow Rate.)
- To collect floatables and settleable solids, design the surface area of the forebay at ≥ 20 ft^2 per 10,000 ft^2 of area draining to the separator. The length of the forebay should be one-third to one-half of the length of the entire separator.
- Include a submerged inlet pipe with a turn-down elbow in the first bay at least 2 feet from the bottom. The outlet pipe should be a Tee, sized to pass the design peak flow and placed at least 12 inches below the water surface.
- Include a shutoff valve at the separator outlet pipe.
- Use absorbents and/or skimmers in the afterbay as needed.

10.5.2 Criteria for Baffles

- Oil retaining baffles (top baffles) should be located at least at one-fourth of the total separator length from the outlet, and should extend down at least 50 percent of the water depth and at least 1 foot from the separator bottom.
- Baffle height to water depth ratios should be 0.85 for top baffles and 0.15 for bottom baffles.

10.6 Oil and Water Separator BMPs

Two BMPs are described in this section: API baffle type separators (Section 10.6.1), and coalescing plate separators (Section 10.6.2).

10.6.1 API (Baffle type) Separator Bay (Ecology BMP T11.10)

API separators are designed for use on large sites greater than 2 acres. Ecology's *Stormwater Management Manual for Western Washington* presents a design modification for using API separators in drainage areas smaller than 2 acres (e.g., fueling stations, commercial parking lots, etc.). However, Ecology also requires each developer to perform detailed performance verification

during at least one wet season when using their modified design. Given this requirement, Pierce County has elected not to allow the use of API separators on sites smaller than 2 acres. The following approach only applies to contributing drainage areas larger than 2 acres.

API Design Criteria

The API design criteria is based on the horizontal velocity of the bulk fluid (V_h), the oil rise rate (V_t), the residence time (t_m), width, depth, and length considerations.

The following is the API sizing procedure:

- Determine the oil rise rate, Vt, in centimeters per second, using Stokes' Law (Water Pollution Control Federation 1985) or empirical determination.
- Stokes Law equation for rise rate, Vt (ft/min):

$$V_t = 1.97g(\sigma_w - \sigma_o)D^2/18\eta_w$$

Where: 1.97 = conversion factor (centimeters per second/ft per minute)

g = gravitational constant (981 centimeters per second squared)

D = diameter of the oil particle (centimeters).

Use

oil particle size diameter, D = 60 microns (0.006 centimeters)

σ_w = water density = 0.999 grams per cubic centimeter (gm/cc) at 32°F

σ_o: Select conservatively high oil density,

For example, if diesel oil @ σ_o = 0.85 gm/cc and motor oil @ σ_o = 0.90 gm/cc can be present then use σ_o = 0.90 gm/cc

η_w = dynamic viscosity of water = 0.017921 poise (gm/cm-sec) at water temperature of 32°F (see API publication 421, February 1990)

For Stormwater Inflow From Drainages More Than 2 Acres

- Determine V_t based on above criteria
- Determine Q

  Q = the 15minute Water Quality design flow rate in ft³/min multiplied by the ratio indicated in Figure 8.6a (for on-line facilities) or Figure 8.6b (for off-line facilities) for the site location (k). Note that WWHM gives the water quality design flow rate in ft³/sec. Multiply this flow rate by 60 to obtain the flow rate in ft³/min.

- Calculate horizontal velocity of the bulk fluid, Vh (in ft/min), and depth (d), ft.

  Vh = 15Vt

  $d = (Q/2Vh)^{1/2}$, with

  Separator water depth, 3≤d≤8 feet (to minimize turbulence). If the calculated depth is less than 3 feet, an API separator is not appropriate for the site. If the calculated depth exceeds 8 feet, consider using two separators (American Petroleum Institute 1990; U.S.

Army Corps of Engineers 1994).

- Calculate the minimum residence time (tm), in minutes, of the separator at depth d:

  $t_m = d/V_t$

- Calculate the minimum length of the separator section, l(s), using:

  F = 1.65

  Depth/width (d/w) of 0.5 (American Petroleum Institute 1990),

  l(s) = FQtm/wd = F(Vh/Vt)d

  For other dimensions, including the length of the forebay, the length of the afterbay, and the overall length, L; refer to Figure 10.1.

- Calculate V = l(s)wd = FQt_m, and A_h = wl(s)

  V = minimum hydraulic design volume, in cubic feet.
  A_h = minimum horizontal area of the separator, in square feet.

10.6.2 Coalescing Plate (CP) Separator Bay (Ecology BMP T11.11)

CP Design Criteria

Calculate the projected (horizontal) surface area of plates needed using the following equation:

$$A_h = Q/V_t = Q/[0.00386^* ((S_w - S_o)/(\mu_w))]$$

Where:

Q = design flow rate (ft^3/min)

V_t = rise rate of the oil droplet

A_h = horizontal surface area of the plates (ft^2; 0.00386 is unit conversion constant)

S_w = specific gravity of water at the design temperature

S_o = specific gravity of oil at the design temperature

μ_w = absolute viscosity of the water (poise).

The above equation is based on an oil droplet diameter of 60 microns.

- Plate spacing should be a minimum of three-fourths of an inch (perpendicular distance between plates) or as determined by the manufacturer. (WEF and ASCE 1998; U.S. Army Corps of Engineers 1994; US Air Force 1991; Jaisinghani, R. 1979).
- Select a plate angle between 45° to 60° from the horizontal.
- Locate plate pack at least 6 inches from the bottom of the separator for sediment storage.
- Add 12 inches minimum head space from the top of the plate pack and the bottom of the vault cover.
- Design inlet flow distribution and baffles in the separator bay to minimize turbulence, short-circuiting, and channeling of the inflow especially through and around the plate packs of the CP separator. The Reynolds Number through the separator bay should be less than 500 (laminar flow).
- Include forebay for floatables and afterbay for collection of effluent (WEF and ASCE 1998).

- The sediment-retaining baffle must be upstream of the plate pack at a minimum height of 18 inches.
- Design plates for ease of removal, and cleaning with high-pressure rinse or equivalent.

Chapter 11. Emerging Technologies

11.1 Background

This chapter addresses emerging (new) technologies that have not been evaluated in sufficient detail to be acceptable for general usage in new development or redevelopment situations.

As a Phase I NPDES stormwater permit holder, Pierce County is required to adopt the Washington State Department of Ecology Stormwater Management Manual for Western Washington (SWMMWW) or an equivalent manual. BMPs listed in the SWMMWW are presumed to provide adequate treatment (see Volume I, Section 1.7.3), but in many situations traditional BMPs such as wet ponds and biofiltration swales may not be appropriate or optimal (due to size and space restraints, or inability to remove target pollutants). Because of this, the stormwater treatment industry emerged to develop new stormwater treatment devices.

Emerging technologies are stormwater treatment devices that are new to the stormwater treatment marketplace. These devices include both permanent and construction site treatment technologies. Many of these devices have not undergone complete performance testing so their performance claims cannot be verified.

11.2 Evaluation of Emerging Technologies

Ecology currently participates in a process to evaluate emerging technologies for permanent and construction site stormwater runoff applications and to convey judgments made by local jurisdictions and others on their acceptance. Based on recommendations from Ecology's Stormwater Technical Advisory Committee (TAC), Ecology has implemented the following process:

- In order to properly evaluate new technologies, performance data must be obtained using the Ecology approved Technology Assessment Protocol-Ecology (TAPE) and the chemical TAPE (CTAPE) or other accepted protocols. These protocols can be downloaded at https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies
- Other acceptable protocols may also be added to Ecology's website.
- Ecology participates in all Technical Review Committee (TRC) and Chemical Technical Review Committee (CTRC) activities, which include reviewing manufacturer performance data and providing recommendations on use level designations.
- Based on performance and other pertinent data from vendors and manufacturers and recommendations by the review committees, Ecology assesses levels of developments of emerging technologies and posts relevant decisions and supporting documentation at its stormwater website.
- Ecology provides oversight and analysis of all submittals to ensure consistency with this manual.

11.3 Applicability and Restrictions

Pierce County has chosen to allow application of new technologies to be used to meet the requirements of this Stormwater Management and Site Development Manual when they reach the General Use Level Designation (GULD). The Pierce County Director of Planning and Public Works has the authority to add additional requirements or conditions to these technologies,

beyond those required by Ecology. **Note that Pierce County will not accept ownership of GULD facilities without prior approval.**

Additional general guidelines regarding the applicability and restrictions of emerging technologies are as follows:

- In most retrofit situations where the requirements of this Stormwater Management and Site Development Manual are not triggered, emerging BMPs may be used, with prior approval by the County. The assumption is that an experimental BMP is better than nothing.
- All technologies receiving Conditional Use Designation (CUD) and county approval will be required to sign a maintenance agreement with the County, stating that they will be responsible for maintaining these structures at all times, in accordance with the manufacturer's requirements or as outlined for the specific CUD BMP by the County. This includes single- family residential applications. In addition, all property owners using these technologies will be responsible for upgrade/replacement of their systems in perpetuity. This includes upgrading or replacing these systems when problems arise, standards change, or the technology is ultimately rejected by the Technical Review Committee or the County.
- Pierce County will generally allow pilot level applications of new technologies in order for manufacturers to obtain data to help fulfill the requirements of the testing protocol of the Technical Review Committee. These projects must be approved in advance by the Director of Planning and Public Works, have an approved monitoring plan from the Technical Review Committee or Ecology, and provide a financial bond to provide cleanup and replacement in the event of failure.

•

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Appendix V-A – Geotextile Specifications

Table A.1. - Geotextile Property Requirements for Underground Drainage.

		Low Survivability	Moderate Survivability
Geotextile Property	**Test Method**	**Woven/Nonwoven**	**Woven/Nonwoven**
Grab Tensile Strength, in machine and x-machine direction	ASTM D4632	180 lbs/115 lbs min.	250 lbs/160 lbs min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	< 50%/>= 50%	< 50%/>= 50%
Seam Breaking Strength (if seams are present) with seam located in the center of 8-inch long specimen oriented parallel to grip faces	ASTM D4632	160 lbs/100 lbs min.	220 lbs/140 lbs min.
Puncture Resistance	ASTM D6241	730 lbs/220 lbs min.	495 lbs/310 lbs min.
Tear Strength, in machine and x-machine direction	ASTM D4533	67 lbs/40 lbs min.	80 lbs/50 lbs min.
Ultraviolet (UV) Radiation stability	ASTM D4355	50% strength retained min., after 500 hrs. in a xenon arc device	50% strength retained min., after 500 hrs. in a xenon arc device

1 All geotextile properties 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 the table).

Table A.2. - Geotextile Property Requirements for Underground Drainage Filtration.

Geotextile Property	Test Method	Class A	Class B	Class C
AOS[2]	ASTM D4751	No. 40 max.	No. 60 max.	No. 80 max.
Water Permittivity	ASTM D4491	0.5 sec^{-1} min.	0.4 sec^{-1} min.	0.3 sec^{-1} min.

1 All geotextile properties 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 the table).

2 Apparent Opening Size (measure of diameter of the pores in the geotextile)

Table A.3. - Geotextile Strength Property Requirements for Impermeable Liner Protection.

Geotextile Property	Test Method	Geotextile Property Requirements1
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	250 lbs min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	> 50%
Seam Breaking Strength (if seams are present)	ASTM D4632 and ASTM D4884 (adapted for grab test)	220 lbs min.
Puncture Resistance	ASTM D4833	125 lbs min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	90 lbs min.
Ultraviolet (UV) Radiation	ASTM D4355	50% strength stability retained min., after 500 hrs. in xenon arc device

1 All geotextile properties 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 the table).

Applications

1. For sand filter drain strip between the sand and the drain rock or gravel layers specify Geotextile Properties for Underground Drainage, moderate survivability, Class A, from Tables A.1 and A.2 in the Geotextile Specifications.
2. For sand filter matting located immediately above the impermeable liner and below the drains, the function of the geotextile is to protect the impermeable liner by acting as a cushion. The specification provided in Table A.3 should be used to specify survivability properties for the liner protection application. Table A.2, Class C should be used for filtration properties. Only nonwoven geotextiles are appropriate for the liner protection application.
3. For an infiltration drain specify Geotextile for Underground Drainage, low survivability, Class C, from Tables A.1 and A.2 in the Geotextile Specifications.
4. For a sand bed cover a geotextile fabric is placed exposed on top of the sand layer to trap debris brought in by the stormwater and to protect the sand, facilitating easy cleaning of the surface of the sand layer. However, a geotextile is not the best product for this application. A polyethylene or polypropylene geonet would be better. The geonet material should have high UV resistance (90 percent or more strength retained after 500 hours in the weatherometer, ASTM D4355), and high permittivity (ASTM D4491, 0.8 sec. -1 or more) and percent open area (CWO22125, 10 percent or more). Tensile strength should be on the order of 200 lbs grab (ASTM D4632) or more.

Courtesy of Tony Allen, Geotechnical Engineer-WSDOT.

Reference for Tables A.1 and A.2: Section 933.2 "Geotextile Properties," 2014 Standard Specifications for Road, Bridge, and Municipal Construction

Pierce County
Stormwater Management and Site Development Manual

Volume VI
Comprehensive Low Impact Development Site Designs

Prepared by: Pierce County Planning and Public Works

Ordinance No. 2021-45

Effective Date: July 1, 2021

Table of Contents

Volume VI Comprehensive Low Impact Development Site Designs

Chapter 1. Introduction and Requirements 1-1

1.1 Volume Intent 1-1

1.2 Applicability and Administration 1-1

1.2.1 Applicability 1-1

1.2.2 Compliance with the Provisions of this Volume 1-1

1.2.3 Submittal Requirements 1-1

1.3 Performance Goal and Objectives 1-2

1.4 Conduct a Site Analysis Prior to Designing a LID Project 1-3

1.4.1 Site Inventory Process 1-3

Chapter 2. Low Impact Development Strategies and BMPs 2-1

2.1 Introduction 2-1

2.2 Maintenance Criteria 2-1

2.3 Full Dispersion (Ecology BMP T5.30) 2-1

2.3.1 Applicability and Limitations 2-1

2.3.2 Design Criteria for Residential, Commercial, and Industrial Projects 2-3

2.3.3 Design Criteria for Roadway Projects 2-5

2.3.4 Calculation of the Total Native Vegetation Retention Achieved 2-10

2.4 Better Site Design (Ecology BMP T5.41) 2-11

2.4.5 Design Criteria 2-11

2.4.6 Lot Layout 2-13

2.5 Preserving Native Vegetation (Ecology BMP T5.40) 2-14

2.5.1 Applicability 2-14

2.5.2 Design Criteria 2-14

2.5.3 Vegetation Protection Post-construction 2-15

2.5.4 Additional Requirements 2-15

2.6 Restoring Site Vegetation 2-15

2.6.1 Application 2-15

2.6.2 Design Criteria 2-16

2.6.3 Planning and Design 2-16

2.6.4 Construction and Operation 2-16

2.7 Minimize Impervious Areas 2-17

2.7.1 Road Design....2-18
2.7.2 Parking Lots....2-19
2.7.3 Driveways....2-19
2.7.4 Curb and Gutter Alternatives....2-19
2.8 Soil Preservation and Amendment (Ecology BMP T5.13)....2-20
Chapter 3. Easements, Maintenance, and Enforcement....3-1
3.1 Dedicated Tracts and Conservation Easements....3-1
3.2 Maintenance Requirements....3-1
3.3 Enforcement....3-1
Volume VI References....Ref-1

Chapter 1. Introduction and Requirements

The primary focus of this volume is on the strategies and practices necessary to achieve the County's Comprehensive LID Site Design requirements, as required by PCC Title 18A – Development Regulations – Zoning, and Title 18J – Development Regulations – Design Standards and Guidelines (or other requirements).

1.1 Volume Intent

This volume presents general guidelines and strategies for site assessment and site layout, as well as detailed requirements for LID BMPs that are integral to Comprehensive LID Site Design. The guidelines and requirements outlined in this volume are to be used primarily to achieve the County's Comprehensive LID Site Design requirements, but also apply to other types of projects. Regardless, all projects still must also review and adhere to the minimum requirements outlined in Volume I.

1.2 Applicability and Administration

1.2.1 Applicability

This volume is applicable to development projects required to achieve the County's Comprehensive LID Site Design approach, per PCC 18J.

Chapter 2 of this volume contains BMPs that are also applicable to projects not subject to the County's Comprehensive LID Site Design approach. Some of the BMPs in Chapter 2 are standard LID BMPs that may be necessary to meet the minimum requirements of this manual.

1.2.2 Compliance with the Provisions of this Volume

The application of the Comprehensive LID Site Design approach is intended to reduce total impervious area, eliminate effective impervious area where possible, retain or restore native soils and vegetation, and reduce the overall development footprint and impact. A successful Comprehensive LID Site Design will use a combination of the LID BMPs included in Chapter 2 of this volume, and additional flow control LID BMPs included in Volume III. This comprehensive approach will achieve the performance goal and objectives outlined in Section 1.3, and will help meet several of the key minimum requirements for all development projects outlined in Volume I.

Where a Comprehensive LID Site Design is required by PCC Title 18A and Title 18J (or other requirements), it will be at the discretion of the county review staff to determine whether the Comprehensive LID Site Design performance goals and objectives have been adequately achieved through the proposed LID site design.

In addition, the applicant is required to meet any applicable requirements set forth in Volumes I through V of this manual. To determine the applicable minimum requirements and the thresholds that trigger those requirements, see Volume I, Chapter 2.

1.2.3 Submittal Requirements

Comprehensive LID Site Design proposals shall comply with the submittal requirements outlined in Volume I, Chapter 3 of this manual. In addition, the following is required with an application for a short plat, preliminary plat, large lot, or land use which has proposed a Comprehensive LID Site Design:

- A LID site design inventory (as outlined in Section 1.4).
- Preliminary road and stormwater design calculations to assure that the design of stormwater treatment for the site has been adequately considered during the lot and open space layout process.
- Documentation showing that any applicable maintenance, management, or ownership submittal requirements outlined in Section 3.2.
- Where required (per the performance goals and objectives outlined in Section 1.3), documentation showing that the BMPs outlined in Chapter 2 have been considered and applied where feasible, and that every attempt was made to achieve near zero effective impervious area for the project.

1.3 Performance Goal and Objectives

This section outlines the performance goals and objectives that govern the review of any proposed Comprehensive LID Site Design. Note that the project proponent must also review and meet any applicable requirements set forth in Volumes I through V of this manual. With the exception of projects implementing Full Dispersion, the Comprehensive LID Site Design requirements outlined in this volume are insufficient by themselves to achieve Volume I, Minimum Requirements #5, #6, and #7. See additional notes below, and Volume I for further guidance and requirements.

The LID site design goal shall be achieved through adherence to the following:

- Target Comprehensive LID Site Design goal for residential projects:
    - Retain or restore 65 percent of the site's native soils and vegetation and set aside these areas into permanent open space areas, such as within a natural resource protection area, or designated tract for the stormwater drainage system.
    - Limit the total impervious area of the site to no more than 10 percent, and disperse all impervious areas in accordance with Section 2.3, Full Dispersion.
    - Residential projects meeting the full dispersion requirements and amaximum of 10 percent impervious area dispersed to 65 percent native forest protection areas have fully met the requirements of Volume I, Minimum Requirements #5, #6, and #7, and are not required to demonstrate that additional BMPs outlined in Chapter 2 have been considered.
- Minimum Comprehensive LID Site Design goal for residential projects:
    - Where the above target goal of applying a maximum of 10 percent impervious area dispersed to 65 percent native forest protection area is not achieved, the applicant must retain or restore a minimum of 50 percent of the site's native soils and vegetation and limit the total impervious area of the site to no more than 25 percent. (Note that sites unable to maintain or create a 65 percent forested or native condition may still use a portion of the retained area to achieve full dispersion for a lesser portion of the developed area, as long as the ratio of the native vegetation area to the dispersed impervious area is not less than 65 to 10. See Section 2.3, Full Dispersion for further details.)
    - Where the above target goal of applying full dispersion is not achieved, the applicant must also demonstrate that the BMPs outlined in Chapter 2 have been considered

and applied where feasible, and that every attempt was made to minimize effective impervious area for the project.

- In addition, where the above target goal of applying full dispersion is not achieved, the applicant must demonstrate that Volume I, Minimum Requirements #5, #6, and #7 (if applicable) have been met.

- Minimum Comprehensive LID Site Design goal for commercial projects:
  - Retain or restore a minimum of 25 percent of the site's native soils and vegetation and set aside these areas into permanent open space areas such as within a natural resource protection area, or designated tract for the stormwater drainage system.
  - Limit the total impervious area of the site to no more than 25 percent, and disperse as much impervious area as feasible in accordance with Section 2.3, Full Dispersion.
  - Demonstrate that the BMPs outlined in Chapter 2 and Volume III have been considered and applied where feasible, and that every attempt was made to minimize effective impervious area for the project.
  - Unlike for residential sites, commercial projects that meet the target Comprehensive LID Site Design goal still may not fully meet Volume I, Minimum Requirements #5, #6, or #7.

1.4 Conduct a Site Analysis Prior to Designing a LID Project

The site analysis is a method of evaluating the topography, soils, vegetation, and water features to determine how the site currently processes stormwater. This evaluation provides information essential for developing strategies to configure lots, determine where best to locate natural resource protection areas, and align road networks in a way that retains and restores natural hydrologic function.

1.4.1 Site Inventory Process

In addition to the site design techniques and requirements outlined in Volume I, the following LID site inventory is a required component of a Comprehensive LID Site Design, and shall be submitted with the application for the project.

Key physical and environmental features shall be inventoried on the proposed development site prior to the site planning process. In addition, important site characteristics on adjacent properties shall be assessed to identify how the project will impact or be influenced by the surrounding area. The functions of key environmental features shall be assessed for performance to determine potential impacts. Development areas shall be identified in the inventory, and ultimately shall be located outside of the natural resource protection areas and within designated buildable areas to minimize soil and vegetation disturbance. Development areas shall also take advantage of a site's natural ability to store and infiltrate stormwater.

A Comprehensive LID Site Design cannot be properly planned and implemented through desktop/map reconnaissance alone and will require onsite inventory and assessment. The following outlines the required elements of the "desktop" assessment only. (It will be up to the design engineer to identify additional onsite assessment requirements for Comprehensive LID Site Designs.)

- Soil surveys to provide broad characterization of regional soils (additional detailed analyses will be required for making detailed design decisions).

- Soil analyses from adjacent properties.
- Critical areas and associated buffers as set forth in PCC Title 18E.
- Tree conservation areas as set forth in PCC Title 18J. This should include the tree species, seral stage, diameter breast height, canopy cover, and condition of groundcover and shrub layer.
- Historic records documenting filling/altering of wetlands or stream channels.
- Aerial photos.
- Topographic features that may act as natural stormwater storage/conveyance (or alternatively, may hinder stormwater and LID approaches).
- Location of groundwater protection areas and/or 1, 5, and 10year time-of-travel zones for municipal well protection areas.
- A description of local site geology, including soil or rock units likely to be encountered, the groundwater regime, and geologic history of the site.
- Identification of natural resource protection areas (e.g., riparian areas, wetlands, steep slopes, and other critical areas; significant wildlife habitat areas and their associated buffers; tree conservation areas; and permeable soils offering the best available infiltration potential).
- Areas suitable and/or proposed for development.

Chapter 2. Low Impact Development Strategies and BMPs

2.1 Introduction

In contrast to conventional BMPs that typically collect and convey runoff to one location on the site, LID BMPs manage stormwater in small-scale, dispersed facilities located as close to the source of the runoff as possible. Most of the strategies and BMPs outlined in this chapter are general approaches applicable to overall site design and construction. Additional design guidelines for several more common engineered LID BMPs are provided in Volume III, Chapter 3. In addition, Volume II, Chapter 3 provides information on requirements for protecting LID BMPs during construction (in accordance with Volume I, Minimum Requirement #2).

BMPs discussed in this chapter include:

- Full Dispersion
- Better Site Design
- Preserving Native Vegetation
- Restoring Site Vegetation
- Minimize Impervious Areas
- Soil Preservation and Amendment.

2.2 Maintenance Criteria

Adequate operation and maintenance (O&M) must be provided for in the design, installation, and operation of all LID BMPs. See Minimum Requirement #9 in Volume I, as well Volume I, Appendix IA for additional information on maintenance requirements. In addition, maintenance considerations and requirements specific to LID site designs are outlined in Chapter 3.

2.3 Full Dispersion (Ecology BMP T5.30)

This BMP allows for "fully dispersing" runoff from impervious surfaces and cleared areas of Project Sites into areas preserved as forest, native vegetation, or cleared area. See Volume III, Section 3.2.1 for General Dispersion Facility Design Criteria.

Projects that meet the requirements outlined below have fully met the requirements of Volume I, Minimum Requirements #5, #6, and #7, and are not required to demonstrate that additional LID BMPs outlined in Chapter 2 have been considered.

2.3.1 Applicability and Limitations

The site (or area of the site) that is applying full dispersion per this BMP must be laid out to allow the runoff from impervious (or cleared) surface to fully disperse into the preserved dispersion area (i.e., have full access to and not be intercepted by pipe(s), ditch(es), stream(s), river(s), pond(s), lake(s), or wetland(s)).

Projects that successfully apply this BMP on all or a portion of their site will decrease effective impervious surfaces, and may void triggering the TDA Thresholds in Minimum Requirement #7.

A site (or an area of a site) that applies full dispersion per this BMP consists of the following

elements:

- **An impervious (or cleared) area.** The impervious (or cleared) area is the area that the design is mitigating for by using this BMP.
- **A flow spreader.** Runoff from the impervious (or cleared) area may need to be routed through a flow spreader (see Volume III, Section 4.9), depending on the site layout and type of impervious surface, as further described below.
- **A dispersion area.** This area defines the limits of the Full Dispersion BMP. The impervious (or cleared) area must disperse into the preserved dispersion area.
    - The dispersion area must be forest, native vegetation, or a cleared area depending on the site type. Details are provided below for what amount of vegetation the dispersion area must contain based on site type.
    - Preservation of existing vegetation areas must meet the requirements outlined under Section 2.5, Preserving Native Vegetation.
    - If the dispersion area must be preserved as forest or native vegetation, it may be a previously cleared area that has been replanted in accordance with **Native Vegetation Landscape Specifications** (below). For projects required to meet the Comprehensive LID Site Design, refer to Section 2.6, Restoring Site Vegetation for replanting requirements.
    - The dispersion area shall be situated to minimize the clearing of existing forest cover, to maximize the preservation of wetlands (though the wetland area and any streams and lakes do not count as part of the dispersion area), and to buffer stream corridors.
    - The dispersion area for single-family lots shall be protected through recorded covenants, permanent signage and fencing in accordance with Section 2.5.3 Vegetation Protection Post-construction. All other individual lots shall be placed in a tract or easement.
    - The dispersion area(s) shall be shown on all property maps and shall be clearly marked during clearing and construction on the site.
    - All trees within the preserved area at the time of permit application shall be retained, aside from the removal of dangerous or diseased trees.
    - The dispersion area may be used for passive recreation and related facilities, including pedestrian and bicycle trails, nature viewing areas, fishing and camping areas, and other similar activities that do not require permanent structures. Cleared areas and areas of compacted soil associated with these areas and facilities must not exceed 8 percent of the dispersion area.
    - The dispersion area may contain utilities and utility easements, but not septic systems. For the purpose of this BMP utilities are defined as potable and wastewater underground piping, underground wiring, and power and telephone poles.
    - For sites with onsite sewage disposal systems, the discharge of runoff from the dispersion area must be located 30-feet upgradient, or 10-feet downgradient of the primary and reserve drainfield areas. This requirement may be modified by the Tacoma-Pierce County Health Department if site topography clearly prohibits flows from intersecting the drainfield or where site conditions (soil permeability, distance between systems, etc.) indicate that this is unnecessary.

- **A flow path through the dispersion area.** The length of the flow path from the impervious (or cleared) area through the dispersion area varies based on the site layout and type of impervious surface, as further described below. Regardless of the site layout and type of impervious surface the flow path must meet the following criteria:
    - The slope of the flow path must be no steeper than 15 percent for any 20-foot reach of the flow path. Slopes up to 20 percent are allowed where flow spreaders are located upstream of the dispersion area and at sites where vegetation can be established.
    - The flow paths from adjacent flow spreaders must be sufficiently spaced to prevent overlap of flows in the flow path area.
    - The flow path is not permitted within an erosion hazard, or landslide hazard area (as defined by PCC Title 18E.80) unless the slope stability impacts of such systems have been analyzed and mitigated by a geotechnical professional, and appropriate analysis indicates that the impacts are negligible.
    - The flow path must be onsite or in an offsite tract or easement area reserved for such dispersion.

2.3.2 Design Criteria for Residential, Commercial, and Industrial Projects

Rural developments should use this BMP wherever possible to minimize effective impervious surfaces.

Full Dispersion from Impervious Surfaces

Impervious surfaces within the project may be "fully dispersed" if they are within a TDA that is less than 10 percent impervious. If the TDA has more than 10 percent impervious area, the design may still fully disperse up to 10 percent of the TDA's area. The impervious areas that are beyond the 10 percent cannot drain to the dispersion area and are subject to the thresholds in Minimum Requirements #6 and #7.. The lawn and landscaping areas associated with the impervious areas being mitigated may be dispersed into the dispersion area. The lawn and landscaped area must comply with Volume III, Section 3.1 Soil Preservation and Amendment.

The dispersion area must be preserved as forest or native vegetation.

The dispersion area shall have a minimum area 6.5 times the area of impervious surface draining to it.

The flow path from the impervious surface through the area preserved as forest or native vegetation must be at least 100-feet in length, or 25-feet for sheet flow from lawn and landscaping areas associated with the impervious area being mitigated.

The following additional guidelines must be followed for the following types of impervious surfaces within the project:

- **Full dispersion from roof surfaces:** Runoff from roof surfaces must either:
    - Provide dispersion BMPs as described in Downspout Dispersion Systems (Volume III, Section 3.9.4) prior to the runoff entering the dispersion area. The dispersion area and flow path must meet the criteria described in this BMP.

    or

    - Combine the roof runoff with the road runoff and follow the guidance for full dispersion from roadway surfaces (below).

- **Full dispersion from driveway surfaces:** Runoff from driveway surfaces must either:
  - Provide dispersion BMPs as described in Sheet Flow Dispersion (Volume III, Section 3.2.3) and Concentrated Flow Dispersion (Volume III, Section 3.2.4) prior to the runoff entering the dispersion area. The dispersion area and flow path must meet the criteria described in this BMP.

  or

  - Combine the driveway runoff with the road runoff and follow the guidance for full dispersion from roadway surfaces (below).
- **Full Dispersion from Roadway Surfaces:** Runoff from roadway surfaces must comply with all of the following requirements:
  1. The road section shall be designed to minimize collection and concentration of roadway runoff. Sheet flow over roadway fill slopes(i.e., where roadway subgrade is above adjacent right-of-way) should be used wherever possible to avoid concentration.
  2. When it is necessary to collect and concentrate runoff from the roadway and adjacent upstream areas (e.g., in a ditch on a cut slope), concentrated flows shall be incrementally discharged from the ditch via cross culverts or at the ends of cut sections. These incremental discharges of newly concentrated flows shall not exceed 0.5 cfs at any one discharge point from a ditch for the 100year runoff event. Where flows at a particular ditch discharge point were already concentrated under existing site conditions (e.g., in a natural channel that crosses the roadway alignment), the 0.5 cfs limit would be in addition to the existing concentrated peak flows.
  3. Ditch discharge points with up to 0.2 cfs discharge for the peak 100year flow shall use rock pads or dispersion trenches to disperse flows into the dispersion area. Ditch discharges with between 0.2 and 0.5 cfs discharge for the 100year peak flow shall use only dispersion trenches to disperse flows into the dispersion area. See Outfalls (Volume III, Section 4.8) for details on rock pads and dispersion trenches.
  4. Dispersion trenches shall be designed to accept surface flows (free discharge) from a pipe, culvert, or ditch end, shall be aligned perpendicular to the flow path, and shall have a minimum 2 feet by 2 feet cross-section, 50-feet in length, filled with 0.75inch to 1.5inch washed rock, and provided with a level notched grade board. Manifolds may be used to split flows up to 2 cfs discharge for the 100year peak flow between up to four trenches. Dispersion trenches shall have a minimum spacing of 50-feet between centerlines.
  5. Flow paths from adjacent discharge points must not intersect within the 100foot flow path lengths, and dispersed flow from a discharge point must not be intercepted by another discharge point. To enhance the flow control and water quality effects of dispersion, the flow path shall not exceed 15 percent slope unless a level spreader is used (see criteria above), and shall be located within a designated open space.
  6. Where the county determines there is a potential for significant adverse impacts downstream (e.g., erosive steep slopes or existing downstream drainage problems), dispersion of roadway runoff may not be allowed, or other measures may be required.

Full Dispersion from Cleared Areas

The runoff from cleared areas that are comprised of bare soil, non-native landscaping, lawn, and/

or pasture is "fully dispersed" if it meets all the following criteria:

- Cleared areas must comply with Soil Preservation and Amendment BMP (Volume III, Section 3.1).
- The dispersion area must be preserved as forest or native vegetation.
- The flow path through the cleared area (and leading to the dispersion area) must not be greater than 25-feet.
- If the cleared area has a width of up to 25-feet:
  - The minimum flow path length from the cleared area through the dispersion area must be at least 25-feet.
- If the cleared area has a width of 25- to 250-feet:
  - The minimum flow path length from the cleared area through the dispersion area must be 25-feet, plus an additional 1-foot for every 3-feet of width of the cleared area (beyond the initial 25-feet) up to a maximum width of 250-feet.
- The topography of the cleared area pervious surface must be such that runoff will not concentrate prior to discharge to the dispersion area.
- The width of the dispersion area must equal the width of the cleared area.

2.3.3 Design Criteria for Roadway Projects

These dispersion criteria apply to the construction of public and private roads not within the context of residential, commercial, or industrial site development. They will likely only be implementable on roads outside of the urban growth areas where roadside areas are not planned for urban density development.

Full dispersion can be applied to public and private road projects that meet the following requirements:

- The dispersion area must be outside of the urban growth area; or if inside the urban growth area, must be in legally protected areas (easements, conservation tracts, public parks).
- If the dispersion area is outside urban growth areas, legal agreements shall be reached with the owner(s) of the property(ies) that contain the dispersion area.
- An agreement with the property owner(s) is advised for any dispersion areas that represent a continuation of past practice. If not a continuation of past practice, an agreement shall be reached with the property owner.

Full Dispersion by Sheet Flow from Uncollected, Unconcentrated Runoff into the Dispersion Area

The runoff from public and private road projects that sheet flow into the dispersion area is "fully dispersed" if it meets all of the following criteria:

- The dispersion area must be preserved as forest or native vegetation.
- Depth to the average annual maximum groundwater elevation shall be at least 3-feet.
- The flow path through any impervious area leading to the dispersion area must not be greater than 75-feet.

- The flow path through any pervious area leading to the dispersion area must not be greater than 150-feet. Pervious flow paths include upgradient road side slopes that run onto the road and downgradient road side slopes that precede the dispersion area.
- The width of the dispersion area shall be equivalent to the width of impervious surface sheet flowing into it.
- Flow path length through the dispersion area:
    - For outwash soils: The following criteria apply to sites (or areas of sites) with outwash soils (Type A – sands and sandy gravels, possibly some Type B – loamy sands). The outwash soils must have an initial saturated hydraulic conductivity rate of 4 inches per hour or greater. The saturated hydraulic conductivity must be based on a Pilot Infiltration Test or the Soil Grain Size Analysis method as identified in Appendix III-A – Methods for Determining Design Infiltration Rates.
        - If the impervious area has a flow path length of up to 20-feet, the flow path length through the dispersion area must be at least 10-feet.
        - If the impervious area has a flow path length greater than 20-feet, the flow path length through the dispersion area must be 10-feet, plus an additional 0.25-feet for every 1-foot of impervious flow path length beyond the initial 20-feet.
    - For other soils: The following criteria apply to sites (or areas of sites) with soils other than those described in the bullet above (Types C and D and some Type B not meeting the criterion described in the bullet above).
        - For every 1-foot of flow path length across the impervious surface . the flow path length through the dispersion area must be 6.5-feet.
        - The minimum flow path length through the dispersion area is 100-feet.
- The lateral slope of the impervious area must be less than 8 percent.
- Road side slopes must be less than 25 percent. Road side slopes do not count as part of the dispersion area unless native vegetation is re-established and slopes are less than 15 percent. Road shoulders that are paved or graveled to withstand occasional vehicle loading count as impervious surface.
- The longitudinal slope of road must be less than or equal to 5 percent.
- The average longitudinal (parallel to road) slope of the dispersion area must be less than or equal to 15 percent.
- The average lateral slope of the dispersion area must be less than or equal to 15 percent.

Full Dispersion of Channelized (Collected and Re-dispersed) Stormwater into the Dispersion Area

The runoff from public and private road projects that is collected and re-dispersed is “fully dispersed” if it meets all of the following criteria:

1. The dispersion area may be either:
    - Preserved as forest or native vegetation.

    or

    - Cleared land. This cleared land option may be only used if the site is outside the Urban

Growth Area and does not have a natural or man-made drainage system.

2. Depth to the average annual maximum groundwater elevation must be at least 3-feet.
3. Channelized flow must be re-dispersed to produce the longest possible flow path.
4. Flows must be evenly dispersed across the dispersion area.
5. Ditch discharge points with up to 0.2 cfs discharge for the peak 100-year flow shall use rock pads or dispersion trenches to disperse flows into the dispersion area. Ditch discharge points with between 0.2 and 0.5 cfs discharge for the 100-year peak flow shall use dispersion trenches to disperse flows into the dispersion area. See Outfalls (Section 4.8) for rock pads and dispersion trenches.
    - Dispersion trenches shall be designed to accept surface flows (free discharge) from a pipe, culvert, or ditch end, shall be aligned perpendicular to the flow path, and shall have a minimum 2-feet by 2-feet cross section, 50-feet in length, filled with 0.75-inch to 1.5-inch washed rock, and provided with a level notched grade board. Manifolds may be used to split flows up to 2 cfs discharge for the 100-year peak flow between up to 4 trenches. Dispersion trenches shall have a minimum spacing of 50-feet between centerlines.
6. Approved energy dissipation techniques may be used.
7. Limited to onsite (associated with the road) flows.
8. The width of the dispersion area shall be equivalent to length of the road from which runoff is collected.
9. The average longitudinal and lateral slopes of the dispersion area must be less than or equal to 8 percent.
10. The slope of any flow path segment within the dispersion area must be no steeper than 15 percent for any 20foot reach of the flow path segment.
11. Flows path length through the dispersion area:
    - For outwash soils: The following criteria apply to sites (or areas of sites) with outwash soils (Type A – sands and sandy gravels, possibly some Type B – loamy sands) that have an initial saturated hydraulic conductivity rate of 4 inches per hour or greater. The saturated hydraulic conductivity must be based on field results using procedures (Pilot Infiltration Test or Soil Grain Size Analysis Method) identified in Appendix III-A – Methods for Determining Design Infiltration Rates.
        - The dispersion area shall be at least half of the impervious drainage area.
    - For other soils: The following criteria apply to sites (or areas of sites) with soils other than those described in the bullet above (Types C and D and some Type B not meeting the criterion in the bullet above).
        - For every 1 foot of flow path length across the impervious surface, the flow path length through the dispersion area must be 6.5-feet.
        - The minimum flow path length through the dispersion area is 100-feet.

Full Dispersion by Engineered Dispersion

The runoff from public and private road projects is "fully dispersed" if it meets all of the following criteria:

1. Stormwater can be dispersed via sheet flow or via collection and re-dispersion in accordance with the techniques for Full Dispersion of Channelized (Collected and Re-dispersed) Stormwater into the Dispersion Area (above).
2. The dispersion area shall be planted with native trees and shrubs.
3. For outwash soils: The following criteria apply to sites (or areas of sites) with outwash soils (Type A – sands and sandy gravels, possibly some Type B – loamy sands) that have an initial saturated hydraulic conductivity rate of 4-inches per hour or greater. The saturated hydraulic conductivity must be based on field results using procedures (Pilot Infiltration Test or Soil Grain Size Analysis Method) identified in Appendix III-A – Methods for Determining Design Infiltration Rates.
    - The dispersion area must be compost amended in accordance with the guidelines in Soil Preservation and Amendment BMP in Volume III, Section 3.1.
    - If the impervious area has a flow path length of up to 20-feet, the flow path length through the dispersion area must be at least 10-feet.
    - If the impervious area has a flow path length greater than 20-feet, the flow path length through the dispersion area must be 10-feet, plus an additional 0.25-feet for every 1-foot of impervious flow path length beyond the initial 20-feet.
4. For other soils: The following criteria apply to sites (or areas of sites) with soils other than those described in the bullet above (Types C and D and some Type B not meeting the criterion in the bullet above).
5. If the dispersion area has Type C or D soils:
    - The dispersion area must be compost amended in accordance with the guidelines in Soil Preservation and Amendment BMP in Volume III, Section 3.1.
    - The dispersion area must be 6.5 times the area of the surface(s) draining to it.
6. The average longitudinal (parallel to the road) slope of the dispersion area shall be less than or equal to 15 percent.
7. The average lateral slope of the dispersion area shall be less than or equal to 15 percent.
8. The depth to the average annual maximum groundwater elevation shall be at least 3-feet.

Native Vegetation Landscape Specifications

These specifications may be used in situations where an applicant wishes to convert a previously developed surface to a native vegetation landscape for purposes of meeting full dispersion requirements or code requirements for forest retention. Native vegetation landscape is intended to have the soil, vegetation, and runoff characteristics approaching that of natural forestland.

Conversion of a developed surface to native vegetation landscape requires the removal of impervious surface, de-compaction of soils, and the planting of native trees, shrubs, and groundcover in compost-amended soil according to all of the following specifications:

1. Existing impervious surface and any underlying base course (e.g., crushed rock, gravel)

must be completely removed from the conversion area(s).

2. Underlying soils must be broken up to a depth of 18-inches. This can be accomplished by excavation or ripping with either a backhoe equipped with a bucket with teeth, or a ripper towed behind a tractor.
3. At least 4-inches of well-decomposed compost must be tilled into the broken up soil as deeply as possible. The finished surface should be gently undulating and must be only lightly compacted.
4. PCC Title 18J contains recommended tree species to be used. The area of native vegetated landscape must be planted with native species trees, shrubs, and ground cover. Species must be selected based on the underlying soils, shade, and moisture conditions; as well as the historic, native indigenous plant community type for the site. Vegetation shall be selected in accordance with the following requirements:
    a. Trees: a minimum of two species of trees must be planted, one of which is a conifer. Conifer trees shall be no less than 3-feet in height and deciduous trees shall have a minimum caliber of 1 inch at the time of planting. Conifer and other tree species must cover the entire landscape area at a spacing of 15- to 20-feet on center or as recommended by a professional landscaper or in accordance with county requirements. No individual species of replacement tree should exceed 50 percent of the total nor should any individual species be less than 10 percent of the total.
    b. Shrubs: a minimum of two species of shrubs should be planted. Space 3 gallon plants at 4-feet on center to cover the entire landscape area, excluding points where trees are planted.
    c. Groundcover: a minimum of two species of ground cover should be planted. Space plants so as to cover the entire landscape area, excluding points where trees or shrubs are planted.

    Note: For landscape areas larger than 10,000 square feet, planting a greater variety of species than the minimum required above is strongly encouraged. For example an acre could easily accommodate three tree species, three species of shrubs and two or three species of ground cover.
5. Trees selected for replacement purposes must be free from injury, pests, diseases, and nutritional disorders. Trees must be fully branched and have a healthy root system.
6. At least 4-inches of hog fuel or other suitable mulch must be placed between plants as mulch for weed control. It is also possible to mulch the entire area before planting; however, an 18-inch diameter circle must be cleared for each plant when it is planted in the underlying amended soil. Note: Plants and their root systems that come in contact with hog fuel or raw bark have a poor chance of survival.
7. Plantings must be watered consistently once per week during the dry season for the first two years.
8. The plantings must be well established on at least 90 percent of the converted area. A minimum of 90 percent plant survival is required after 3 years.

Conversion of an area that was under cultivation to native vegetation landscape requires a different treatment. Elimination of cultivated plants, grasses, and weeds is required before planting and will be required on an on-going basis until native plants are well-established. In

addition:

1. The soil shall be tilled to a depth of 18-inches. A minimum of 8-inches of soil having an organic content of 6 to 12 percent is required, or a 4-inch layer of compost may be placed on the surface before planting, or 4-inches of clean wood chips may be tilled into the soil, as recommended by a landscape architect or forester.
2. After soil preparation is complete, continue with steps 4 through 8 above. Placing 4-inches of compost on the surface may be substituted for the hog fuel or mulch. For large areas where frequent watering is not practical, bare-root stock may be substituted at a variable spacing from 10- to 12-feet on center (with an average of 360 trees per acre) to allow for natural groupings and 4- to 6-feet on center for shrubs. Allowable bare-root stock types are 1-1, 2-1, P-1, and P-2. Live stakes at 4-feet on center may be substituted for willow and red-osier dogwood in wet areas.

Maintenance shall include intensive site preparation, including weed control and soil amendment. Ongoing maintenance shall include weeding and watering for a minimum of 3 years from installation so as to achieve a minimum 90 percent survival of all planted vegetation. If during the 3-year period survival of planted vegetation falls below 90 percent, additional vegetation shall be installed as necessary to achieve the required survival percentage. Additionally, the likely cause of the high rate of plant mortality shall be determined and corrective actions shall be taken as needed to insure plant survival. If it is determined that the original plant choices are not well suited to site conditions, these plants shall be replaced with plant species that are better suited to the site.

Clearly written management plans and protection mechanisms are necessary for maintaining the benefits of vegetation restoration areas for the long term. Some of the mechanisms for protection include dedicated tracts, transfer to local land trusts (large areas), and homeowner association covenants. Property owner education should be incorporated in all of these strategies.

Runoff Model Representation

Areas that are fully dispersed do not have to use approved runoff models to demonstrate compliance. They are presumed to fully meet the Runoff Treatment and Flow Control requirements Minimum Requirements #6 and #7.

2.3.4 Calculation of the Total Native Vegetation Retention Achieved

Calculation of native vegetation retention achieved shall exclude water bodies (such as large ponds or lakes 10 acres or greater) and include areas part of a common conservation easement (such as parks, stormwater, open space, wetland buffers, or critical area tracts) or areas incorporated into the individual lot design where conservation easements are placed on that portion of the lot. However, proposed residential subdivisions and PDDs shall locate a minimum of 75 percent of the required native vegetation within areas of land separate from residential lots, such as those listed above. When lots or building sites are located contiguous to protective tracts the preferred location of the native vegetation areas is the area adjacent to these tracts.

2.4 Better Site Design (Ecology BMP T5.41)

Fundamental hydrological and stormwater management concepts must be applied at the site design phase that are:

- more integrated with natural topography,
- reinforcing the hydrologic cycle,
- more aesthetically pleasing, and
- often less expensive to build.

A few site planning principles help to:

- locate development on the least sensitive areas of a site;
- accommodate residential land use; and
- mitigate the impact on stormwater quantity and quality.

2.4.5 Design Criteria

Knowing how the site processed stormwater historically is important in determining appropriate Better Site Design strategies. The site analysis (see Section 1.4) will provide information on how the site and the surrounding areas process stormwater both currently and historically (before any land use changes had altered those processes). This information will aid the designer in determining preferred site layout options, and in deciding what appropriate site design BMPs will help either maintain or restore natural pre-developed stormwater processes.

Initial delineation, site management, and site design strategies to be considered and implemented as feasible include:

- **Define Development Envelope and Protected Areas** – The first step in site planning is to define the development envelope. This is done by identifying protected areas, setbacks, easements and other site features, and by consulting applicable local standards and requirements. Site features to be protected may include important existing trees, steep slopes, erosive soils, riparian areas, or wetlands.

  By keeping the development envelope compact, environmental impacts can be minimized, construction costs can be reduced, and many of the site's most attractive landscape features can be retained. In some cases, economics or other factors may not allow avoidance of all sensitive areas. In these cases, care can be taken to mitigate the impacts of development through site work and other landscape treatments.

- **Minimize Directly Connected Impervious Areas** - Impervious areas directly connected to the drainage system are the greatest contributors to urban nonpoint source pollution. Any impervious surface that drains into a catch basin or other conveyance structure is a "directly connected impervious surface." As stormwater runoff flows across parking lots, roadways, and other paved areas, the oil, sediment, metals, and other pollutants are collected and concentrated. If this runoff is collected by a drainage structure and carried directly along impervious gutters or in sealed underground pipes, it has no opportunity for filtering by plant material or infiltration into the soil. It also increases in velocity and amount, causing increased peak-flows in the winter and decreased base- flows in the summer.

  A basic site design principle for stormwater management is to minimize these directly connected impervious areas. This can be done by limiting overall impervious land coverage

or by infiltrating and/or dispersing runoff within these impervious areas.

- **Maximize Permeability** – Within the development envelope, many opportunities are available to maximize the permeability of new construction. These include minimizing impervious areas, paving with permeable materials, clustering buildings, and reducing the land coverage of buildings by smaller footprints. All of these strategies make more land available for infiltration and dispersion through natural vegetation.

  Clustered driveways, small visitor parking bays and other strategies can also minimize the impact of transportation-related surfaces while still providing adequate access.

  Once site coverage is minimized through clustering and careful planning, pavement surfaces can be selected for permeability. A patio of brick-on-sand, for example, is more permeable than a large concrete slab. Engineered soil/landscape systems are permeable ground covers suitable for a wide variety of uses. Permeable/porous pavements can be used in place of traditional concrete or asphalt pavements in many low traffic applications.

  Maximizing permeability at every possible opportunity requires the integration of many small strategies. These strategies will be reflected at all levels of a project, from site planning to materials selection. In addition to the environmental and aesthetic benefits, a high-permeability site plan may allow the reduction or elimination of expensive underground conveyance systems, Flow Control BMPs, and/or Runoff Treatment BMPs, yielding significant savings in development costs.

- **Build Narrower Streets** - More than any other single element, street design has a powerful impact on stormwater quantity and quality. In residential development, streets and other transportation-related structures typically can comprise between 60 and 70 percent of the total impervious area, and, unlike rooftops, streets are almost always directly connected to the drainage system.

  The combination of large, directly connected impervious areas, together with the pollutants generated by automobiles, makes the street network a principal contributor to stormwater pollution in residential areas.

  Street design is usually mandated by local municipal standards. These standards have been developed to facilitate efficient automobile traffic, maximize parking, and allow for emergency vehicle access. Most require large impervious land coverage. In recent years, new street standards have been gaining acceptance that meet the access requirements of local residential streets while reducing impervious land coverage. These standards generally create a new class of street that is narrower than the current local street standard, called an "access" street. An access street is intended only to provide access to a limited number of residences.

  Because street design is the greatest factor in a residential development's impact on stormwater quantity and quality, it is important that designers, municipalities and developers employ street standards that reduce impervious land coverage.

- **Maximize Choices for Mobility** – Given the cost of automobile use, both in land area consumed and pollutants generated, maximizing choices for mobility is a basic principle for environmentally responsible site design. By designing residential developments to promote alternatives to automobile use, a primary source of stormwater pollution can be mitigated.

  Bicycle lanes and paths, secure bicycle parking at community centers and shops, direct, safe pedestrian connections, and transit facilities are all site-planning elements that maximize

choices for mobility.

- **Use Drainage as a Design Element** – Unlike conveyance drainage systems that hide water beneath the surface and work independently of surface topography, a drainage system for stormwater infiltration or dispersion can work with natural land forms and land uses to become a major design element of a site plan.

  By applying stormwater management techniques early in the site plan development, the drainage system can suggest pathway alignments, optimum locations for parks and play areas, and potential building sites. In this way, the drainage system helps to generate urban form, giving the development an integral, more aesthetically pleasing relationship to the natural features of the site. Not only does the integrated site plan complement the land, it can also save on development costs by minimizing earthwork and expensive drainage features.

- See Volume II, Section 3.3 for additional requirements specific to protection of LID BMPs during construction (in accordance with Volume I, Minimum Requirement #2, Element #13).

Finally, designers should also refer to the Low Impact Development Technical Guidance Manual for Puget Sound (WSU 2012), specifically Chapter 3, for additional guidelines and graphics for better site designs and layouts.

2.4.6 Lot Layout

In addition to the general delineation, site management, and site design strategies outlined above, lot layout can play a particularly important role in Comprehensive LID Site Designs. Comprehensive LID projects shall employ planning strategies to minimize site disturbance, maximize protection of native soil and vegetation, and permanently set aside the open tracts for multiple objectives including stormwater management. The following general objectives should guide the placement and orientation of lots for LID projects:

- Cluster homes to reduce overall development envelope and road length.
- Orient lots to use shared driveways to access houses along common lot lines.
- Reduce front yard setbacks to reduce driveway length.
- Strategically locate lots for dispersing stormwater to open space areas.
- Orient lots and buildings to maximize opportunities for on-lot infiltration or open conveyance through vegetated systems.

2.5 Preserving Native Vegetation (Ecology BMP T5.40)

Preserving native vegetation onsite to the maximum extent feasible will minimize the impacts of development on stormwater runoff. Per Section 1.3, it is preferable that 65 percent or more of the project site be protected for the purposes of retaining or enhancing existing forest cover and preserving wetlands and stream corridors. Where that cannot be achieved, the minimum vegetation retention requirements outlined in Section 1.3 must be met. The following sections present the strategies and practices for meeting the native vegetation preservation requirements. Additional details on flow dispersion to native vegetation areas are presented under Section 2.3, Full Dispersion.

2.5.1 Applicability

New development often takes place on tracts of forested land. Unless sufficient care is taken and planning done, in the interval between buying the property and completing construction much of this resource is likely to be destroyed.

With vegetation retention, the primary goal is to retain large, connected tracts of native vegetation areas, either through a cluster design or on individual lots, to maintain the natural hydrologic function and provide infiltration areas for overland flows generated in developed portions of the site. Forest and native growth areas allow rainwater to naturally percolate into the soil, recharging groundwater for summer stream flows and reducing surface water runoff that creates erosion and flooding. Conifers can retain up to about 50 percent of all rain that falls during a typical storm. Of this rainfall, 20 to 30 percent may never reach the ground but evaporates or is taken up by the tree.

On lots that are one acre or greater, preservation of 65 percent or more of the site in native vegetation will allow the use of flow dispersion techniques presented in Section 2.3,Full Dispersion. Sites that can fully meet the requirements ofFull dispersion are not required to provide runoff treatment or flow control facilities (as required by Volume I, Minimum Requirements #5, #6, and #7).

2.5.2 Design Criteria

- The preserved area shall be situated to minimize the clearing of existing forest cover, to maximize the preservation of wetlands, and to buffer stream corridors.
- Where feasible, trees and other native vegetation shall be retained in groups of sufficient size to maintain adequate growing conditions to support natural successional patterns and develop diverse multilayer canopy structure, snags, large woody debris, understory vegetation, and forest duff. Growing conditions include slope, aspect, soil structure and moisture, sun exposure, humidity, wind, co-dependence on or competition among adjacent plants as well as other microclimatic factors.
- The preserved area shall be shown on all property maps and shall be clearly marked during clearing and construction on the site.
- Maximize the amount of preserved area that can be located downslope from the building sites, to optimize the use of Full dispersion.
- For trees that are adjacent to existing or proposed structures or other impervious surfaces, it is important to also review Volume III, Section 3.3 Tree Retention and Tree Planting to identify possible flow control credits that may be achieved through targeted tree retention.

2.5.3 Vegetation Protection Post-construction

The following steps must be taken to protect vegetation after construction:

- Mechanisms shall be put in place to assure long-term protection of vegetation retention areas. Mechanisms to protect conservation areas include setting aside conservation areas into separate tracts, permanent easements, homeowner covenants, maintenance agreements, and education (see Chapter 3 for additional detail).
- Maintenance plans and agreements must be in compliance with Volume I, Chapter 3, and must address issues including but not limited to:
  - Pest and disease management practices
  - Pruning requirements
  - Irrigation requirements
  - Fertilization requirements
  - Fire fuel management practices.
- Permanent signs shall be installed indicating that removal of trees or vegetation is prohibited within the native vegetation retention areas (with the exception of the removal of dangerous and diseased trees).
- Permanent fencing is required around the limits of the vegetation retention areas. The type, size, and location of the fencing shall be approved by county review staff and should be made of materials that blend in with the natural surroundings (e.g., wood split-rail, pinned if necessary) and located in such a manner as to not impede the movement of wildlife within the vegetation retention areas.

2.5.4 Additional Requirements

In addition to the general requirements outlined above, criteria specified in Volume III, Section 3.3 Tree Retention and Tree Planting are pertinent to vegetation retention. In particular, developers should be aware of the specific measures to protect trees during construction.

2.6 Restoring Site Vegetation

2.6.1 Application

Restoration of site vegetation shall be applied in the following situations:

1. Where project areas have been disturbed and are scheduled to be replanted with native trees and vegetation, in order to maximize the hydrologic benefits of a native site (in accordance with the Comprehensive LID Site Design performance goals outlined in Section 1.3).
2. Where a project wishes to convert a previously developed surface to a native vegetation landscape, either for purposes of meeting the requirements of Full dispersion or code requirements for vegetation restoration.

See also Section 2.3 Full Dispersion for requirements related to using vegetated areas for dispersion credits, as well as Volume III, Section 3.3, Tree Retention and Tree Planting for requirements specific to trees (as well as tree flow control credits).

Vegetation restoration/planting methods shall conform to published standards as appropriate to the type of natural resource protection area.

2.6.2 Design Criteria

In situations where it is not feasible to retain existing trees and vegetation of sufficient size and quantity to achieve the target amount of tree cover, additional tree cover shall be provided where feasible through supplemental tree and vegetation plantings. In addition, on those sites where vegetation cover does not exist due to previous removal, vegetation cover shall be reestablished to the maximum extent feasible. The following standards shall be utilized:

2.6.3 Planning and Design

- The applicant shall comply with the provisions for tree replacement as set forth in PCC Title 18J.
- Trees selected for replacement purposes must be free from injury, pests, diseases, and nutritional disorders. Trees must be fully branched and have a healthy root system.
- Coniferous and broad leaf evergreen trees shall be no less than 4-feet in height at time of planting. Deciduous trees shall be a minimum of 8-feet in height or have a minimum caliper size of 1.5-inch at time of planting.
- PCC Title 18J contains recommended tree species to be used. The area of native vegetated landscape must be planted with native species trees, shrubs, and ground cover. Species must be selected based on the underlying soils, shade, and moisture conditions; as well as the historic, native indigenous plant community type for the site. Vegetation shall be selected in accordance with the following requirements:
    - **Trees:** a minimum of two species of trees must be planted, one of which is a conifer. Conifer and other tree species must cover the entire landscape area at a spacing recommended by a professional landscaper or in accordance with county requirements. No individual species of replacement tree should exceed 50 percent of the total nor should any individual species be less than 10 percent of the total.
    - **Shrubs:** a minimum of two species of shrubs should be planted. Space plants to cover the entire landscape area, excluding points where trees are planted.
    - **Groundcover:** a minimum of two species of ground cover should be planted. Space plants so as to cover the entire landscape area, excluding points where trees or shrubs are planted.

Note: For landscape areas larger than 10,000 square feet, planting a greater variety of species than the minimum suggested above is strongly encouraged. For example, an acre could easily accommodate three tree species, three species of shrubs, and two or three species of groundcover.

2.6.4 Construction and Operation

Conversion of a developed surface to native vegetation landscape requires the removal of impervious surface; de-compaction of soils; and/or the planting of native trees, shrubs, and ground cover in compost-amended soil according to all of the following specifications:

1. Existing impervious surface and any underlying base course (e.g., crushed rock, gravel, etc.) must be completely removed from the conversion area(s).

2. Underlying soils must be broken up to a depth of 18-inches. This can be accomplished by excavation or ripping with either a backhoe equipped with a bucket with teeth, or a ripper towed behind a tractor.
3. At least 4-inches of well-decomposed compost must be tilled into the broken up soil as deeply as possible. The finished surface should be gently undulating and must be only lightly compacted.
4. At least 4-inches of hog fuel or other suitable mulch must be placed between plants as mulch for weed control. It is also possible to mulch the entire area before planting; however, an 18inch-diameter circle must be cleared for each plant when it is planted in the underlying amended soil. Note: plants and their root systems that come in contact with hog fuel or raw bark have a poor chance of survival.

Conversion of an area that was under cultivation to native vegetation landscape requires a different treatment. Elimination of cultivated plants, grasses, and weeds is required before planting and will be required on an on-going basis until native plants are well-established. In addition:

1. The soil shall be tilled to a depth of 18-inches. A minimum of 8-inches of soil having an organic content of 6 to 12 percent is required, or a four inch layer of compost may be placed on the surface before planting, or 4-inches of clean wood chips may be tilled into the soil, as recommended by a landscape architect or forester.
2. After soil preparation is complete, continue with steps 3 through 4 above. Placing 4-inches of compost on the surface may be substituted for the hog fuel or mulch. For large areas where frequent watering is not practical, bare-root stock may be substituted at a variable spacing from 10- to 12-feet on center (with an average of 360 trees per acre) to allow for natural groupings and 4- to 6-feet on center for shrubs. Allowable bare-root stock types are 11, 21, P1, and P2. Live stakes at 4 feet on center may be substituted for willow and red-osier dogwood in wet areas.

Maintenance shall include intensive site preparation, including weed control and soil amendment. Ongoing maintenance shall include weeding and watering for a minimum of 3 years from installation so as to achieve a minimum 90 percent survival of all planted vegetation. If during the 3year period survival of planted vegetation falls below 90 percent, additional vegetation shall be installed as necessary to achieve the required survival percentage. Additionally, the likely cause of the high rate of plant mortality shall be determined and corrective actions shall be taken as needed to ensure plant survival. If it is determined that the original plant choices are not well suited to site conditions, these plants shall be replaced with plant species that are better suited to the site.

Clearly written management plans and protection mechanisms are necessary for maintaining the benefits of vegetation restoration areas for the long term. Some of the mechanisms for protection include dedicated tracts, transfer to local land trusts (large areas), and homeowner association covenants. Property owner education should be incorporated in all of these strategies.

2.7 Minimize Impervious Areas

The following sections contain strategies for reducing the impacts of impervious surfaces associated with transportation and mobility related networks.

2.7.1 Road Design

The objective for a Comprehensive LID roadway system design is to reduce the amount of impervious area associated with the road network. This may be achieved by utilizing permeable pavement, examining alternative street layouts, and determining the best option for increasing the number of homes per unit length of road, as well as aligning roads to maximize opportunities for discharging to adjacent dispersion or bioretention areas. Strategies to be applied (where feasible) for reducing the amount and impact of impervious area associated with the road network include:

- Design the road layout to follow the existing topographic contours to minimize cuts and fills.
- Design the road layout to avoid crossing natural resource protection areas, thereby minimizing the disruption of sheet flow within these areas.
- Natural resource protection areas or bioretention areas shall be located down-gradient of roads, alleys, and other impervious surfaces when feasible.
- Infiltrate or slowly convey storm flows in roadside bioretention cells and swales, and through permeable paving and aggregate storage systems under the pavement. (Note that if using infiltration and/or conveyance under roads and parking areas in a retrofit setting the design must consider the integrity and protection of adjacent infrastructure.)
- Roads should be designed to service clusters of development located within the buildable portions of the site (i.e., cluster housing), thereby reducing the overall length of the roadway network.

Road Cross Sections

The objective of modifying road cross sections is to reduce the roadway width to the minimum amount of impervious surface necessary, while still accommodating emergency vehicle access, and utilizing permeable pavements where feasible. Note: Existing applicable road standards still apply except as modified below:

- For projects that trigger Minimum Requirements #1 through #5 or #1 through #10 (see Volume I, Chapter 2), permeable pavement is one option that must be evaluated for onsite stormwater management for roads with very low traffic volumes and very low truck traffic (see Volume III, Section 3.5.2 for additional details). If permeable pavement surfaces are used adjacent to conventional impervious road sections for sidewalks or pullout parking, use design techniques described in Volume III, Section 3.5 to prevent saturation of the impervious road section and migration of aggregate base material from the impervious to the permeable section.
- An example LID road section is provided in Attachments Section A, Detail 27.0.
- Sidewalks and trails must be disconnected from the traveled way portion of the road, to the maximum extent feasible. Sidewalks may be separated from the roadway by placement of a vegetated open channel or bioretention area between the sidewalk and the roadway.
- Sidewalks and trails shall be constructed of permeable pavement, provided that the runoff through the material will not be directed towards the subgrade of the traveled lane portion of a roadway (unless the subgrade is designed to handle these flows). Permeable pavement for sidewalks and trails which abut lots, in lieu of a roadside sidewalk, shall be Americans with Disabilities Act (ADA) compliant. An example sidewalk design is provided in Attachments Section A, Detail 27.0.

Alleys shall be constructed with permeable pavement, provided that the runoff through the material will not be directed towards the subgrade of the traveled lane portion of a roadway (unless the subgrade is designed to handle these flows).

2.7.2 Parking Lots

The objective of alternative parking lot designs is to eliminate excessive impervious areas dedicated to parking and to minimize the effective impervious area of parking areas, while still providing adequate parking for various land use classifications.

Parking Lot Requirements

- Utilize the minimum off-street parking requirements outlined in PCC Title 18A for non-residential uses. The total amount of parking spaces may exceed the minimums outlined in Title 18A. However, any parking lot space above the required minimum amount shall be constructed of permeable pavement or accommodated in a multi-storied or underground parking structure.
- The designer must incorporate permeable pavement to the maximum extent feasible into the parking lot to promote infiltration of runoff (see also Volume III, Section 3.5, as well as Volume I, Minimum Requirement #5).
- Bioretention areas shall be used to maximize infiltration and attenuation of surface runoff (see also Volume III, Section 3.4).

2.7.3 Driveways

Driveways are typically constructed with impervious surfaces and as such represent an opportunity to further minimize impervious surfaces and their hydrologic impacts. The following methods shall be used to reduce the amount and hydrologic impact of impervious surfaces associated with driveways:

- Driveways shall be constructed using permeable pavement and graded in such a manner to prevent stormwater runoff from saturating the subgrade of the traveled lane portion of the roadway (if not using permeable pavement for the adjacent road). Surface and subsurface (e.g., discharge from the permeable pavement) stormwater runoff should drain to the adjacent permeable road, vegetated infiltration areas such as soil amended lawns, vegetated open channels, or bioretention areas.
- Runoff from driveways constructed of impervious surfaces shall be directed to vegetated infiltration areas such as soil amended lawns, dispersion areas, or bioretention areas.

2.7.4 Curb and Gutter Alternatives

Because of the effect they have on concentrating runoff flows, the use of curb and gutter systems is highly discouraged in Comprehensive LID Site Designs. The discussion below is intended to give guidance for appropriate LID methods for designing curb and gutter alternatives in situations where there is a need for constructing a curb and gutter system.

Applicability

- Needs where use of curb and gutter may be considered include incorporation of or tie into a road with a functional classification of Collector, Secondary, or Major Arterial roadways, or in an ultra-urban setting. Local feeder roads in Comprehensive LID sites should not be

designed with curb and gutter systems.

- Where specific community design standards require the use of curb and gutters in all or part of the road network, alternative curb and gutter designs (discussed below) must be considered that will still meet the functional requirements.

Design Criteria

- Where curb and gutters are required in a community to provide a means of separation between the pedestrians and the motorized traffic, an alternative design using placement of a vegetated channel between the sidewalk and the roadway should be considered. In addition, a visual barrier consisting of a 1foot-wide concrete strip along the edge of the pavement at the same surface elevation of the pavement shall be constructed. This concrete strip gives drivers a visual cue of the edge of the driving surface and can help protect the vegetated channel from tire ruts.
- Another alternative is to provide through curb inlets in the curb at 10 to 15 foot spacing to allow runoff to enter adjacent stormwater management areas. See Volume III, Section 4.9 for additional flow spreading options.
- Design options for curb and gutter alternatives are provided in Attachments Section A, Detail 26.3.

2.8 Soil Preservation and Amendment (Ecology BMP T5.13)

Preservation and enhancement of the existing upper soil horizon is of primary importance to the success of Comprehensive LID Site Designs. Maintaining and amending the upper soil structure plays a significant role in maintaining natural stormwater processes on the site, and can be a low-cost way to minimize impacts to site hydrology. The details of this BMP are provided in Volume III, Section 3.1, and must be incorporated into Comprehensive LID Site Designs to the maximum extent feasible.

Chapter 3. Easements, Maintenance, and Enforcement

In order to assure that the Comprehensive LID Site Design techniques continue to function over time, long-term management and maintenance strategies need to be addressed. The goal is to ensure successful management and maintenance of the vegetation retention areas, open space tracts, and LID BMPs through proper transition to subsequent owners and/or organizations that have long-term responsibility and vested interest. In addition to the O&M requirements for individual BMPs required under Volume I, Minimum Requirement #9, and outlined in Appendix IA; the following apply specifically to Comprehensive LID Site Design projects.

3.1 Dedicated Tracts and Conservation Easements

- Any vegetation retention, open space areas, bioretention areas, bioswales, or any other feature utilized for stormwater purposes shall be adequately protected through the application of dedicated tracts and, where applicable, conservation easements, so that these elements will remain in such capacity in perpetuity.
- Large open space areas adjacent to riparian areas, wetlands, or critical fish and wildlife habitat areas may be transferred to local land trusts for long-term management and stewardship or managed by homeowners/building associations with specific maintenance covenants.
- Stewardship and management plans that address long-term protection and maintenance shall be developed for these sites and submitted to the county for approval.

3.2 Maintenance Requirements

Management plans and maintenance agreements for vegetation retention areas, open space tracts, and LID BMPs shall be in conformance with the requirements set forth in Section 2.5, Preserving Native Vegetation, and Volume I, Chapter 3 of this manual.

3.3 Enforcement

Enforcement of this volume shall be in conformance with provisions established in PCC Title 18

Volume VI References

WSU. Low Impact Development Technical Guidance Manual for Puget Sound. 2012.

Pierce County
Stormwater Management and Site Development Manual

Attachments - Sections A through H

Prepared by: Pierce County Planning and Public Works
Ordinance No. 2021-45
Effective Date: July 1, 2021

Table of Contents

Attachments - Sections A through H

Section A - Quantity Design Details A-3

Section B - Quality Design Details B-1

Section C - Erosion and Sediment Control Plan Details C-1

Section D - Soil Evaluation Report Forms D-1

Soil Evaluation Report
Form 1: General Site Information D-2

Instructions for completing Form 1: Soil Evaluation Report D-3

Soil Evaluation Report
Form 2: Soil Log Information D-4

Instructions for completing Form 2: Soil Log Information D-5

Section E - Standard Stormwater Notes E-1

Standard Stormwater Notes E-2

Section F - Stormwater Facility Informational Sign Specifications F-1

Stormwater Facility Informational Sign Specifications F-2

Section G - Covenants Forms F-4

Covenants F-5

Section H - Change Order Review Form F-6

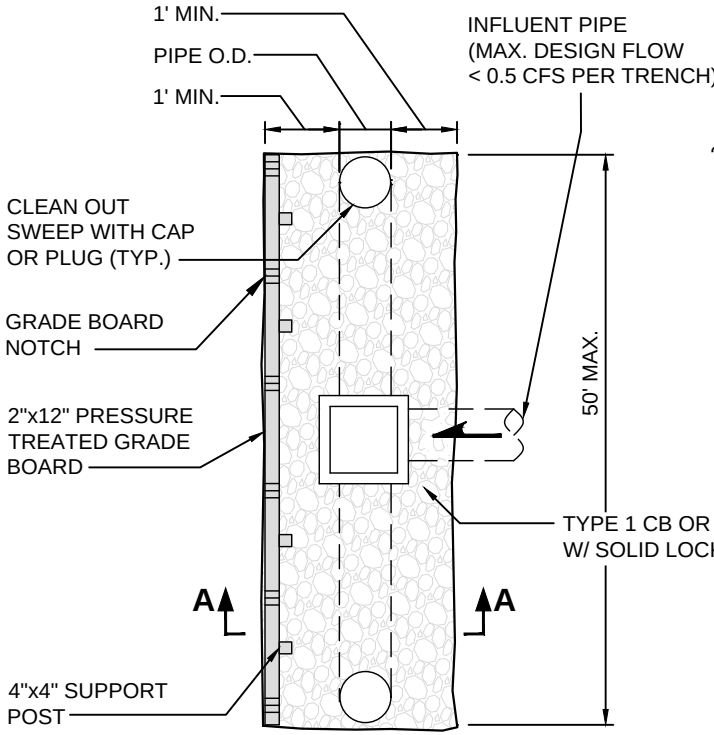
Change Order Review Form F-7

Change Order Review Form F-8

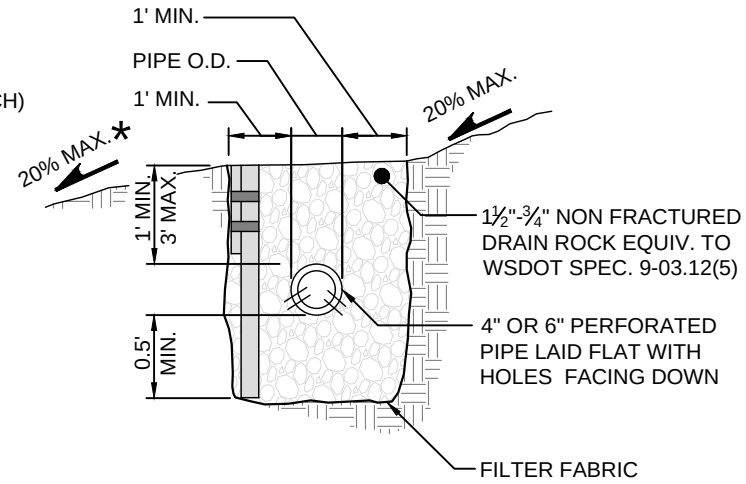
Section A - Quantity Design Details

Detail	Heading
1.0	Flow Dispersion Trench
2.0	Grass Buffer Infiltration Trench Schematic
3.0	Stormwater Infiltration Trench Section
4.0	Parking Lot Perimeter Trench Schematic
5.0	Infiltration Pond Schematic
5.1	Detention Pond Schematic
6.0	Quarry Spall and Gravel Filter Window
7.0	Emergency Overflow Spillway
8.0	Rock Outfall (Culvert Discharge Protection)
9.0	Gabion Outfall
10.0	*reserved for future use*
11.0	Infiltration Trench Sump Structure (Commercial)
11.1	Residential Roof Downspout System
12.0	Control Structure
12.1	Oil Pollution Control Device
13.0	Orifices – Baffle
14.0	Standard Pierce County Drywell Detail
15.0	Observation Well
16.0	Overflow Structure with Debris Cage
17.0	Debris Barrier 1 & 2
17.1	Debris Barrier 3
18.0	*reserved for future use*
19.0	Typical Detention Tank (dry/wet)
19.1	Typical Detention Vault (dry/wet)
19.2	Detention Tank/Vault Access Details
20.0	Pipe Anchor Details
21.0	Detention Pond Accesses Schematic
22.0	Catch Basin Stencil
23.0	Drywell and Trench Details
24.0	Chain Link Fence Type 1 (modified)
24.1	Chain Link Fence Type 3 (modified)
24.2	Chain Link Fence Type 6 (modified)
25.0	Crest Gage
26.0	Bioretention in Neighborhood Streets & Local Roads
26.1	Curb Cuts for Bioretention
26.2	Bioretention Overflow Structure
26.3	Through Curb Inlet
27.0	Pervious Concrete Roadway & Sidewalk(s)
27.1	Subsurface Permeable Pavement Check Dam

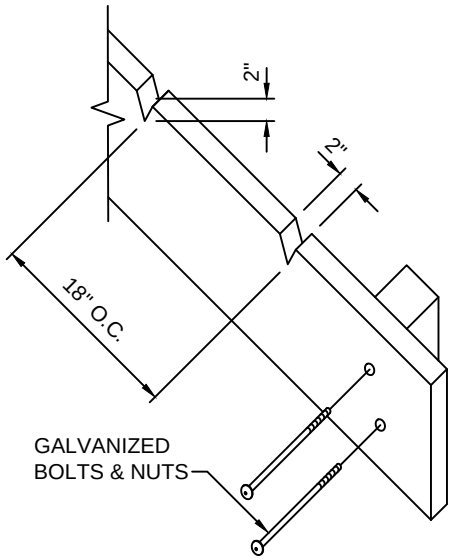
* 15% MAX. FOR FLOW CONTROL / WATER QUALITY TREATMENT



PLAN



SECTION A-A



GRADE BOARD WITH NOTCHES

NOTES:

1. THIS TRENCH SHALL BE CONSTRUCTED SO AS TO PREVENT POINT DISCHARGE AND/OR EROSION.
2. TRENCHES MAY BE PLACED NO CLOSER THAN 50 FEET TO ONE ANOTHER. (100 FEET ALONG FLOW LINE.)
3. TRENCH AND GRADE BOARD MUST BE LEVEL. ALIGN TO FOLLOW CONTOURS OF SITE.
4. GRADE BOARD SUPPORT POST SPACING AS REQUIRED BY SOIL CONDITIONS.
5. THE END OF EACH PIPE RUN SHALL HAVE AN ACCESSIBLE CLEAN OUT SWEEP. PIPE END SHOULD BE VISIBLE OR THE LOCATION STAKED.

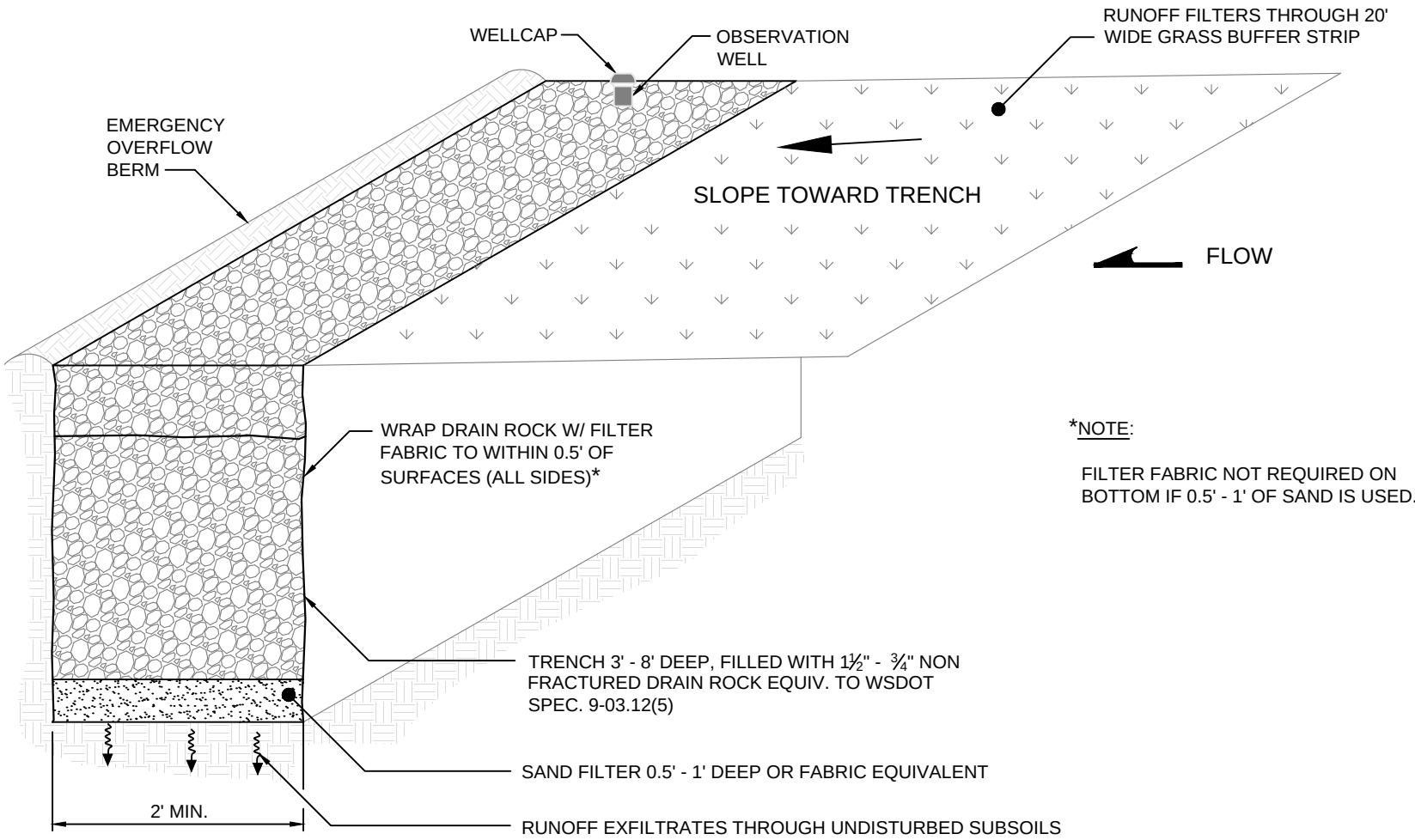
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

FLOW DISPERSION TRENCH

SECTION A - 1.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



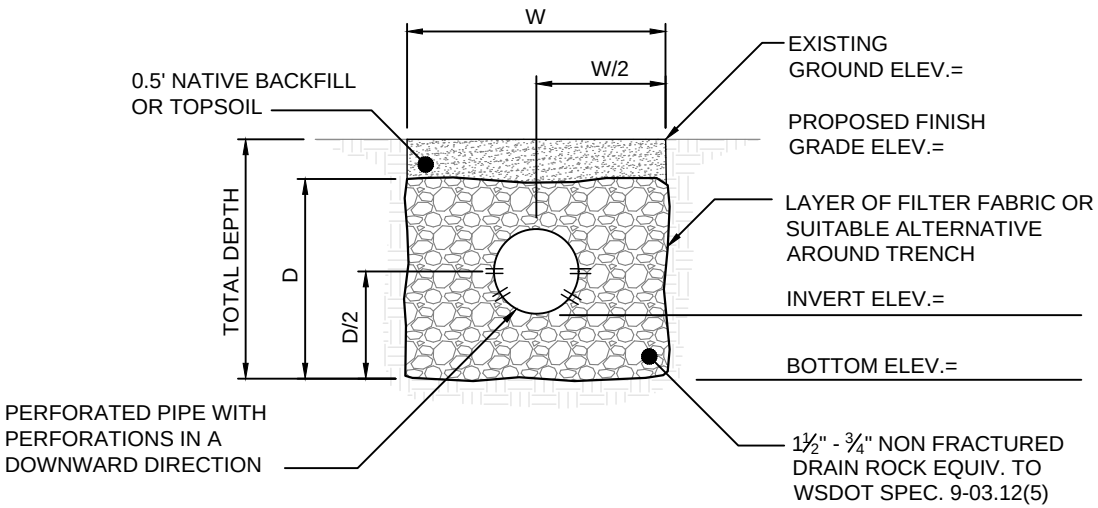
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Tacoma, Washington 98409

GRASS BUFFER INFILTRATION TRENCH

SECTION A - 2.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



TRENCH SECTION

NOTE:

PERFORATED CONCRETE UNDERDRAIN PIPE MEETING WSDOT SPECIFICATIONS CHAPTER 9-05.2 (2) MAY BE USED WITH THE ADDITIONAL CONDITIONS:

1. THE PERFORATIONS SHALL BE CIRCULAR AND A MINIMUM OF ½" DIAMETER.
2. THEY SHALL BE CLEANLY CUT AND BE SMOOTH AND UNIFORM WITH NO EXCESS CONCRETE LEFT FROM THE HOLE PERFORATIONS PROCESS.
3. THERE SHALL BE A MINIMUM OF 7 SETS OF PERFORATIONS WITH 2 HOLES PER SET OF PERFORATIONS FOR EACH 3.5' OF PIPE LENGTH.
4. RUBBER GASKETS OR GROUTING OF THE JOINTS FOR PERFORATED PIPE RUNS WILL NOT BE REQUIRED.
5. INSPECTION OF THE PERFORATED CONCRETE PIPE SHALL BE MADE BY THE MUNICIPALITY BEFORE INSTALLATION OF THE PIPE IN THE GROUND.

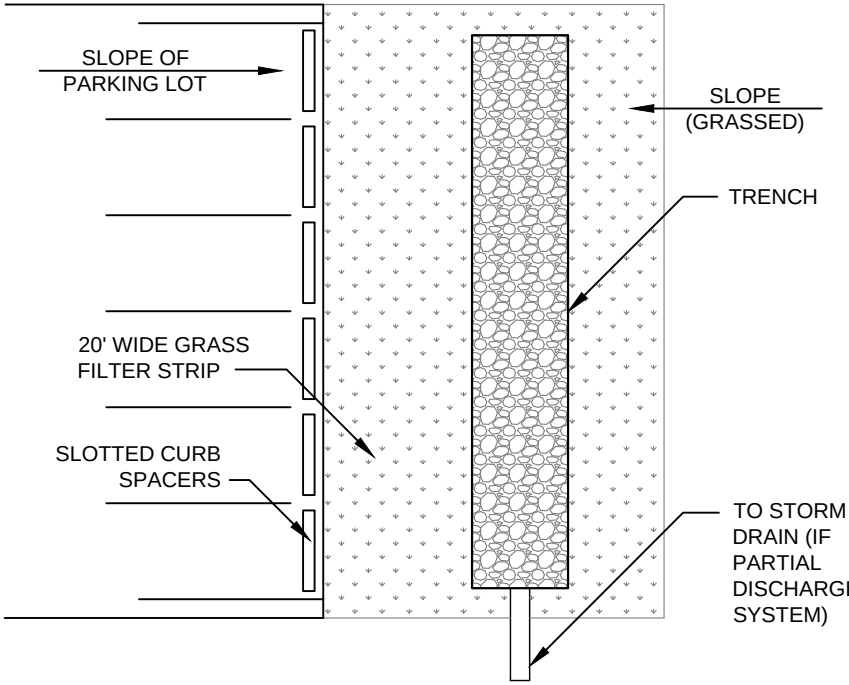
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STORMWATER INFILTRATION TRENCH

SECTION A - 3.0

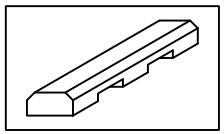
ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



PLAN

NOTE: REFER TO DETAIL A 2.0 FOR MORE DETAIL



NOTE: SLOTTED CURBS ACT AS A LEVEL SPREADER

SLOTTED CURB SPACER

*NOTE: SAND MAY BE USED IN-LIEU OF FILTER FABRIC ON BOTTOM.

SECTION

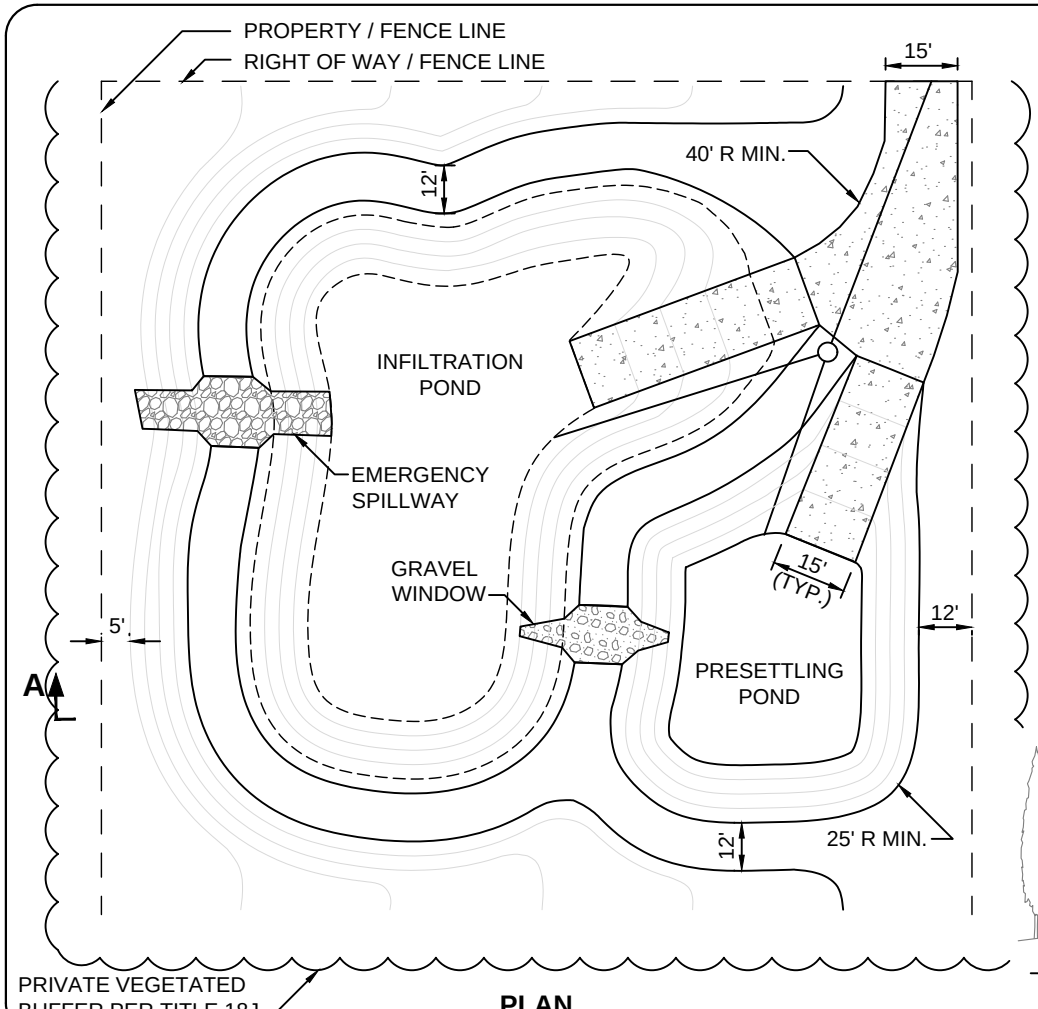
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Tacoma, Washington 98409

PARKING LOT PERIMETER TRENCH

SECTION A - 4.0

ORDINANCE: 2021-45

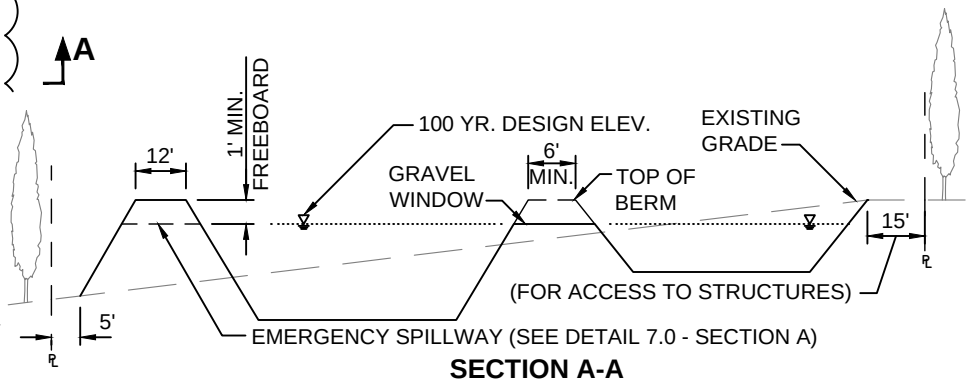
EFFECTIVE DATE: 7/1/2021



PLAN

NOTES:

1) ALL ACCESS ROADS TO PONDS, CONTROL STRUCTURES, AND CATCH BASINS SHALL BE 15' MIN. WIDTH WITH 40' MIN. RADIUS TURNS. THE ACCESS RAMPS SHALL EITHER BE PAVED WITH A 15% MAX. GRADE OR GRAVEL WITH A 12% MAX. GRADE.
2) ACCESS AROUND PONDS (NOT SERVICING A RAMP, CATCH BASIN, OR CONTROL STRUCTURE) SHALL BE 12' MIN. WIDTH WITH 25' MIN. RADIUS TURNS.
3) PROPERTY SHALL BE FENCED ON PROPERTY/TRACT LINES.
4) PRIVATE VEGETATED BUFFER SHALL BE PLANTED OUTSIDE OF PROPERTY LINES.
5) POND BOTTOMS MAY BE VEGETATED.
6) EMERGENCY OVERFLOW SHALL FLOW TO A DEFINED WATER COURSE OR APPROVED LOCATION.
7) DETAIL IS A SCHEMATIC REPRESENTATION ONLY. ACTUAL CONFIGURATION WILL VARY DEPENDING ON SPECIFIC SITE CONSTRAINTS AND APPLICABLE DESIGN CRITERIA, OTHER TYPES OF PRETREATMENT BMP'S MAY BE ACCEPTABLE.
8) WHERE ACCESS TO CONTROL STRUCTURE EXCEEDS 75 FEET A VEHICLE TURN AROUND MUST BE PROVIDED OR CONTINUOUS 15' WIDE PAVED LOOP AROUND PERIMETER ACCESS ROAD.



SECTION A-A

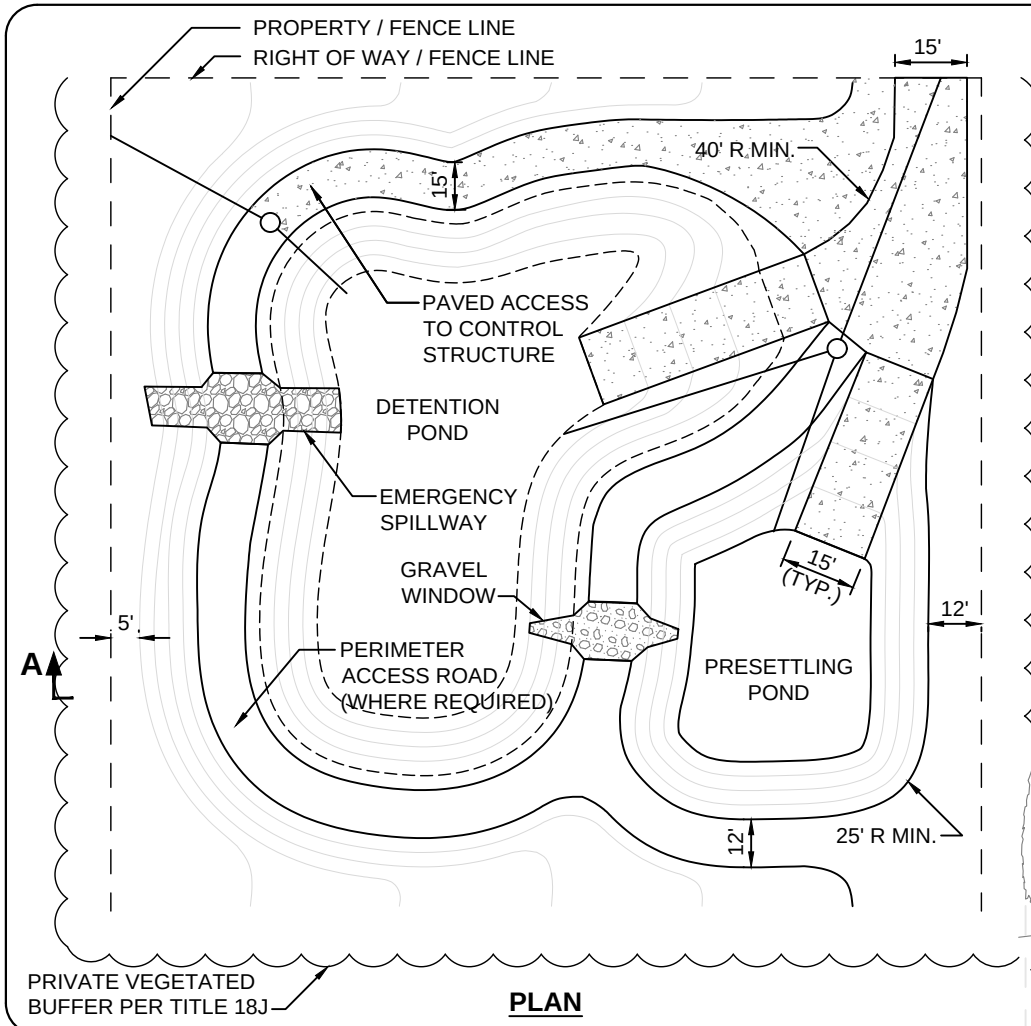
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INFILTRATION POND

SECTION A - 5.0

ORDINANCE: 2021-45

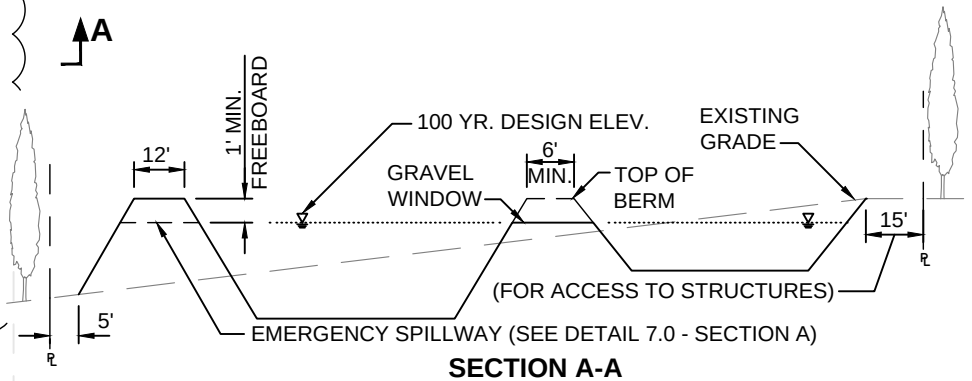
EFFECTIVE DATE: 7/1/2021



PLAN

NOTES:

1) ALL ACCESS ROADS TO PONDS, CONTROL STRUCTURES, AND CATCH BASINS SHALL BE 15' MIN. PAVED WIDTH WITH 40' MIN. RADIUS TURNS. THE ACCESS RAMPS SHALL EITHER BE PAVED WITH A 15% MAX. GRADE OR GRAVEL WITH A 12% MAX. GRADE.
2) ACCESS AROUND PONDS (NOT SERVICING A RAMP, CONTROL STRUCTURE, OR CATCH BASIN) SHALL BE 12' MIN. WIDTH WITH 25' MIN. RADIUS TURNS.
3) PROPERTY SHALL BE FENCED ON PROPERTY/TRACT LINES.
4) PRIVATE VEGETATED BUFFER SHALL BE PLANTED OUTSIDE OF PROPERTY LINES.
5) POND BOTTOMS MAY BE VEGETATED.
6) EMERGENCY OVERFLOW SHALL FLOW TO A DEFINED WATER COURSE OR APPROVED LOCATION.
7) DETAIL IS A SCHEMATIC REPRESENTATION ONLY. ACTUAL CONFIGURATION WILL VARY DEPENDING ON SPECIFIC SITE CONSTRAINTS AND APPLICABLE DESIGN CRITERIA, OTHER TYPES OF PRETREATMENT BMP'S MAY BE ACCEPTABLE.
8) WHERE ACCESS TO CONTROL STRUCTURE EXCEEDS 75 FEET A VEHICLE TURN AROUND MUST BE PROVIDED OR CONTINUOUS 15' WIDE PAVED LOOP AROUND PERIMETER ACCESS ROAD.



SECTION A-A

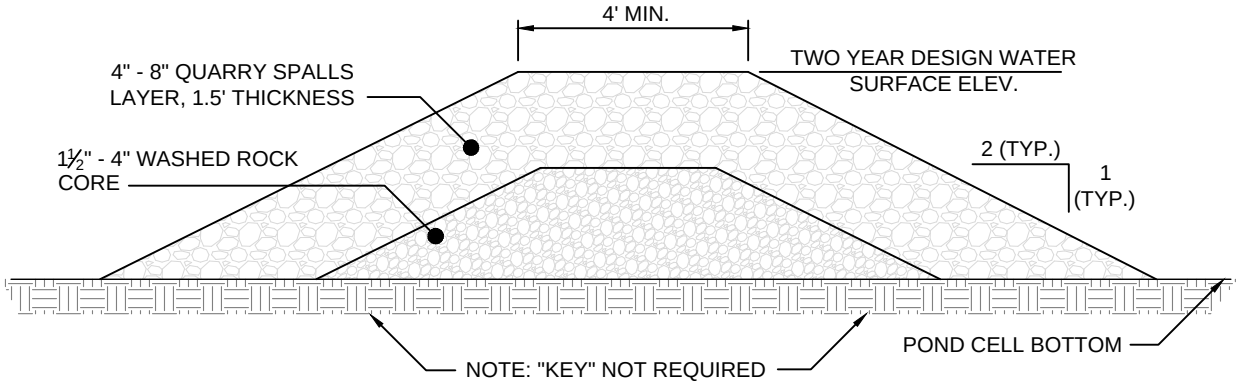
Pierce County
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Tacoma, Washington 98409

DETENTION POND

SECTION A - 5.1

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



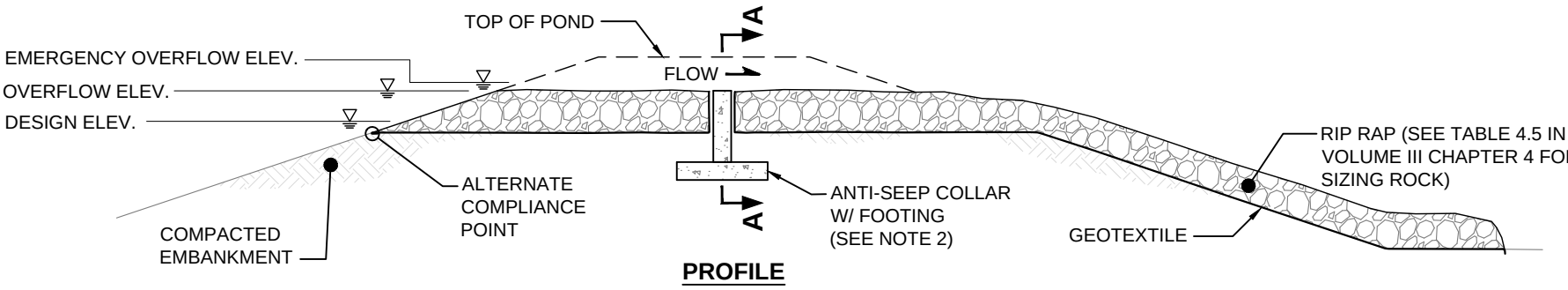
Pierce County
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QUARRY SPALL AND GRAVEL FILTER WINDOW

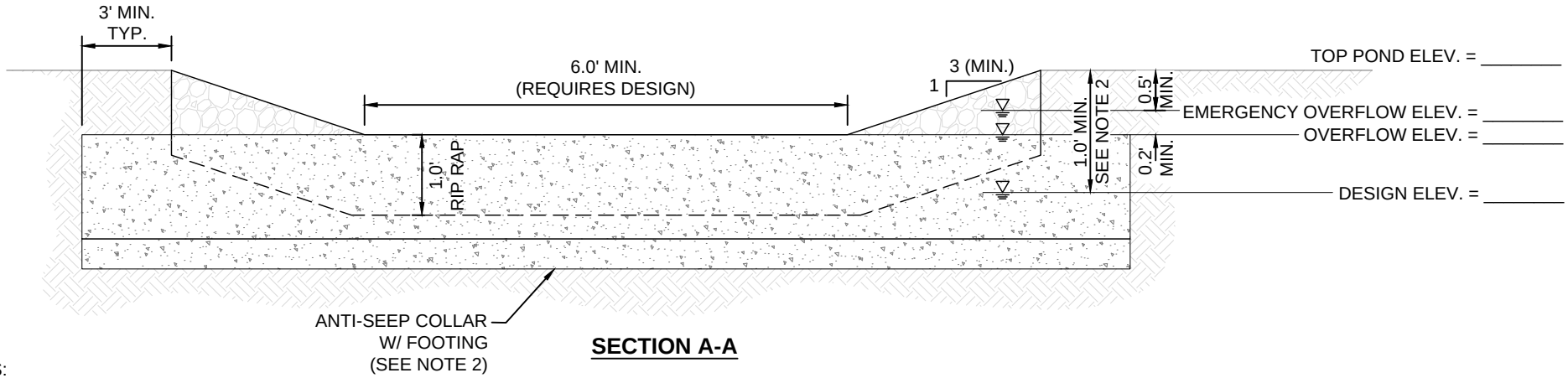
SECTION A - 6.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



PROFILE



SECTION A-A

NOTES:

1) THE EMERGENCY OVERFLOW SPILLWAY SHALL BE DESIGNED TO PASS THE 100-YEAR, DESIGN STORM EVENT FOR DEVELOPED CONDITIONS SEE EQUATION AT VOLUME III CHAPTER 3. SPILLWAY SHOULD ONLY HAVE FLOW WHEN A COMPONENT OF THE CONTROL STRUCTURE HAS FAILED OR A STORM GREATER THAN THE DESIGN STORM HAS OCCURRED.

2) SPILLWAY SHALL HAVE AN ANTI-SEEP COLLAR TO HOLD OVERFLOW WATER SURFACE ELEVATION OR THE OVERFLOW WATER SURFACE ELEVATION SHALL BE BELOW THE ALTERNATE COMPLIANCE POINT. ENGINEER WILL DESIGN THE ANTI-SEEP COLLAR AND PROVIDE RE-BAR LAYOUT IN ADDITIONAL DETAIL.

3) A CONCRETE LINED SPILLWAY IS AN ACCEPTABLE ALTERNATIVE TO AN ANTI-SEEP COLLAR.

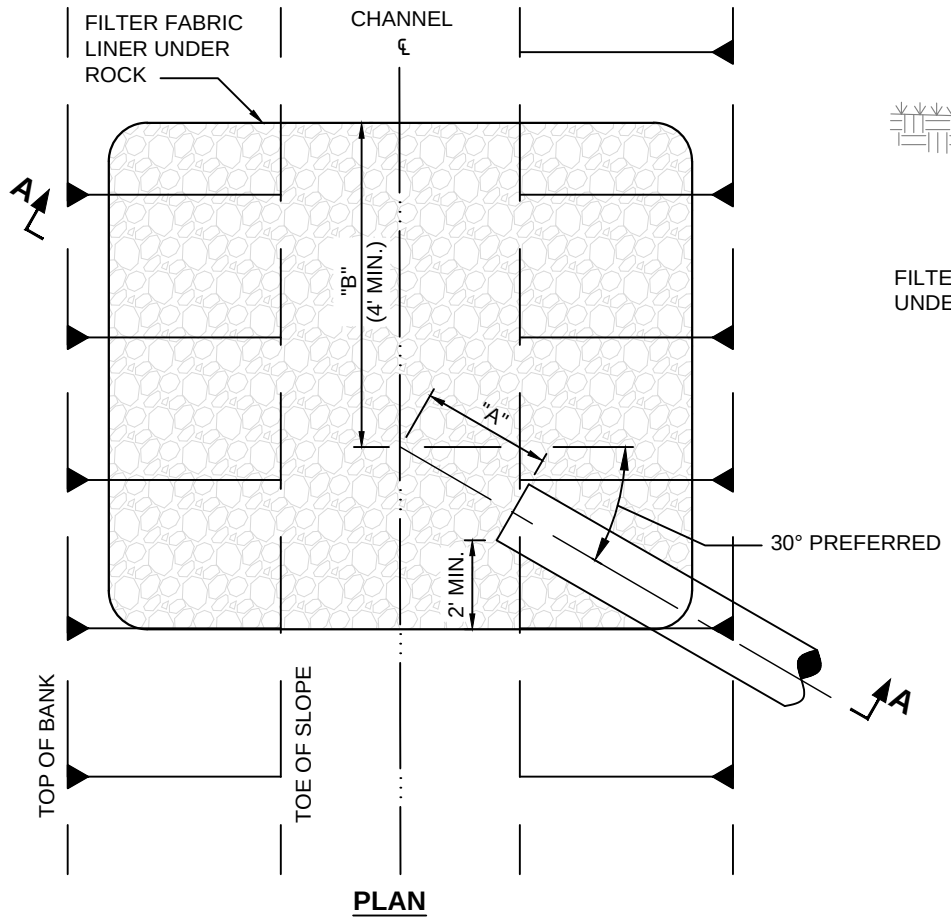
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EMERGENCY OVERFLOW SPILLWAY

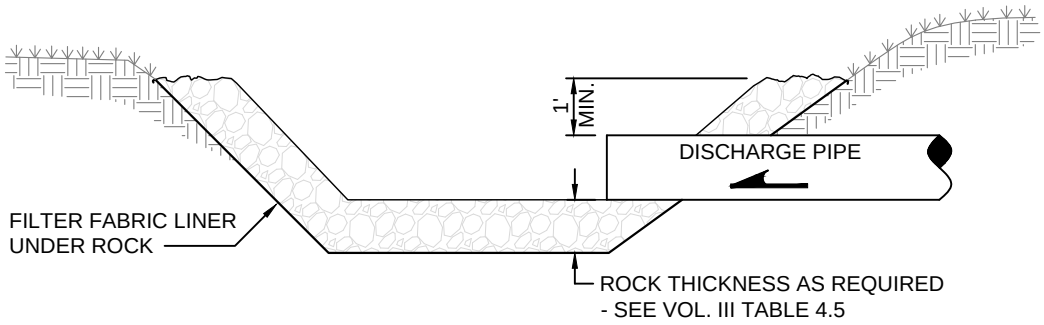
SECTION A - 7.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



PLAN



SECTION A-A

NOTES:

1. BASED ON DISCHARGE VELOCITIES FROM VOL. V TABLE 4.5. DIMENSIONS "A+B" WILL BE A MIN. OF 8' FOR ROCK LINING AND A MIN. OF 12' FOR RIP RAP.
2. IF DISTANCE "A" IS GREATER THAN 8' FOR ROCK LINING AND 12' FOR RIP RAP THEN ARMORING IS REQUIRED ONLY ON THE DISCHARGE SIDE OF THE CHANNEL.

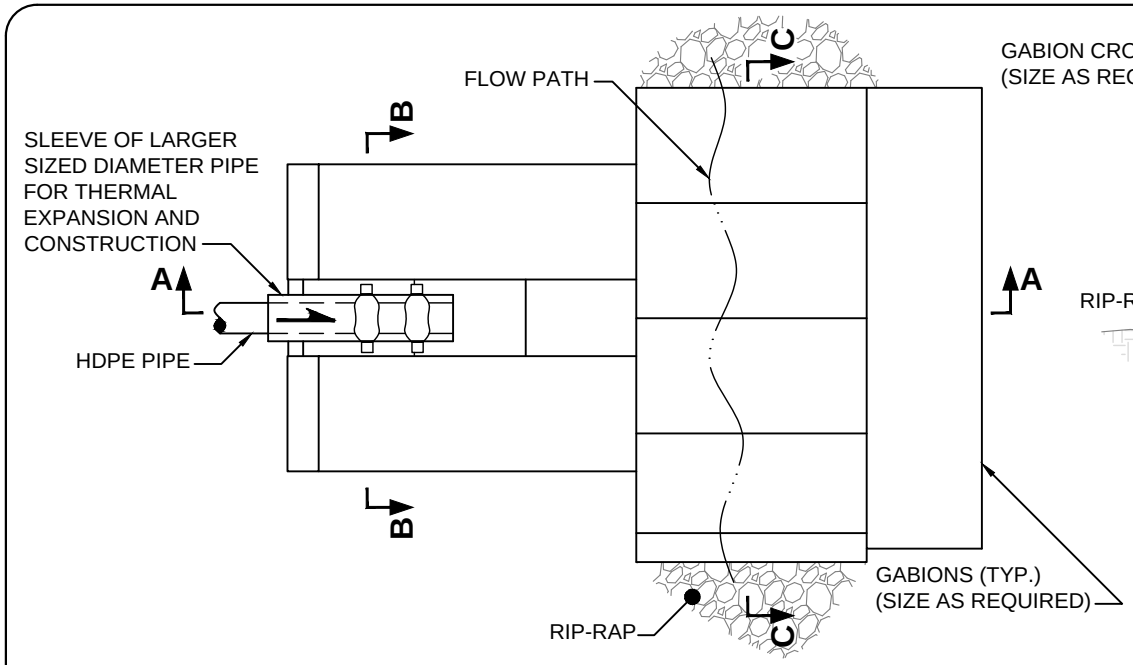
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ROCK OUTFALL
(CULVERT DISCHARGE PROTECTION)

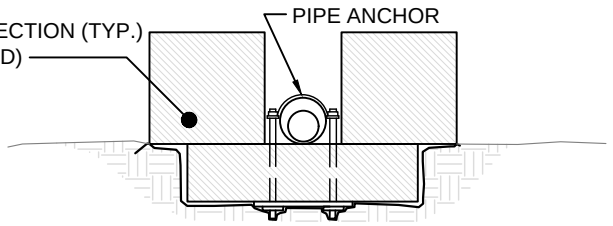
SECTION A - 8.0

ORDINANCE: 2021-45

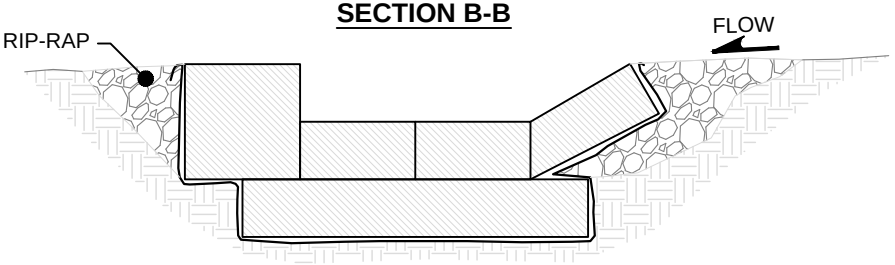
EFFECTIVE DATE: 7/1/2021



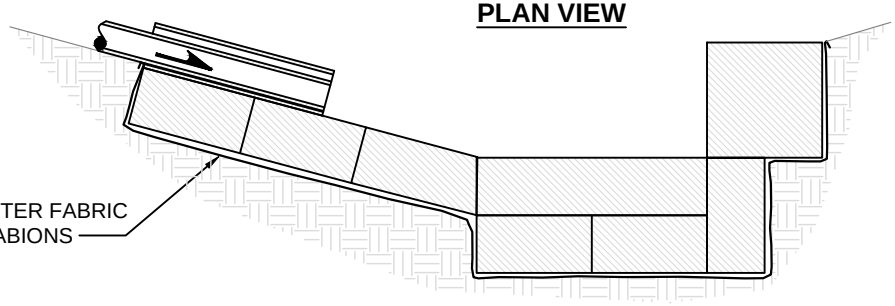
PLAN VIEW



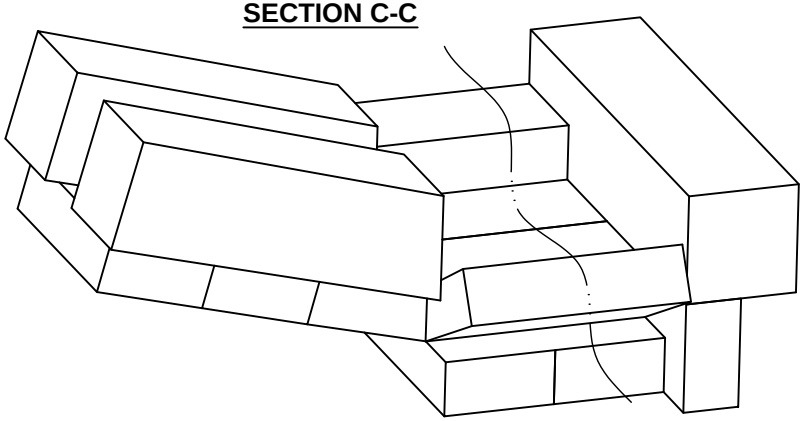
SECTION B-B



SECTION C-C



SECTION A-A



ISOMETRIC VIEW

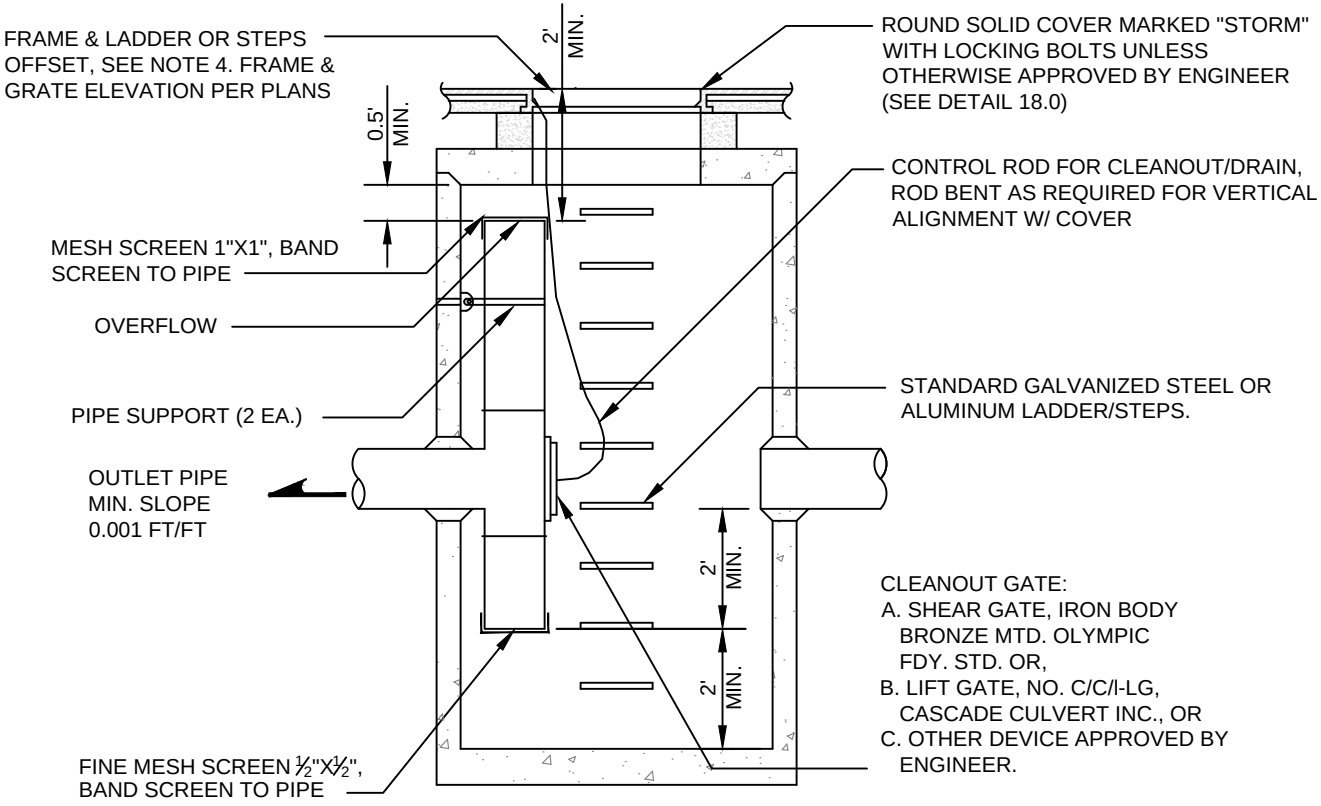
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Tacoma, Washington 98409

GABION OUTFALL

SECTION A - 9.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



PLAN VIEW

NOTES:

1. PIPE SIZED & SLOPES, PER PLANS.
2. OUTLET CAPACITY NOT LESS THAN COMBINED INLETS.
3. METAL PARTS:
   A. CORROSION RESISTANT OR GALVANIZED OR ALLUMINUM TYPE 2.
   B. IF GALVANIZED STEEL PIPE, HAVE ASPHALT TREATMENT 1.
4. FRAME & LADDER OR STEPS OFFSET SO:
   A. CLEANOUT GATE IS VISIBLE FROM TOP.
   B. CLIMB DOWN SPACE IS CLEAR OF RISER & CLEANOUT GATE.
   C. FRAME IS CLEAR OF CURB.
5. STRUCTURE SHALL BE A TYPE 2 CATCH BASIN 4.5 DIAM. MIN.

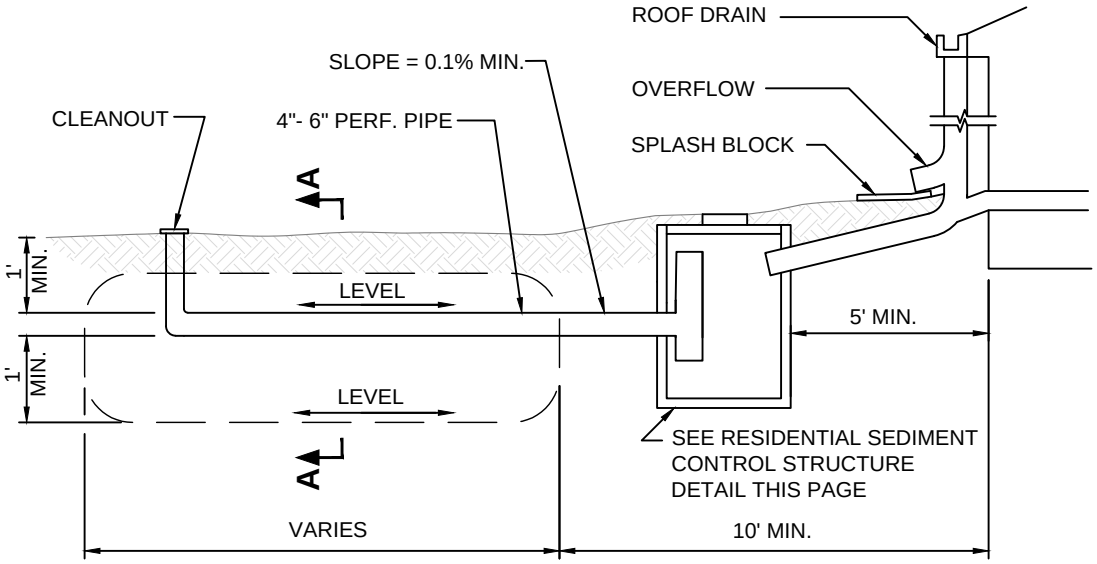
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INFILTRATION TRENCH SUMP STRUCTURE (COMMERCIAL)

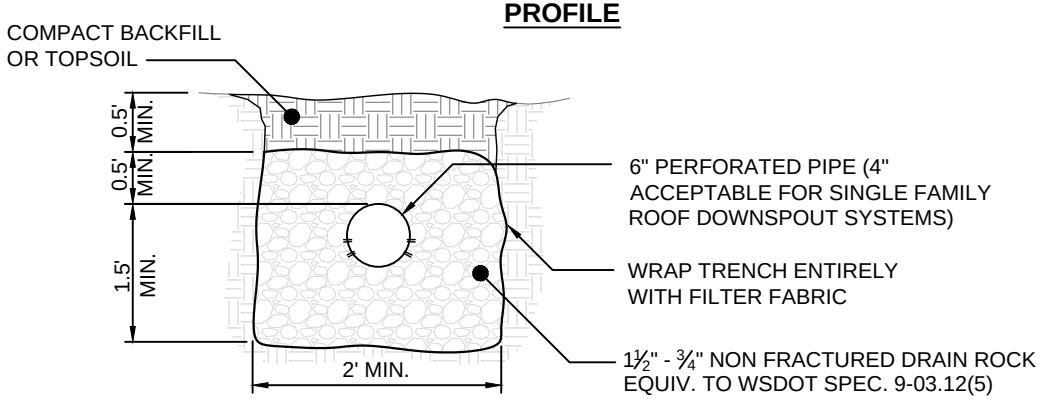
SECTION A - 11.0

ORDINANCE: 2021-45

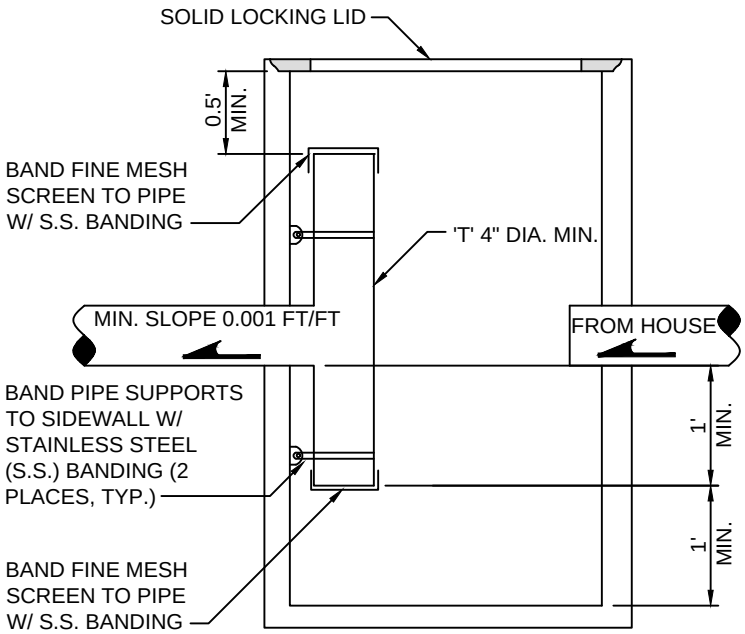
EFFECTIVE DATE: 7/1/2021



PROFILE



SECTION A-A



RESIDENTIAL SEDIMENT CONTROL STRUCTURE

NOTE:

SEE TABLE 3.5 IN VOLUME III FOR TRENCH LENGTH.

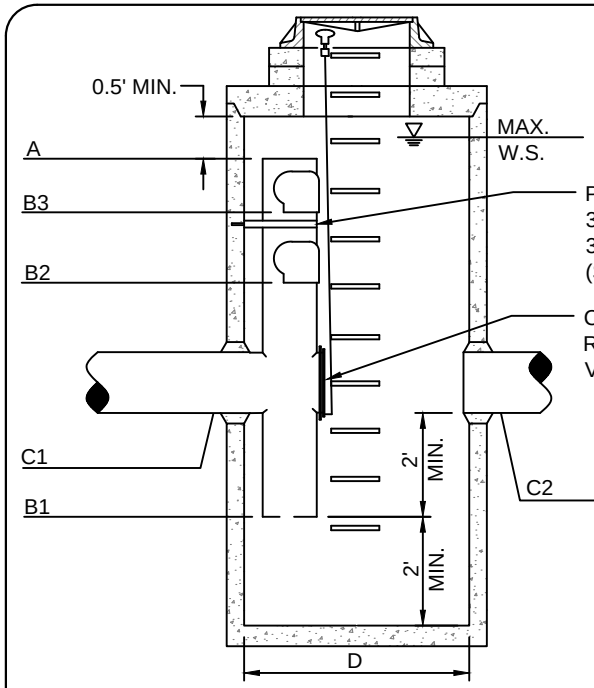
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RESIDENTIAL ROOF DOWNSPOUT SYSTEM

SECTION A - 11.1

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

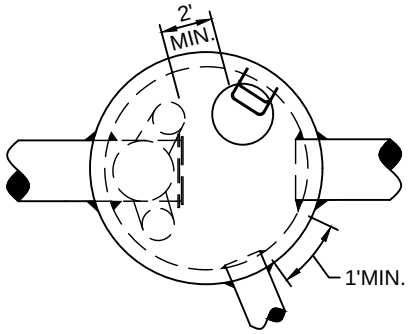


SECTION

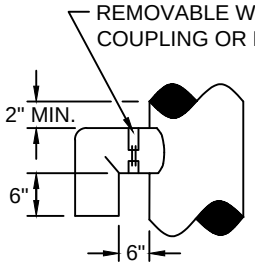
A = PIPE DIAM.
B1 = BOTTOM ORIFICE
B2 = MIDDLE ORIFICE
B3 = TOP ORIFICE
C1 = CB OUTLET I.E.
C2 = CB INLET I.E.

PIPE SUPPORT:
3" x 0.075" ALUMINUM, OR
3" x 0.079" STEEL
(SEE NOTE 8)

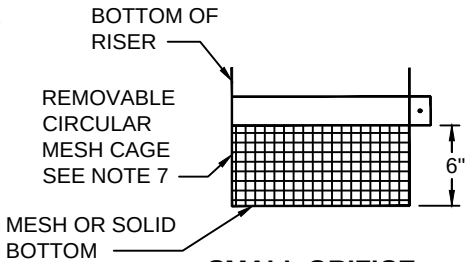
CLEAN-OUT GATE W/ CONTROL ROD. ROD BENT AS REQUIRED FOR VERTICAL ALIGNMENT W/ COVER



TOP VIEW



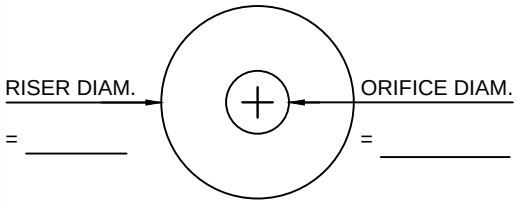
ORIFICE DETAIL



SMALL ORIFICE SCREEN DETAIL

NOTES:

1. CATCH BASIN TYPE 2 WITH FLOW RESTRICTOR AND OIL POLLUTION CONTROL DEVICE.
2. PROVIDE ACCESS TO BOTTOM WITH LADDER AND CLEARANCE.
3. THE EMERGENCY OVERFLOW SPILLWAY ELEVATION SHALL BE EQUAL OR HIGHER THAN MAX W.S. ELEV. SEE EMERGENCY OVERFLOW SPILLWAY DETAIL 7.0.
4. MAX W.S. ELEV. SHALL EQUAL 100 YEAR DESIGN FLOW.
5. LADDER / STEPS SHALL BE 1" Ø GALVANIZED STEEL OR THERMO PLASTIC EXTRUDED.
6. ORIFICE DIAMETER 0.5' MIN.
7. PROVIDE MESH CAGE PROTECTION FOR ORIFICE IF LESS THAN ½" DIAMETER. BOLT REMOVABLE MESH CAGE TO RISER WITH ATTACHED BOLT-ON BANDED COUPLING. CAGE TO BE MADE WITH ¼" MESH SCREEN IN ALUMINUM OR STAINLESS STEEL.
8. THE PIPE SUPPORTS AND THE FLOW RESTRICTOR SHALL BE CONSTRUCTED OF THE SAME MATERIAL AND BE ANCHORED AT A MAX. SPACING OF 36". ATTACH THE PIPE SUPPORTS TO THE MANHOLE WITH 5/8" STAINLESS STEEL EXPANSION BOLTS OR EMBED THE SUPPORTS INTO THE MANHOLE WALL 2".



RESTRICTOR PLATE (B1) DETAIL

CONTROL STRUCTURE DETAIL TABLE

LOCATION	A OVERFLOW		B1		B2		B3		C1		C2		D (IN.)	MAX. WS ELEV. NOTE 4	EMER OVER FLOW NOTE 3
	ELEV.	DIAM.	ELEV.	DIAM.	ELEV.	DIAM.	ELEV.	DIAM.	ELEV.	DIAM.	ELEV.	DIAM.			

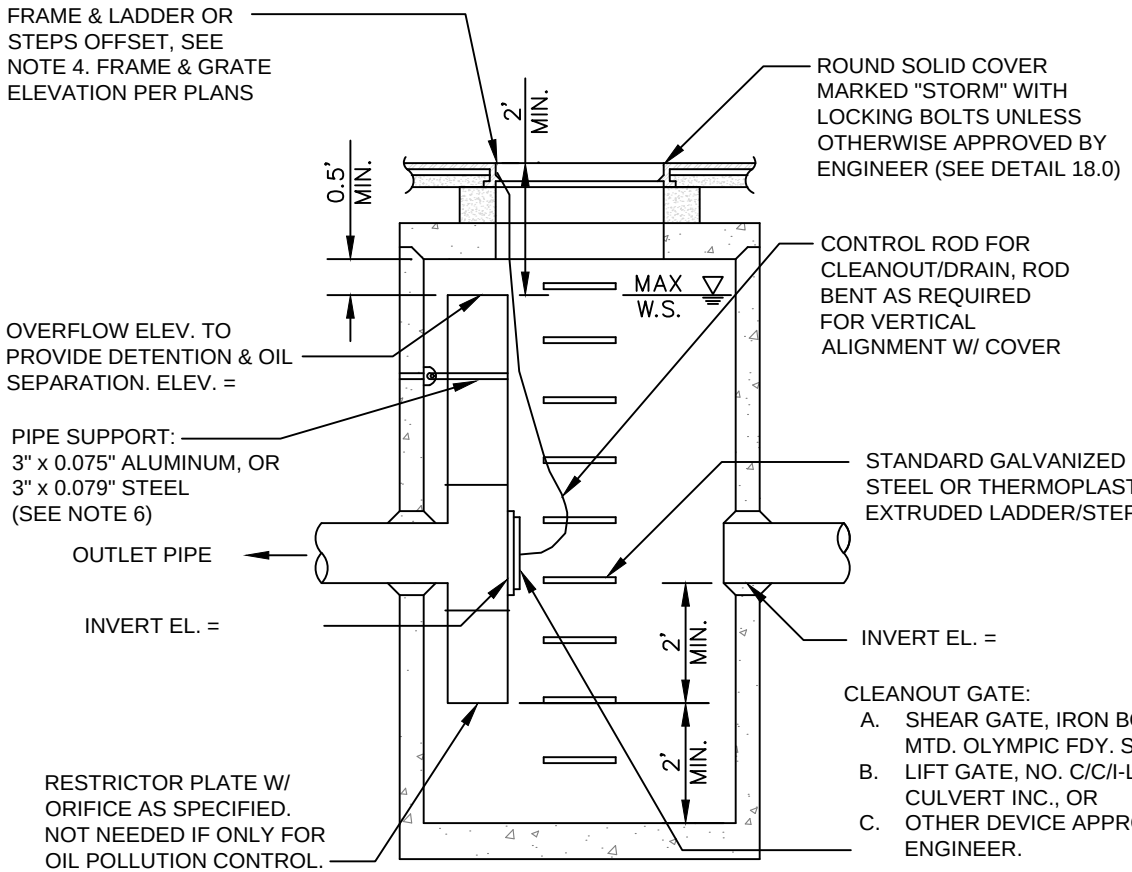
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CONTROL STRUCTURE

SECTION A - 12.0

ORDINANCE: 2021-45

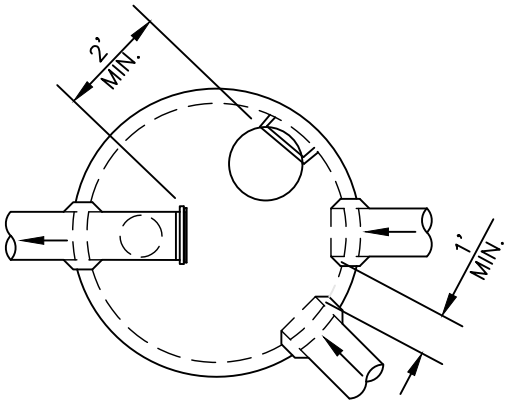
EFFECTIVE DATE: 7/1/2021



PLAN VIEW

NOTES:

1. PIPE SIZES & SLOPES, PER PLAN
2. OUTLET CAPACITY NOT LESS THAN COMBINED INLETS.
3. METALS PARTS:
   A. CORROSION RESISTANT OR GALVANIZED OR ALUMINUM TYPE 2
   B. IF GALVANIZED STEEL PIPE, HAVE ASPHALT TREATMENT 1.
4. FRAME & LADDER OR STEPS OFFSET SO:
   A. CLEANOUT GATE IS VISIBLE FROM TOP.
   B. CLIMBDOWN SPACE IS CLEAR OF RISER & CLEANOUT GATE.
   C. FRAME IS CLEAR OF CURB.
5. STRUCTURE SHALL BE A TYPE 2 CATCH BASIN 54" MINIMUM DIAMETER.
6. THE PIPE SUPPORTS AND THE FLOW RESTRICTOR SHALL BE CONSTRUCTED OF THE SAME MATERIAL AND BE ANCHORED AT A MAX. SPACING OF 36". ATTACH THE PIPE SUPPORTS TO THE MANHOLE WITH 5/8" STAINLESS STEEL EXPANSION BOLTS OR EMBED THE SUPPORTS INTO THE MANHOLE WALL 2".



TOP VIEW

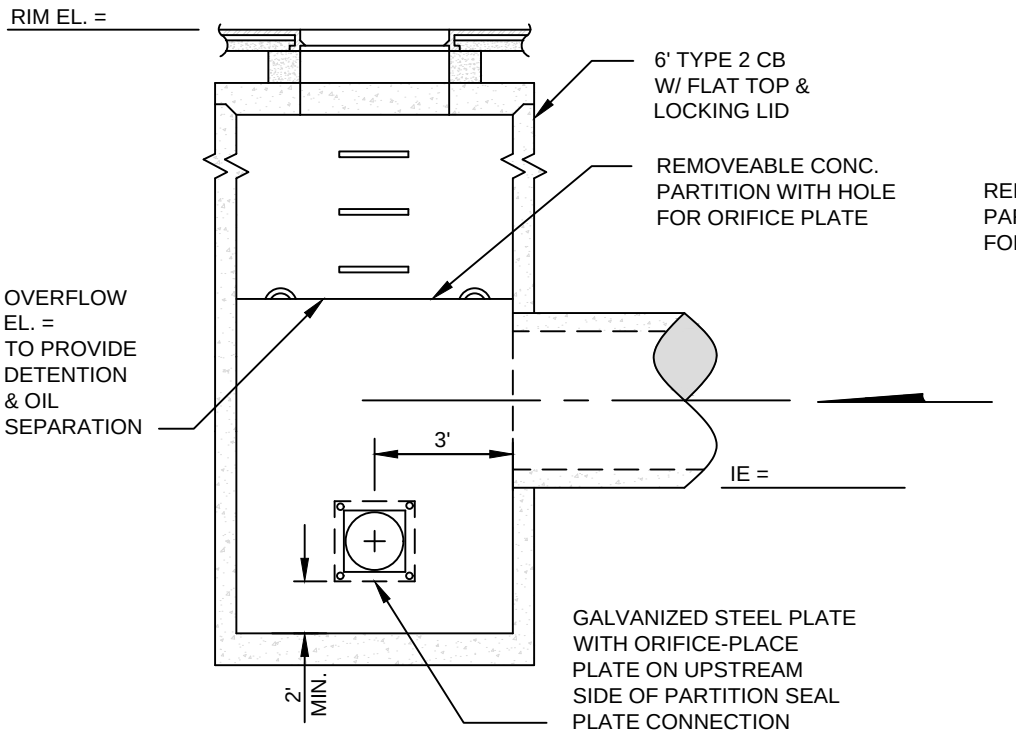
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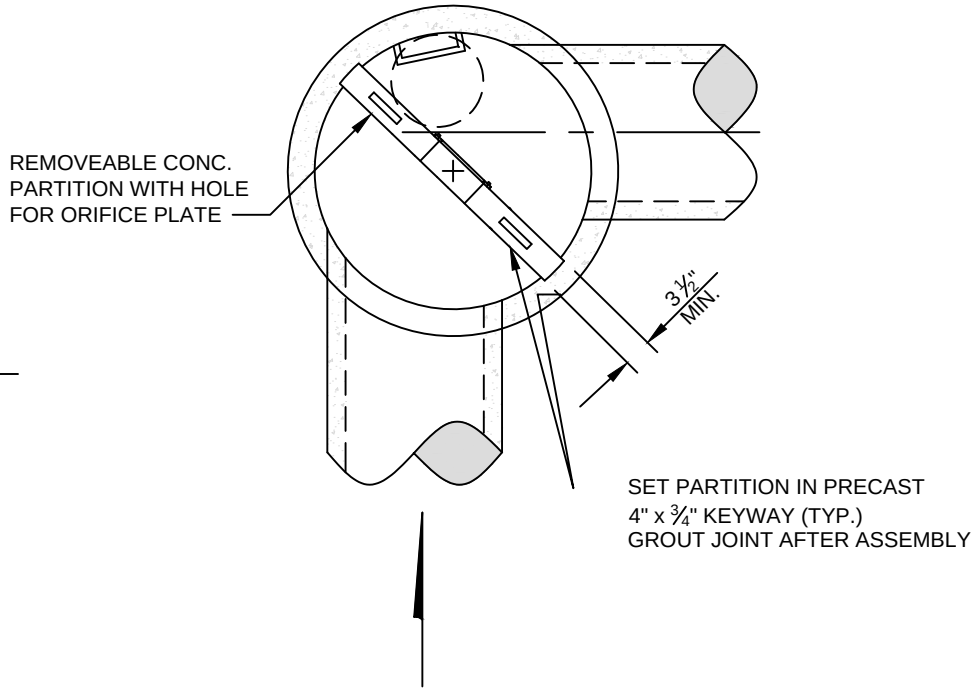
OIL POLLUTION CONTROL DEVICE

SECTION A - 12.1

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021





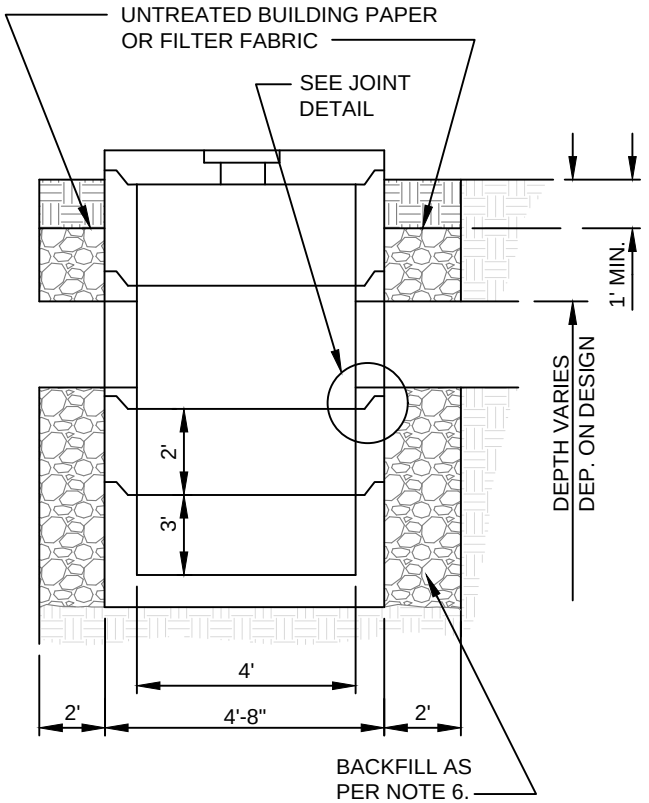
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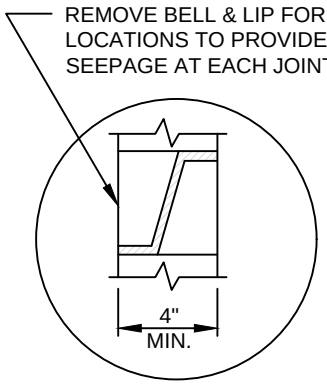
ORIFICES - BAFFLE

SECTION A - 13.0

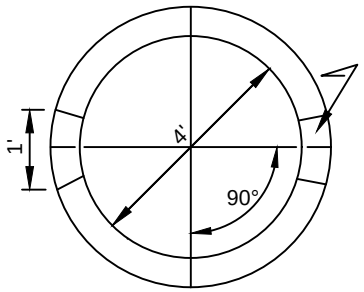
ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



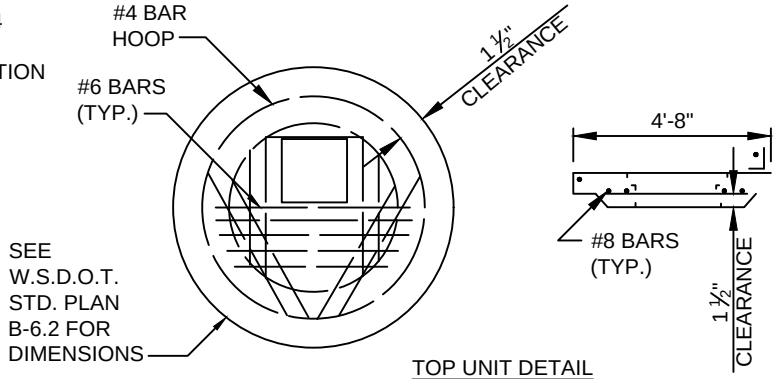


JOINT DETAIL



PLAN OF RING SECTION

REMOVE 1' SECTION OF JOINT ON EACH RING AT FOUR LOCATIONS AS SHOWN (SEE JOINT DETAIL)



TOP UNIT DETAIL

NOTES:

1. DRYWELL IS A TYPE II CATCH BASIN & MODIFIED AS SHOWN.
2. DRYWELL TO BE BUILT IN 1' OR 2' SECTIONS ONLY. EXCEPT FOR BASE WHICH SHALL BE A 3' SECTION.
3. BASE SECTION TO BE PLACED ON STABLE GROUND.
4. EACH DRYWELL SYSTEM SHALL HAVE AN OVERFLOW SYSTEM. SIZE TO BE DEPENDENT ON DESIGN CALCULATIONS.
5. TOP UNIT SHALL MEET W.S.D.O.T. SPEC. FOR A TYPE 2 CATCH BASIN.
6. BACKFILL SHALL BE ¾" - 2½" WASHED GRAVEL. MATERIAL PASSING THE #40 SIEVE SHALL NOT EXCEED 2% BY WEIGHT.
7. IF DRYWELL SYSTEM USES PIPES, SEE DETAIL A 3.0.

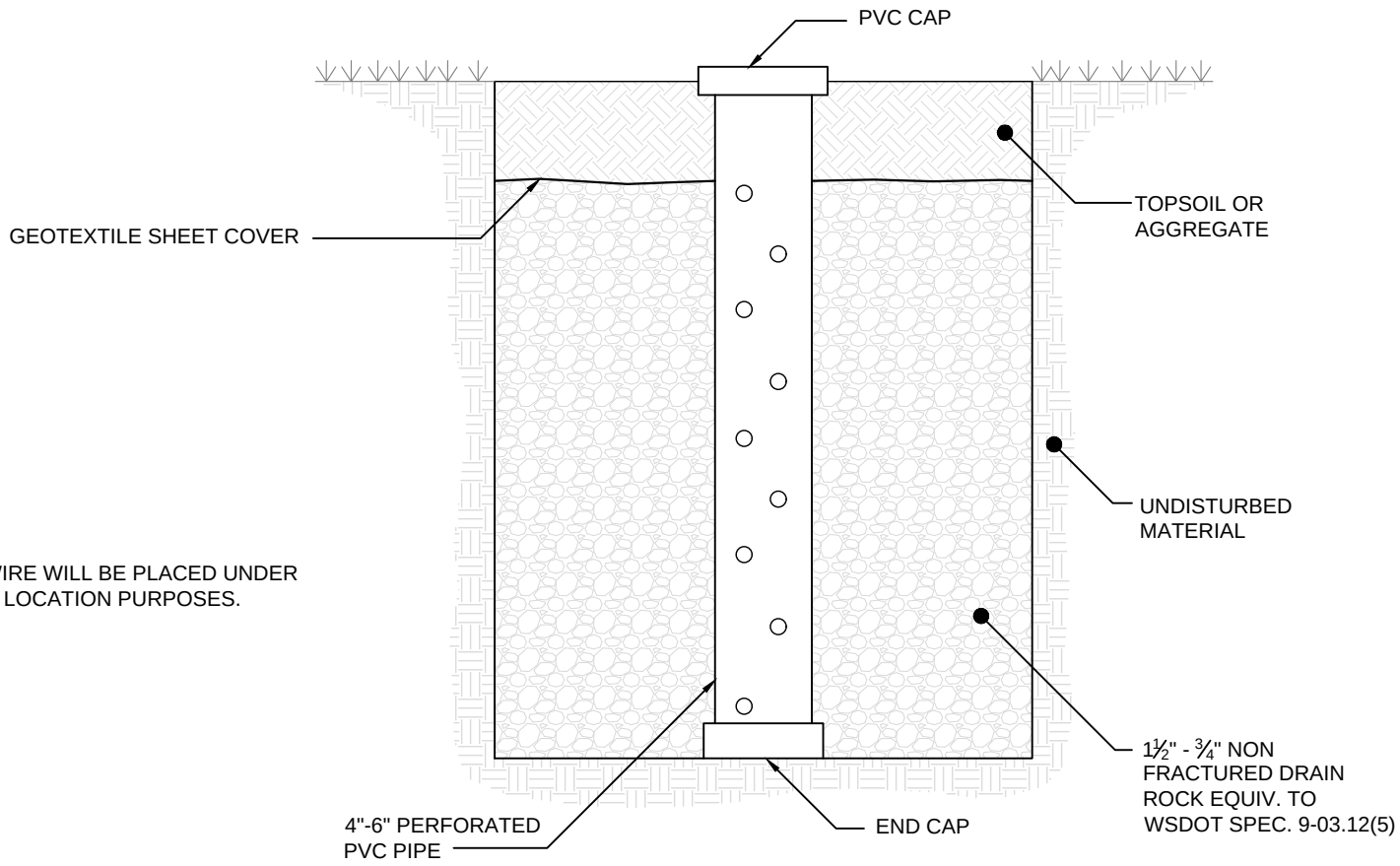
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DOWNSPOUT INFILTRATION DRYWELL SYSTEM

SECTION A - 14.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



NOTE:

TRACE WIRE WILL BE PLACED UNDER CAP FOR LOCATION PURPOSES.

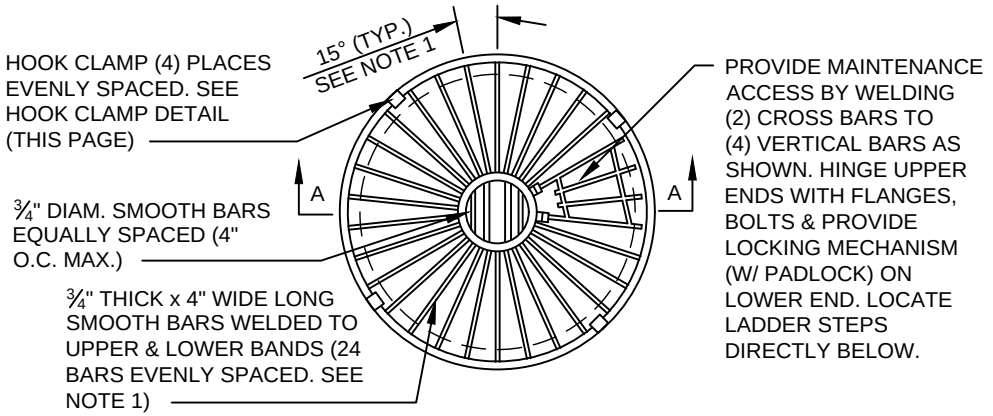
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OBSERVATION WELL

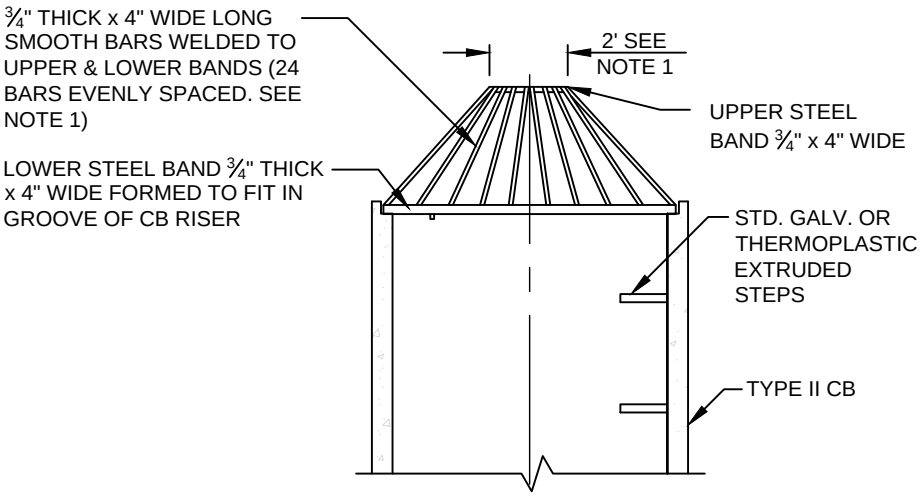
SECTION A - 15.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



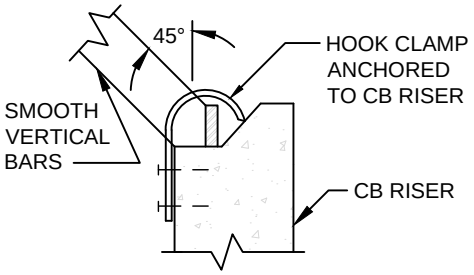
PLAN VIEW
N.T.S.



SECTION A-A
N.T.S.

NOTES:

1. DIMENSIONS ARE FOR INSTALLATION ON 54" DIAM. CB. FOR DIFFERENT DIAM. CB'S ADJUST DIMENSIONS TO MAINTAIN 45° ANGLE ON "VERTICAL" BARS & 4" O.C. MAX. SPACING OF BARS AROUND LOWER STELL BAND. WHEN VERITCAL BAR SPACING EXCEEDS 4" O.C., PROVIDE HORIZONTAL RINGS 4" O.C.
2. METAL PARTS: CORROSION RESISTANT (STEEL PARTS GALVANIZED OR STAINLESS STEEL).
3. THIS DEBRIS BARRIER IS ALSO RECOMMENDED FOR USE ON THE INLET TO ROADWAY CROSS-CULVERTS WITH HIGH POTENTIAL FOR DEBRIS COLLECTION (EXCEPT ON CLASS 2 STREAMS).



DETAIL HOOK CLAMP
N.T.S.

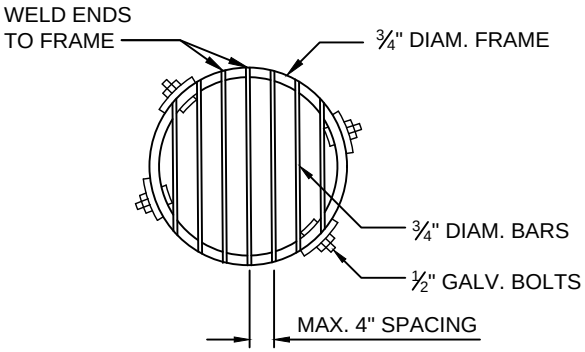
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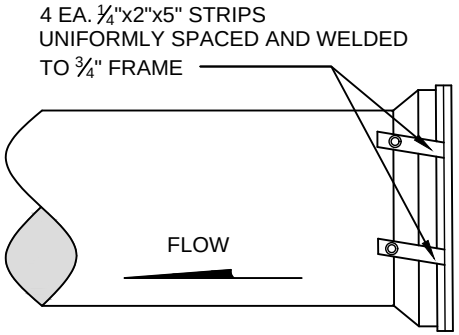
OVERFLOW STRUCTURE WITH DEBRIS CAGE

SECTION A - 16.0

ORDINANCE: 2021-45

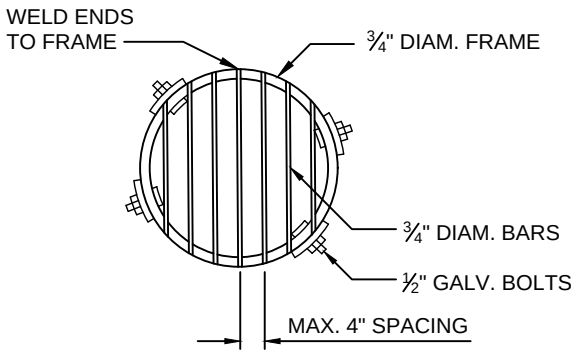
EFFECTIVE DATE: 7/1/2021

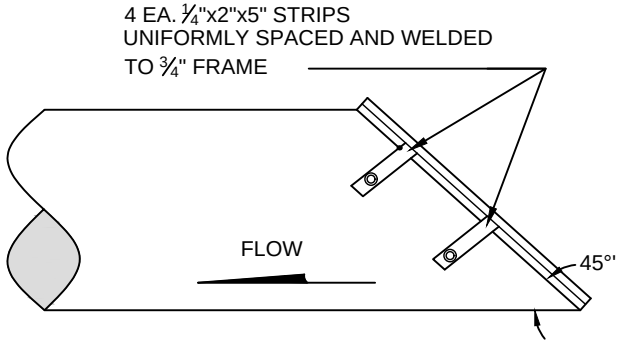




NOTE: ALL STEEL PARTS TO BE GALVANIZED AND ASPHALT COATED (TREATMENT 1 OR BETTER).

DEBRIS BARRIER 1 (90°)





NOTE: ALL STEEL PARTS TO BE GALVANIZED AND ASPHALT COATED (TREATMENT 1 OR BETTER).

DEBRIS BARRIER 2 (45°)

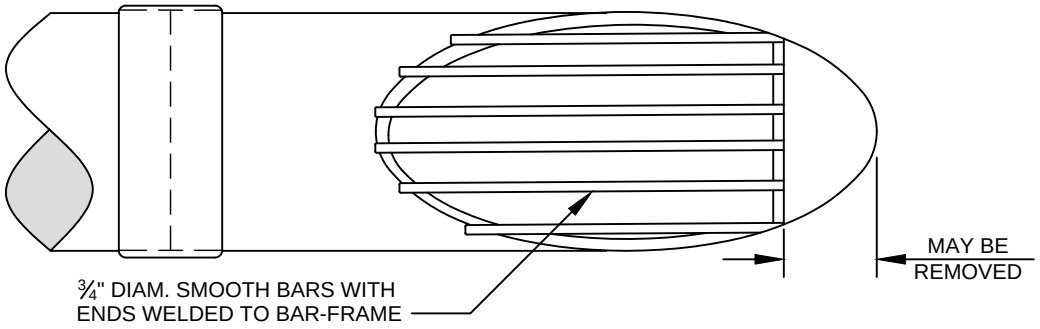
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Planning and Public Works
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DEBRIS BARRIER 1 & 2

SECTION A - 17.0

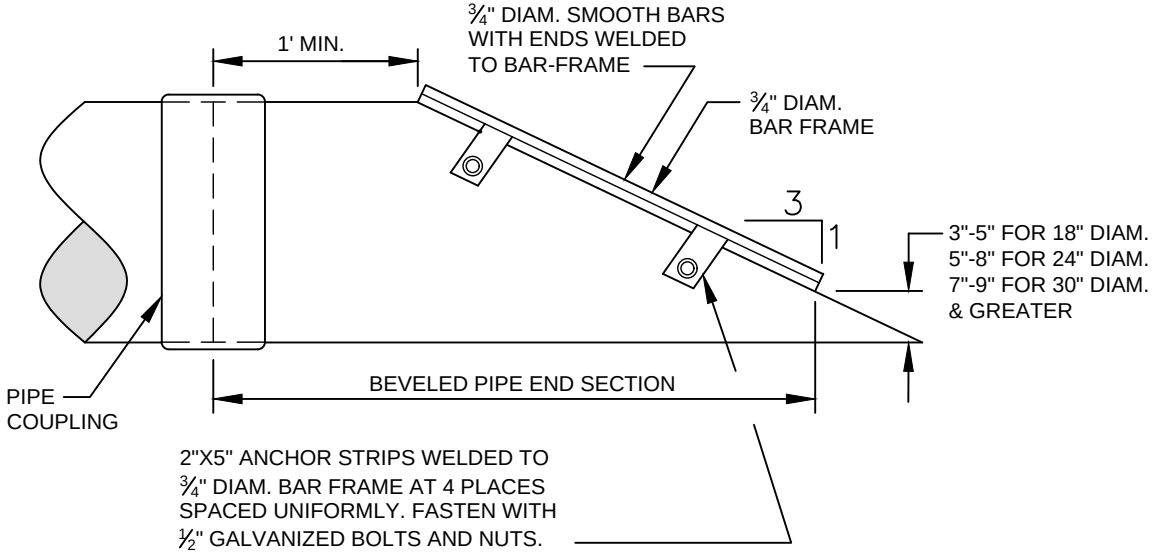
ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

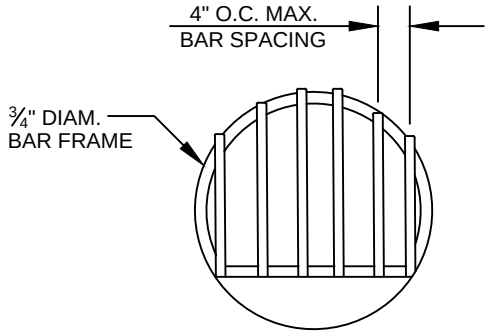


NOTES:

1. CPEP -- SMOOTH INTERIOR PIPE REQUIRES BOLTS TO SECURE DEBRIS BARRIER TO PIPE.
2. ALL STEEL PARTS TO BE GALVANIZED AND ASPHALT COATED (TREATMENT 1 OR BETTER).



NOTE: END-SECTION SHOWN



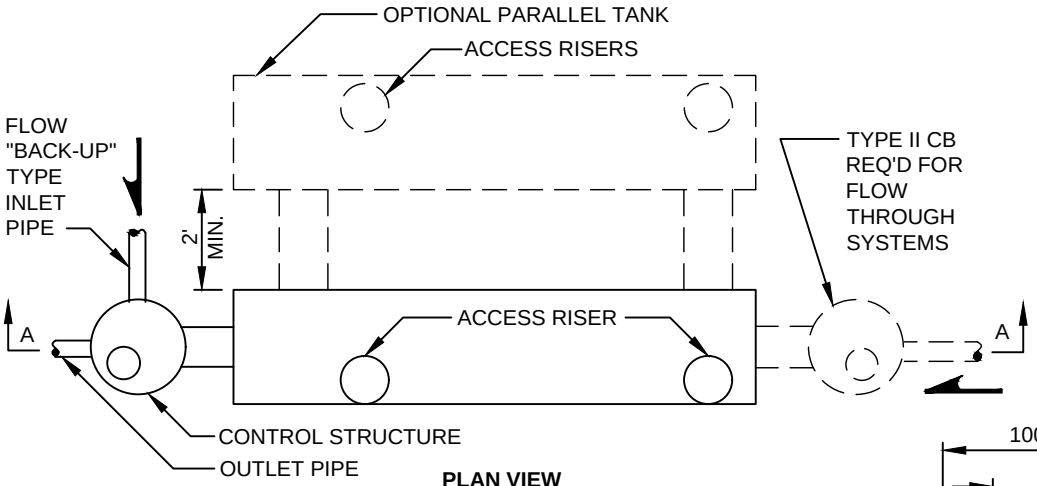
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Planning and Public Works
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Tacoma, Washington 98409

DEBRIS BARRIER 3

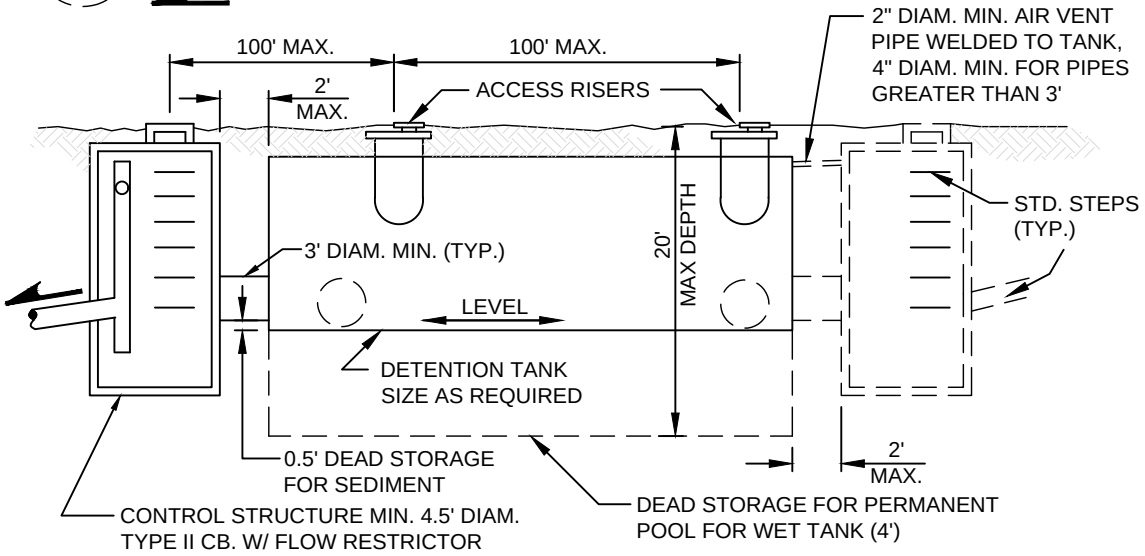
SECTION A - 17.1

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



PLAN VIEW



SECTION A-A

NOTES:

1. ALL METAL PARTS CORROSION RESISTANT. STEEL PART GALV. & ASPH. COATED. (TREATMENT 1 OR BETTER)
2. TANK MUST MEET TRAFFIC LOADING PER PCC TITLE 17B.
3. SEE DETAIL "A 12.0 - CONTROL STRUCTURE" FOR MORE DETAIL
4. SEE DETAIL "A 19.2 - DETENTION TANK/ VAULT ACCESS DETAILS"

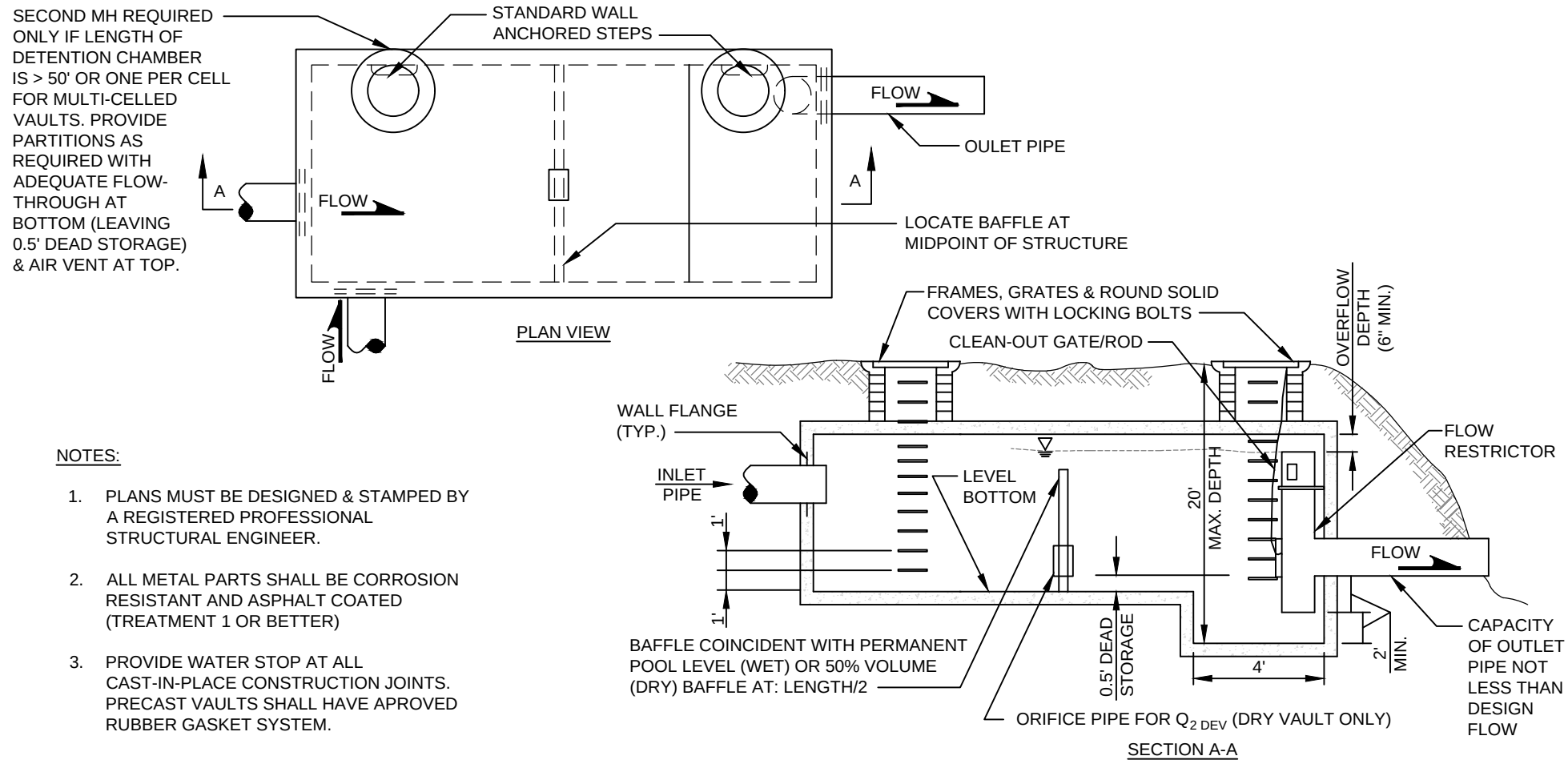
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TYPICAL DETENTION TANK (DRY/WET)

SECTION A - 19.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



NOTES:

1. PLANS MUST BE DESIGNED & STAMPED BY A REGISTERED PROFESSIONAL STRUCTURAL ENGINEER.
2. ALL METAL PARTS SHALL BE CORROSION RESISTANT AND ASPHALT COATED (TREATMENT 1 OR BETTER)
3. PROVIDE WATER STOP AT ALL CAST-IN-PLACE CONSTRUCTION JOINTS. PRECAST VAULTS SHALL HAVE APROVED RUBBER GASKET SYSTEM.

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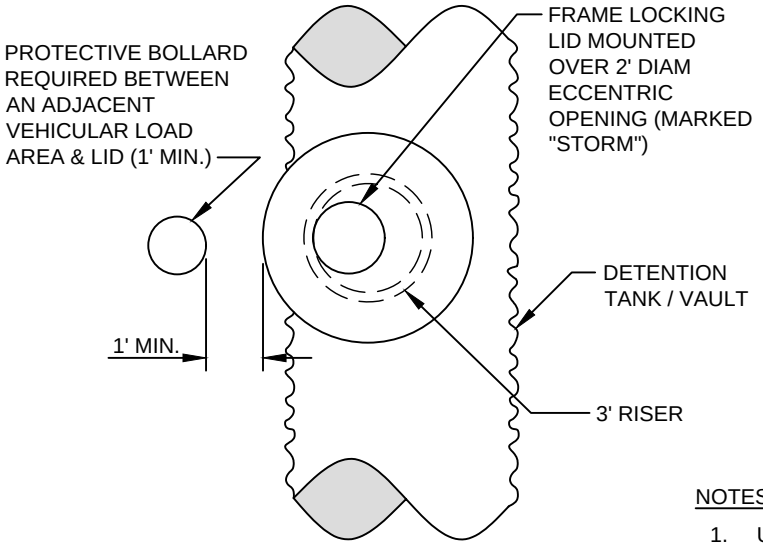
TYPICAL DETENTION VAULT (DRY/WET)

SECTION A - 19.1

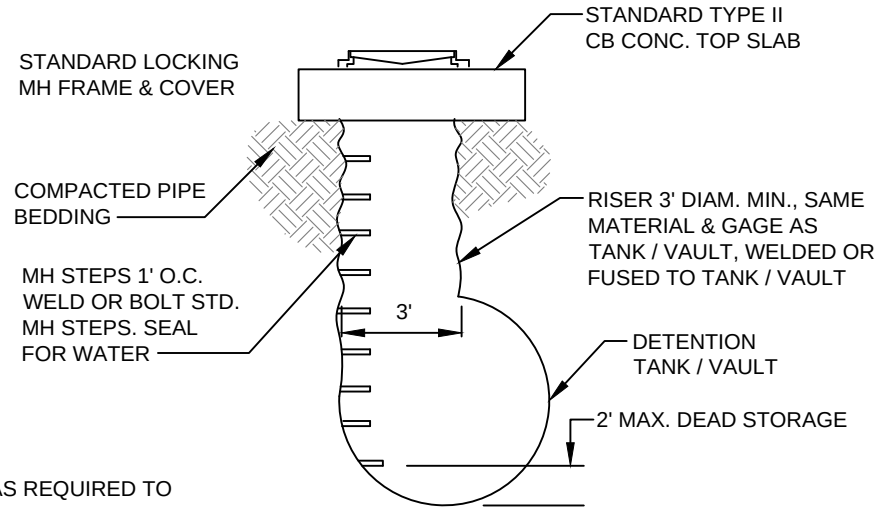
ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

RESTRICTIONS FOR APPLICATION:
USE ONLY FOR ACCESS TO DETENTION TANKS / VAULTS. NOT ALLOWED FOR USE IN ROADWAYS, DRIVEWAYS, PARKING STALLS OR WHERE VEHICULAR LOADS WOULD OCCUR.



PLAN VIEW



SECTION

NOTES:

1. USE ADJUSTING BLOCKS AS REQUIRED TO BRING FRAME TO GRADE.
2. ALL METAL PARTS SHALL BE CORROSION RESISTANT. STEEL PARTS GALVANIZED AND ASPHALT COATED. (TREATMENT 1 OR BETTER).
3. MUST BE CONVENIENTLY LOCATED FOR MAINTENANCE VEHICLE ACCESS.

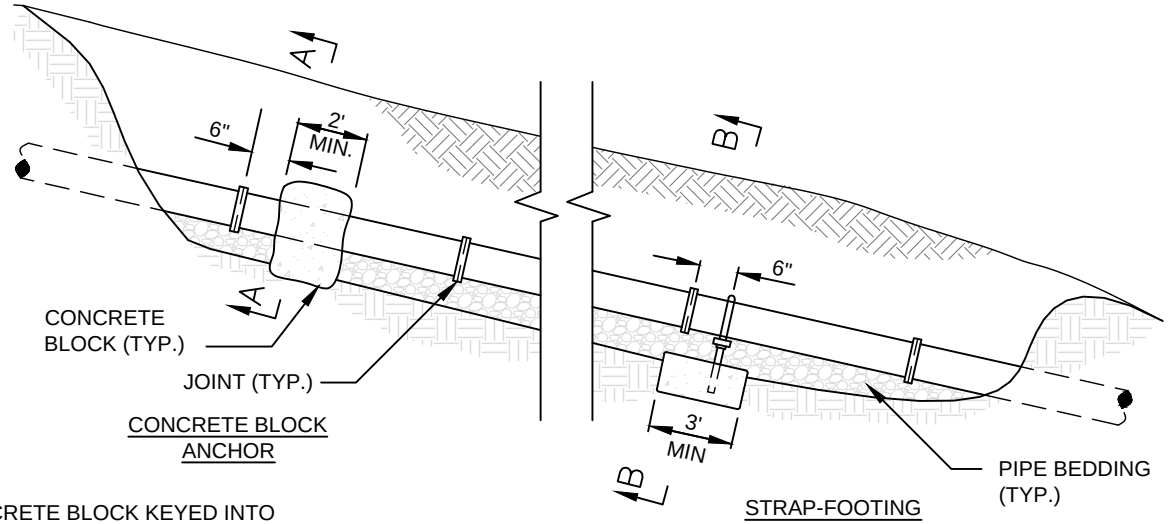
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DETENTION TANK/VAULT ACCESS DETAILS

SECTION A - 19.2

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

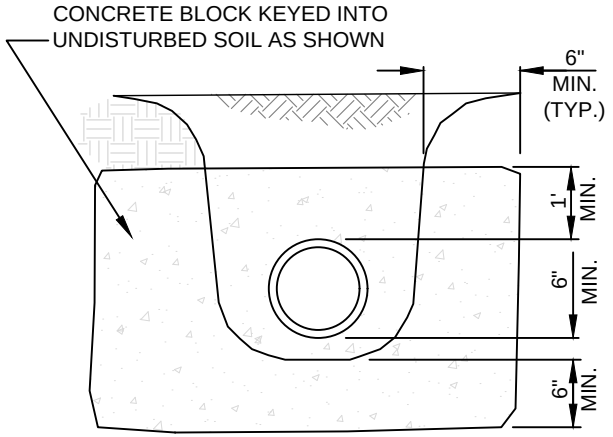


CONCRETE BLOCK ANCHOR

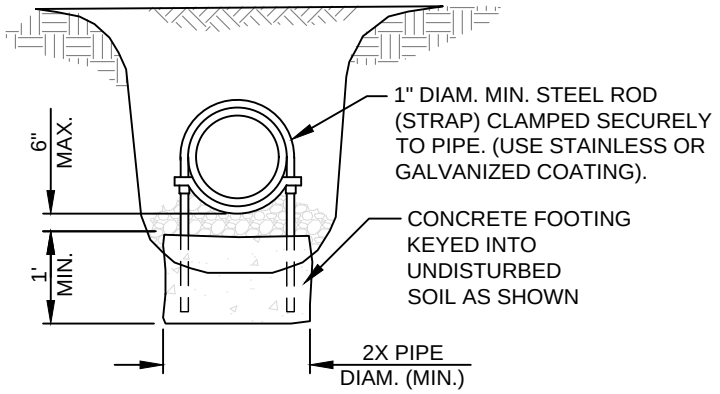
STRAP-FOOTING ANCHOR

NOTES:

1. SPACING FOR PIPE ANCHORS TO BE @ MAX. 20' INTERVALS.
2. IF USING HDPE PIPES, ADDITIONAL BANDS FOR CONCRETE POUR MAY BE NEEDED.



SECTION A-A



SECTION B-B

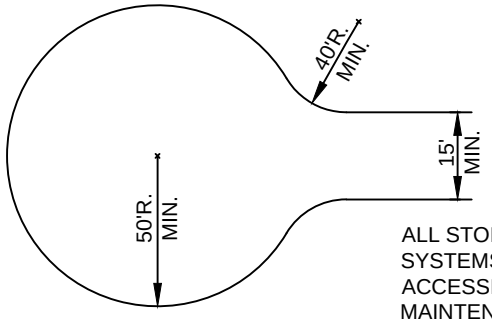
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PIPE ANCHOR DETAILS

SECTION A - 20.0

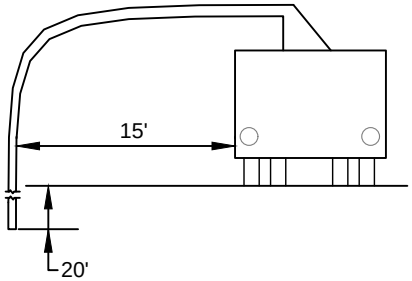
ORDINANCE: 2021-45

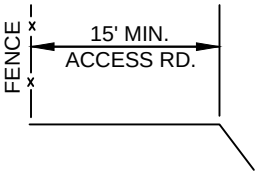
EFFECTIVE DATE: 7/1/2021



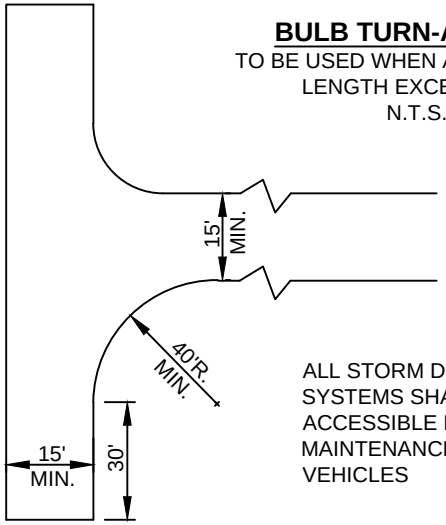
ALL STORM DRAIN SYSTEMS SHALL BE ACCESSIBLE BY MAINTENANCE VEHICLES

BULB TURN-AROUND
TO BE USED WHEN ACCESS ROAD LENGTH EXCEEDS 75'
N.T.S.



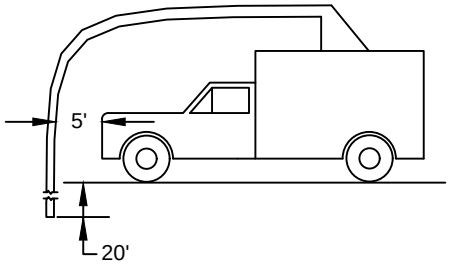


ACCESS ROAD DETAIL
N.T.S.

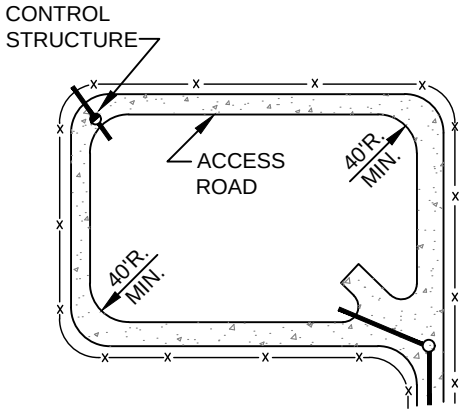


ALL STORM DRAIN SYSTEMS SHALL BE ACCESSIBLE BY MAINTENANCE VEHICLES

HAMMERHEAD TURN-AROUND
TO BE USED WHEN ACCESS ROAD LENGTH EXCEEDS 75'
N.T.S.



PIERCE COUNTY MAINTENANCE EQUIPMENT ACCESS CAPABILITIES
N.T.S.



FULL POND ACCESS
N.T.S.

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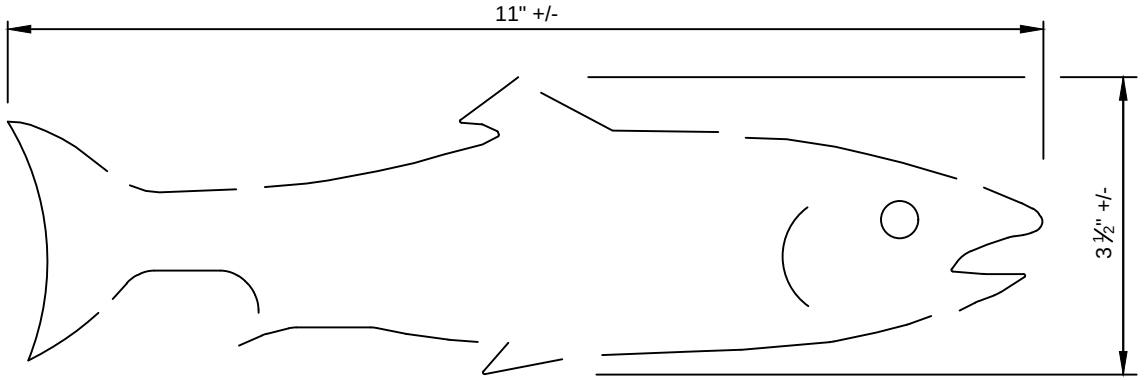
DETENTION POND ACCESS

SECTION A - 21.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

DUMP NO WASTE



DRAINS TO (STREAM, LAKE, RIVER, WETLANDS)

NOTE: LETTERING IS TWO INCHES HIGH AND PROPORTIONAL IN WIDTH

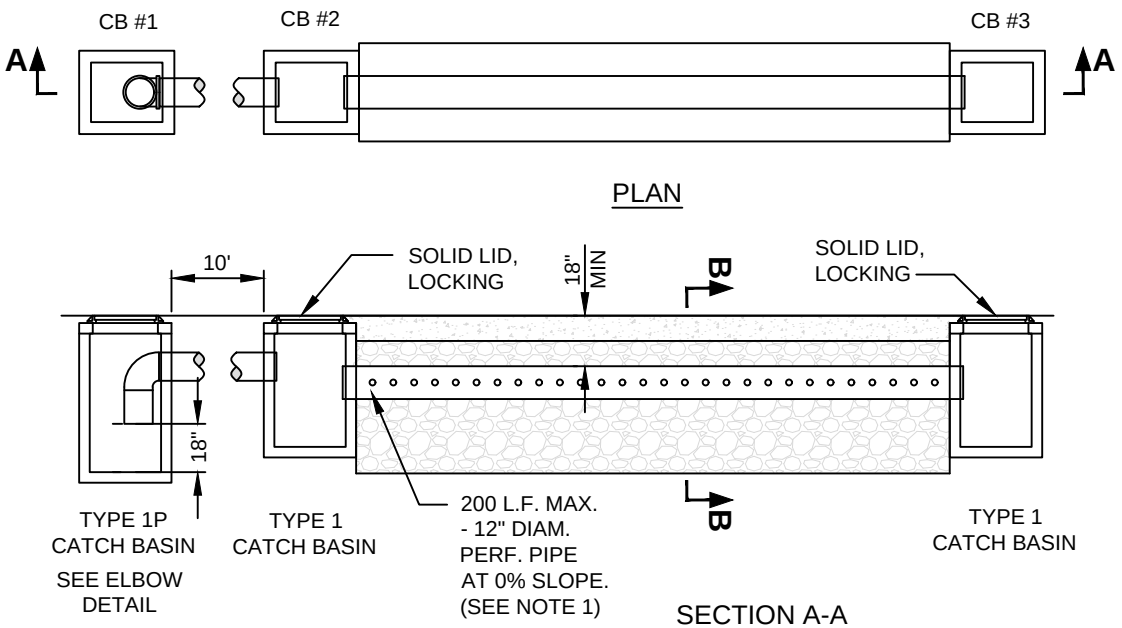
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CATCH BASIN STENCIL

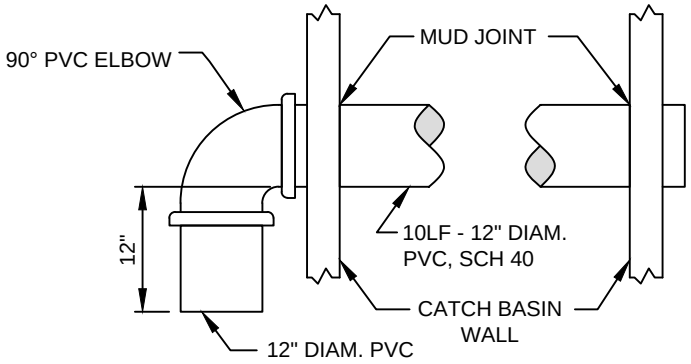
SECTION A - 22.0

ORDINANCE: 2021-45

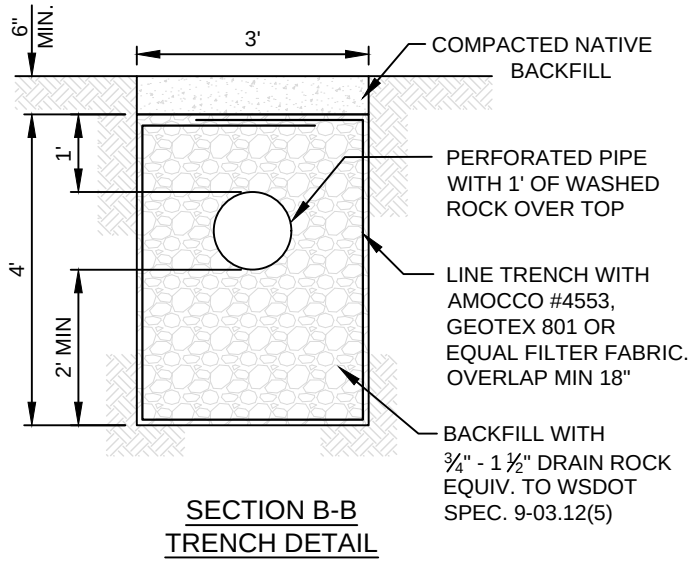
EFFECTIVE DATE: 7/1/2021



SECTION A-A
TYPICAL STANDARD
DRYWELL DETAIL



ELBOW DETAIL



SECTION B-B
TRENCH DETAIL

NOTES:

1. APPROVED PERF. PIPE MATERIAL SHALL BE: HDPE, CPSSP, OR APPROVED EQUAL.
2. PERFORATIONS MUST BE DOWNWARD FACING.
3. IF SYSTEM IS WHOLLY LOCATED WITHIN RIGHT-OF-WAY AND THE PERF. PIPE LENGTH IS LESS THAN 100 L.F., THEN CB #3 (END OF DRAIN FIELD) MAY BE REPLACED WITH AN END CAP.
4. IF CATCH BASIN RIMS ARE LOCATED WITHIN A VEHICLE TRAVEL SURFACE, THEN THE RIM ELEVATION SHALL BE SAME ELEVATION AS FINISH GRADE, OTHERWISE RIM ELEVATION SHALL BE 0.33' HIGHER THAN FINISH GRADE.

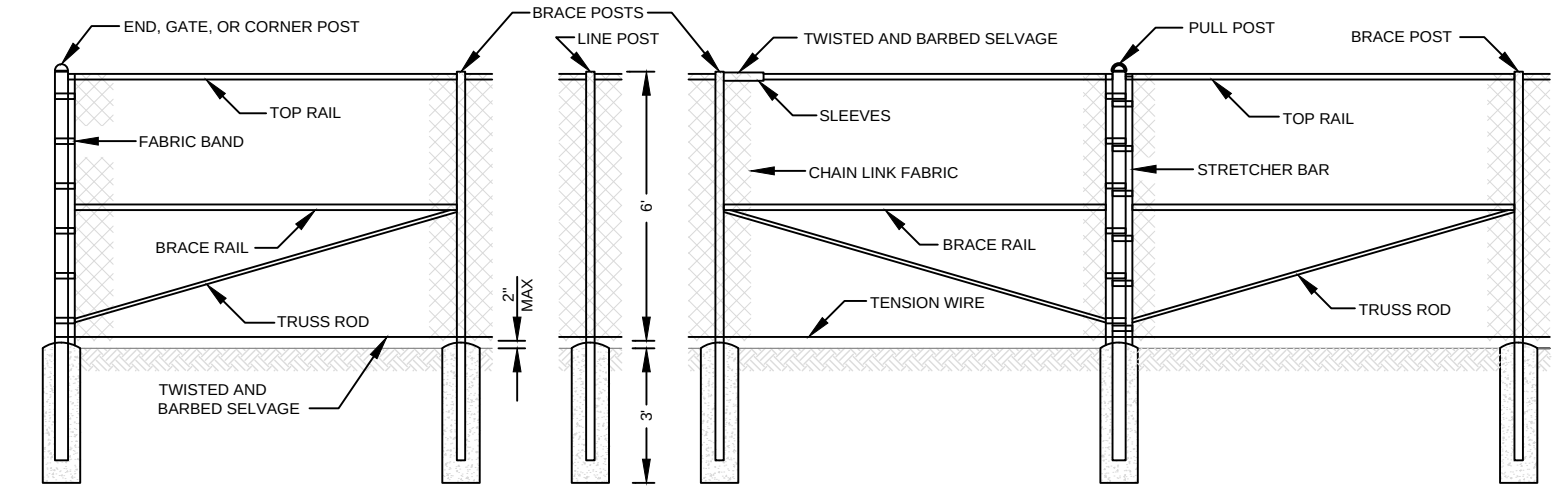
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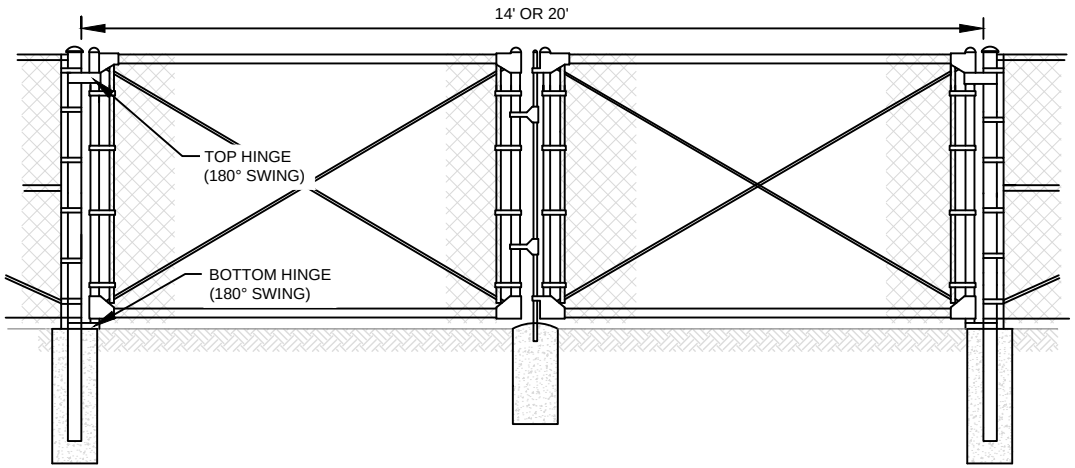
DRYWELL AND TRENCH

SECTION A - 23.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021





NOTES:

1) ALL CONCRETE POST BASES SHALL BE 12" MIN. DIAMETER.
2) ALL POSTS SHALL BE SPACED AT 10' MAX. INTERVALS UNLESS APPROVED BY COUNTY.
3) TOP OR BOTTOM TENSION WIRES SHALL BE PLACED WITHIN THE LIMITS OF THE FIRST FULL FABRIC WEAVE.
4) ALL POSTS ARE ROUND.
5) ALL POSTS ARE MIN. 8' - 8" IN LENGTH.
6) DETAIL BASED ON 1997 WSDOT STANDARD PLANS L-2 CHAIN LINK FENCE TYPE 1, WITH MODIFICATIONS MADE BY PIERCE COUNTY.
7) 9 GAUGE FABRIC VINYL COATED GREEN / BLACK.
8) TOLERANCE FOR WALL THICKNESS IS 12.5%.

BRACE RAIL & TOP RAIL		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
1 ¼	2.27	0.133

LINE & BRACE POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
2	3.65	0.154

END, CORNER, & PULL POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
2½	5.79	0.203

GATE POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
3½	9.12	0.226

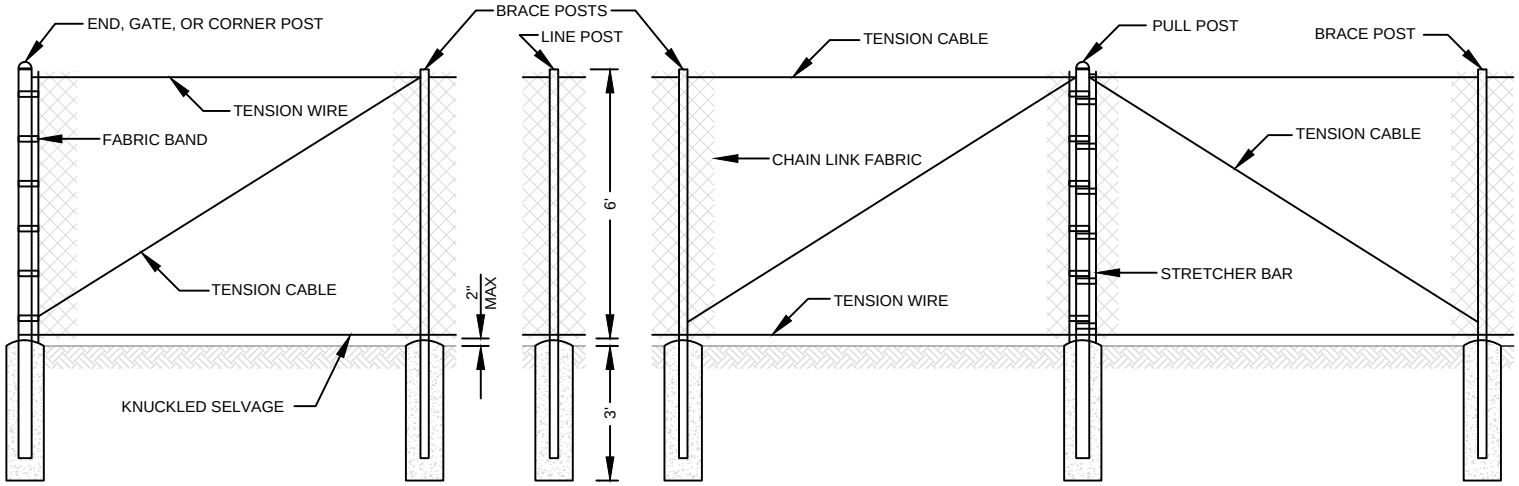
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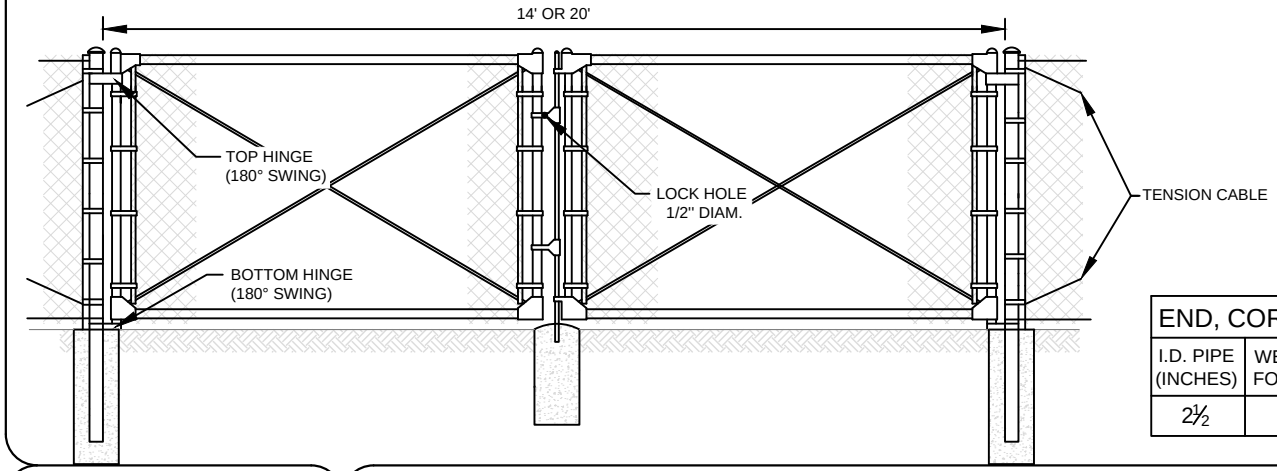
CHAIN LINK FENCE TYPE 1 (MODIFIED)

SECTION A - 24.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021





NOTES:

1) ALL CONCRETE POST BASES SHALL BE 12" MIN. DIAMETER.
2) ALL POSTS SHALL BE SPACED AT 10' MAX. INTERVALS UNLESS APPROVED BY COUNTY.
3) TOP OR BOTTOM TENSION WIRES SHALL BE PLACED WITHIN THE LIMITS OF THE FIRST FULL FABRIC WEAVE.
4) ALL POSTS ARE ROUND.
5) ALL POSTS ARE MIN. 8' - 8" IN LENGTH.
6) DETAIL BASED ON 2007 WSDOT STANDARD PLANS L-20.10-00 CHAIN LINK FENCE TYPE 3, WITH MODIFICATIONS MADE BY PIERCE COUNTY.
7) 9 GAUGE FABRIC VINYL COATED GREEN / BLACK.
8) TOLERANCE FOR WALL THICKNESS IS 12.5%.

LINE & BRACE POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
2	3.65	0.154

END, CORNER, & PULL POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
2½	5.79	0.203

GATE POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
3½	9.12	0.226

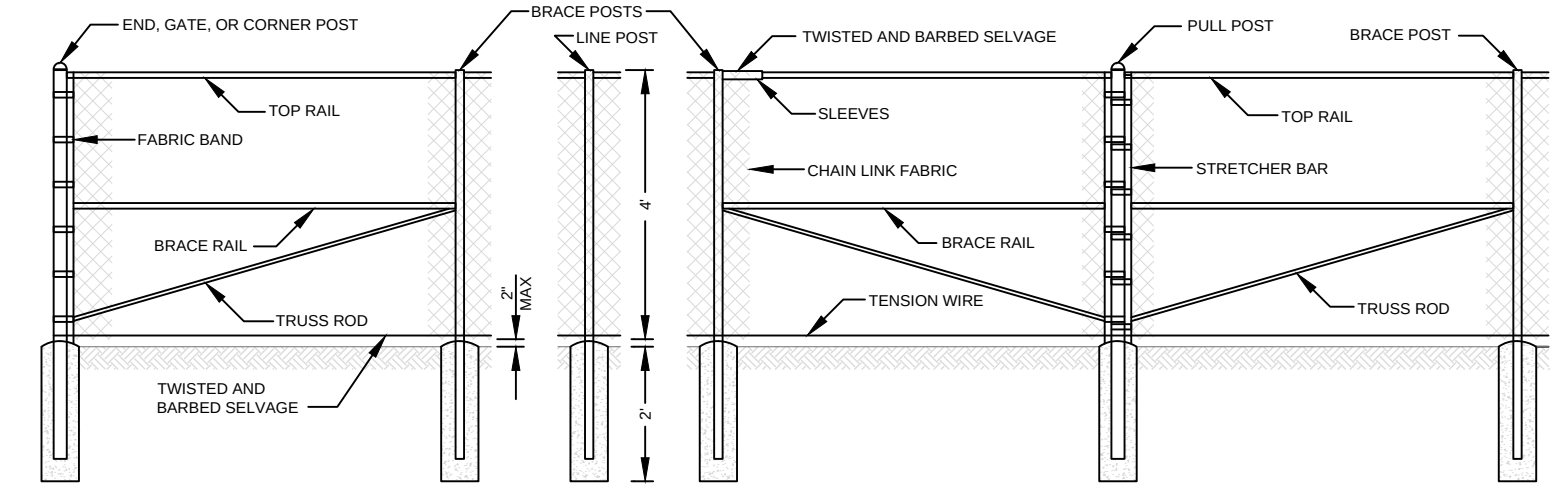
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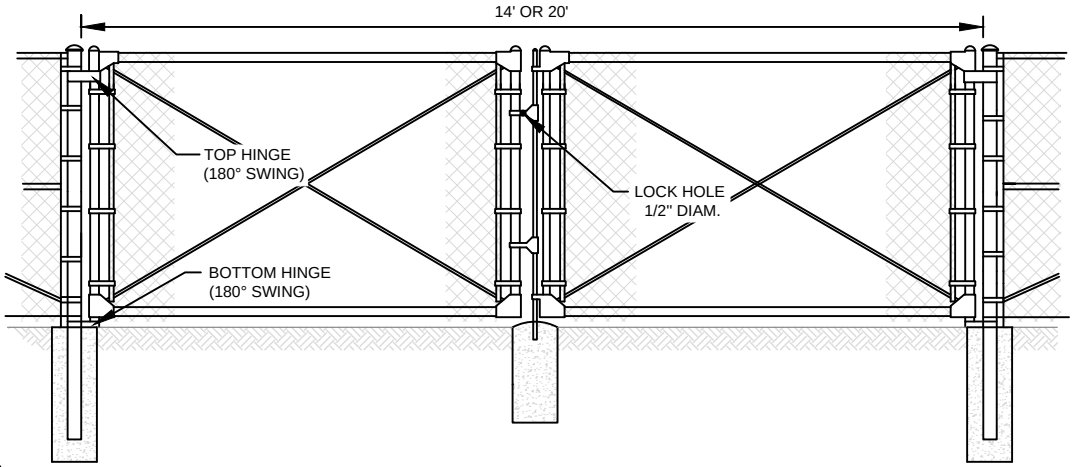
CHAIN LINK FENCE TYPE 3 (MODIFIED)

SECTION A - 24.1

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021





NOTES:

1) ALL CONCRETE POST BASES SHALL BE 12" MIN. DIAMETER.
2) ALL POSTS SHALL BE SPACED AT 10' MAX. INTERVALS UNLESS APPROVED BY COUNTY.
3) TOP OR BOTTOM TENSION WIRES SHALL BE PLACED WITHIN THE LIMITS OF THE FIRST FULL FABRIC WEAVE.
4) ALL POSTS ARE ROUND.
5) ALL POSTS ARE MIN. 5' - 6" IN LENGTH.
6) DETAIL BASED ON 1997 WSDOT STANDARD PLANS L-2 CHAIN LINK FENCE TYPE 6, WITH MODIFICATIONS MADE BY PIERCE COUNTY.
7) 9 GAUGE FABRIC VINYL COATED GREEN / BLACK.
8) TOLERANCE FOR WALL THICKNESS IS 12.5%.

BRACE RAIL & TOP RAIL		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
1 ¼	2.27	0.133

LINE & BRACE POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
2	3.65	0.154

END, CORNER, & PULL POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
2½	5.79	0.203

GATE POST		
I.D. PIPE (INCHES)	WEIGHT PER FOOT (LBS)	WALL THICKNESS (IN)
3½	9.12	0.226

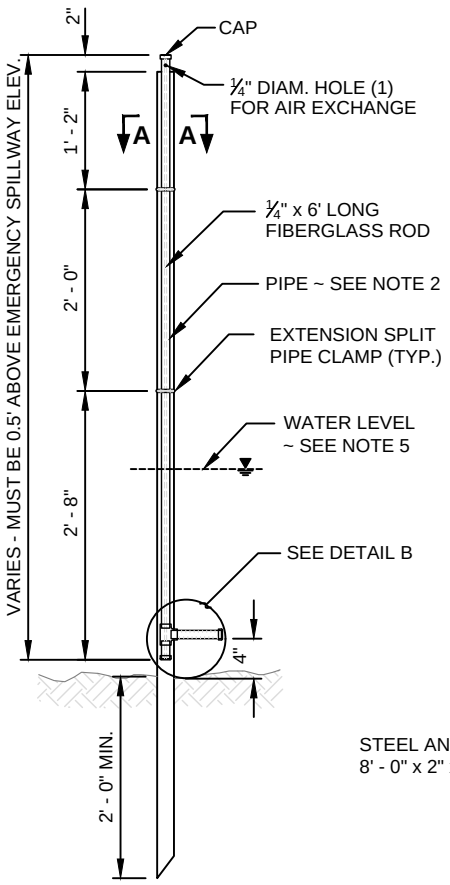
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CHAIN LINK FENCE TYPE 6 (MODIFIED)

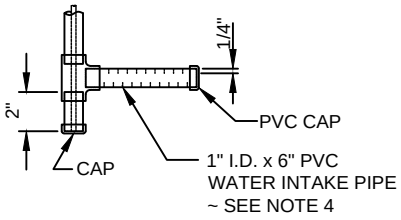
SECTION A - 24.2

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

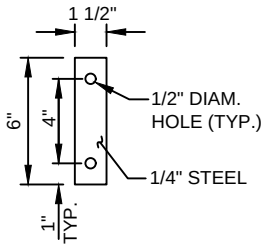


CREST GAGE

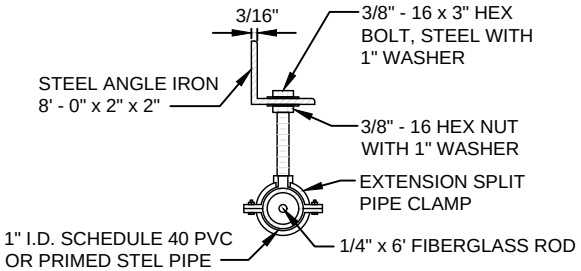


WATER INTAKE AND CLEANOUT ASSEMBLY

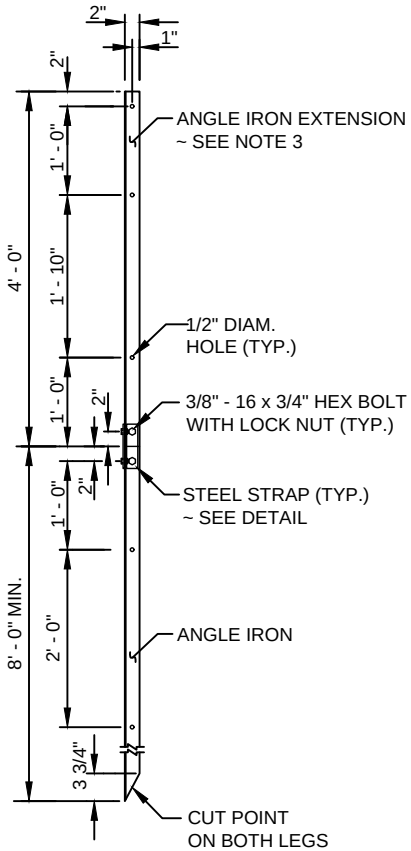
DETAIL (B)



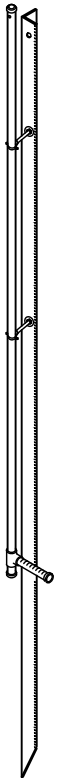
STEEL STRAP



SECTION (A)



ANGLE IRON DETAIL
(SHOWN WITH EXTENSION)



ISOMETRIC VIEW

NOTES

1. ALL ANGLE IRONS AND STEEL STRAPS SHALL BE GALVANIZED IN ACCORDANCE WITH ASSHTO M 232.
2. PIPE, CAPS, AND T-ADAPTER SHALL BE 1" I.D. WHITE PVC, OR PRIMED STEEL, EXCEPT THE WATER INTAKE PIPE SHALL BE WHITE PVC. PIPE SHALL BE SCH. 40. ALL PIPE JOINTS SHALL BE THREADED.
3. GAGE ASSEMBLY PIPE, FIBERGLASS ROD, AND ANGLE IRON CAN BE EXTENDED AS NEEDED TO FIT SITE REQUIREMENTS. EXTRA PIPE CLAMPS SHALL BE ADDED FOR SECURITY.
4. SCORE THE WATER INTAKE PIPE 1/4" DEEP, 1/32" WIDE (WIDTH OF SAW BLADE), EVERY 1/2", ALTERNATING CUTS ON TOP AND BOTTOM FOR DRAINAGE. PLACE AT LOWEST WATER LEVEL.
5. WATER LEVEL MAY VARY, DEPENDING ON SEASON.
6. POUR IN APPROXIMATELY 1 TABLESPOON OF CORK DUST AT INSTALLATION, AND AFTER EACH READING.
7. ALTERNATIVE ANCHORING METHODS MAY BE APPROVED BY COUNTY.

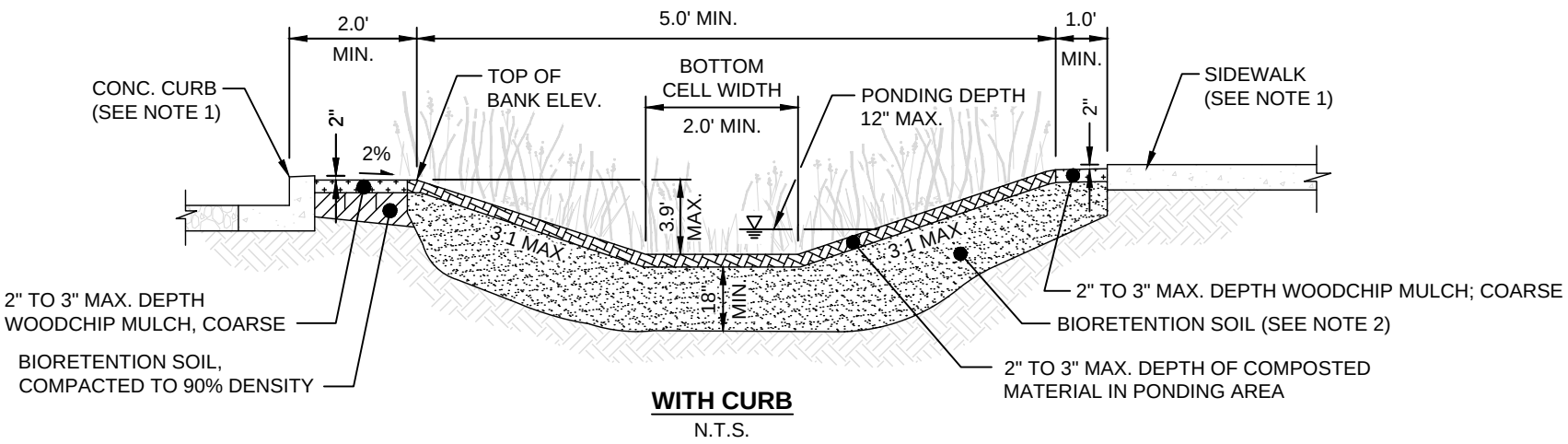
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

CREST GAGE

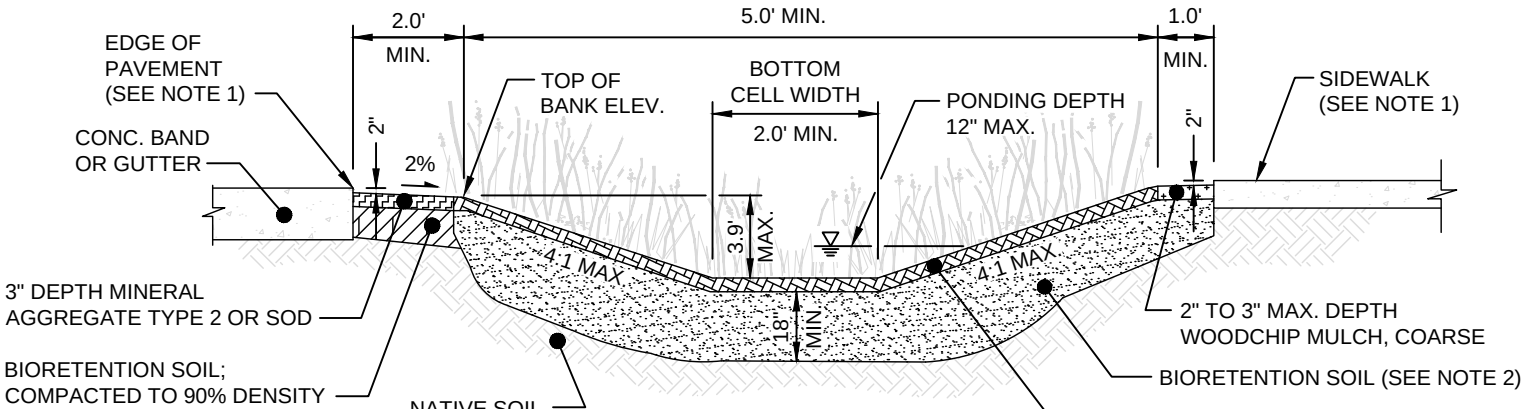
SECTION A - 25.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



WITH CURB
N.T.S.



WITHOUT CURB
N.T.S.

NOTES:

1. SIDEWALK, ROADWAY, AND/OR TOP OF CURB ELEVATION(S) MUST BE SET ABOVE OVERFLOW ELEVATIONS.
2. SCARIFY SUBGRADE 3" MIN. BEFORE BIORETENTION SOIL INSTALLATION.

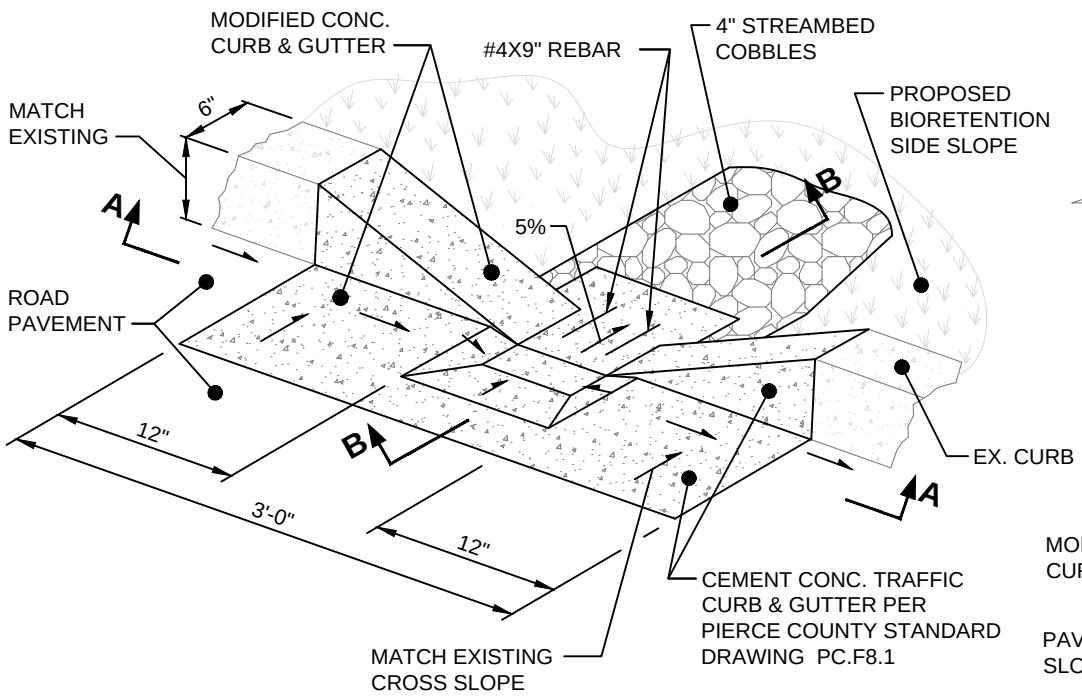
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

BIORETENTION IN NEIGHBORHOOD STREETS AND LOCAL ROADS

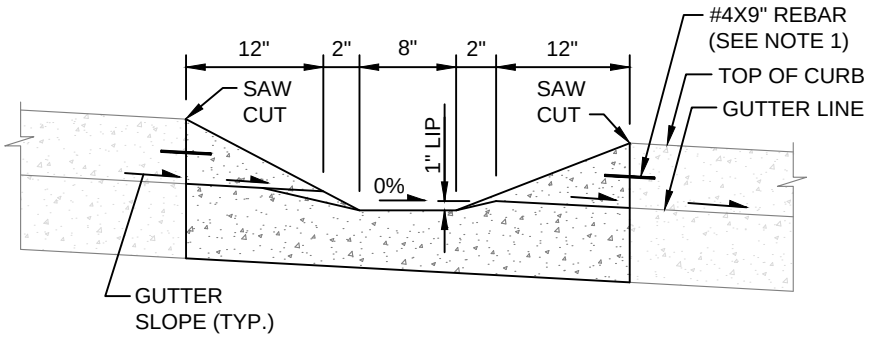
SECTION A - 26.0

ORDINANCE: 2021-45

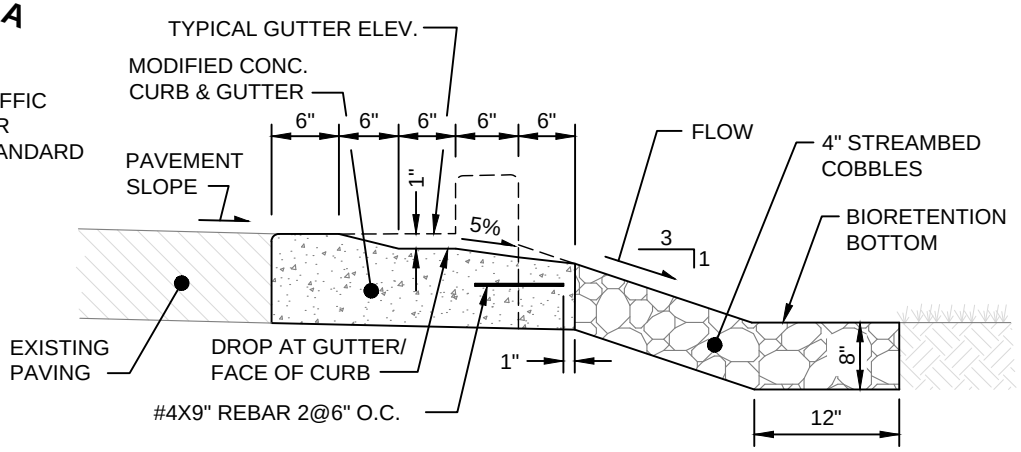
EFFECTIVE DATE: 7/1/2021



CURB CUT (ISOMETRIC)
N.T.S.



SECTION A-A
N.T.S.



SECTION B-B
N.T.S.

NOTES:

1. FOR REBAR INSTALLATION INTO EXISTING CURB(S), DRILL 3/4 " MIN. DIAM. HOLES AND FILL WITH EPOXY GROUT (TYPE I OR IV EPOXY PER SEC. 9-26)

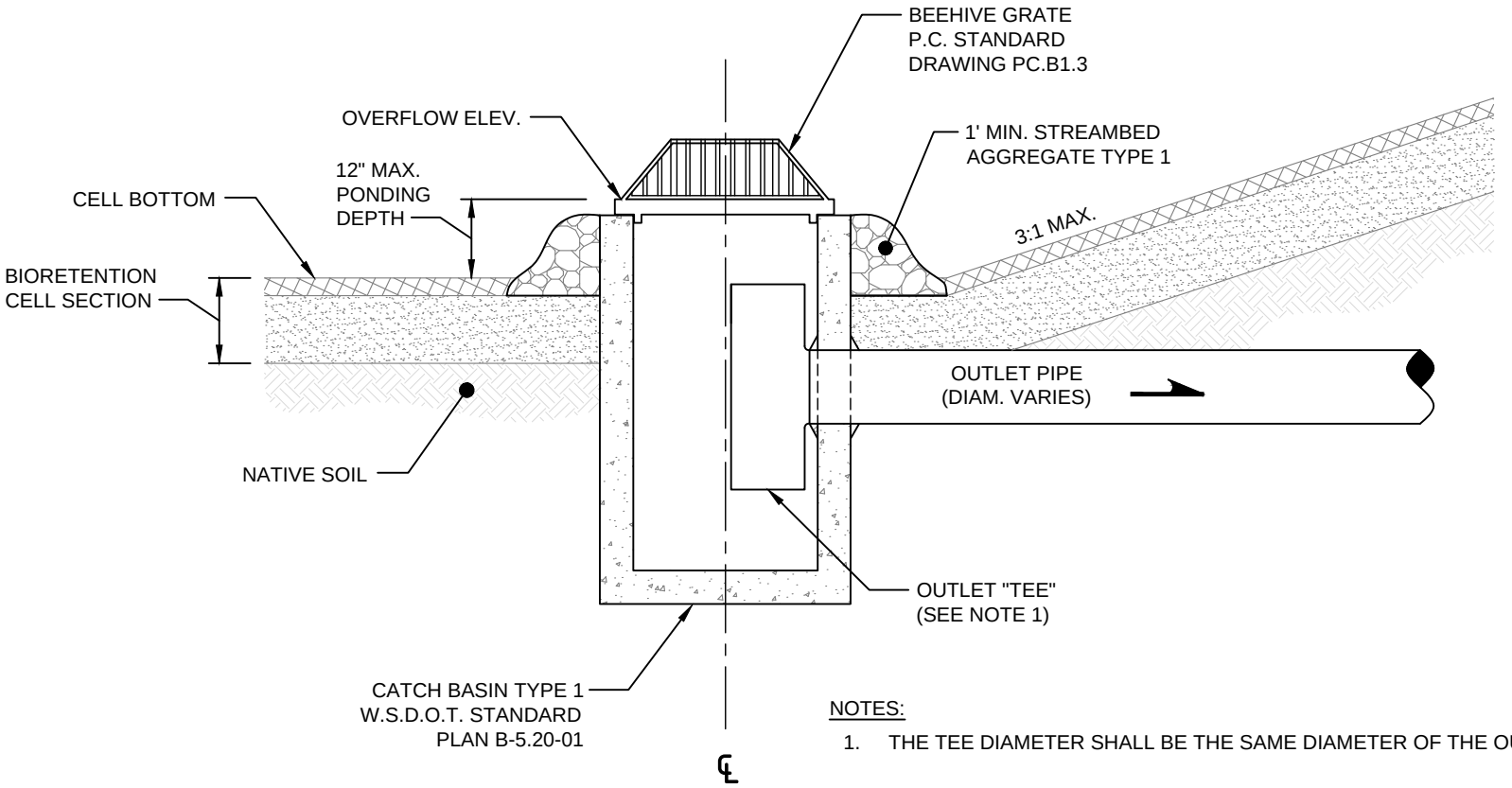
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CURB CUTS FOR BIORETENTION

SECTION A - 26.1

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



NOTES:

1. THE TEE DIAMETER SHALL BE THE SAME DIAMETER OF THE OUTLET PIPE.

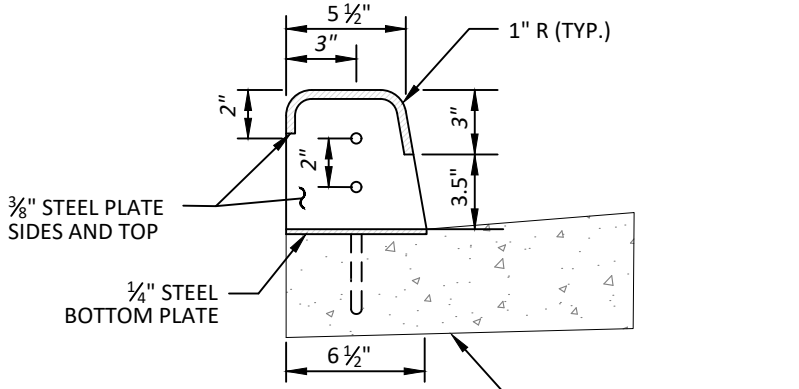
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BIORETENTION OVERFLOW STRUCTURE

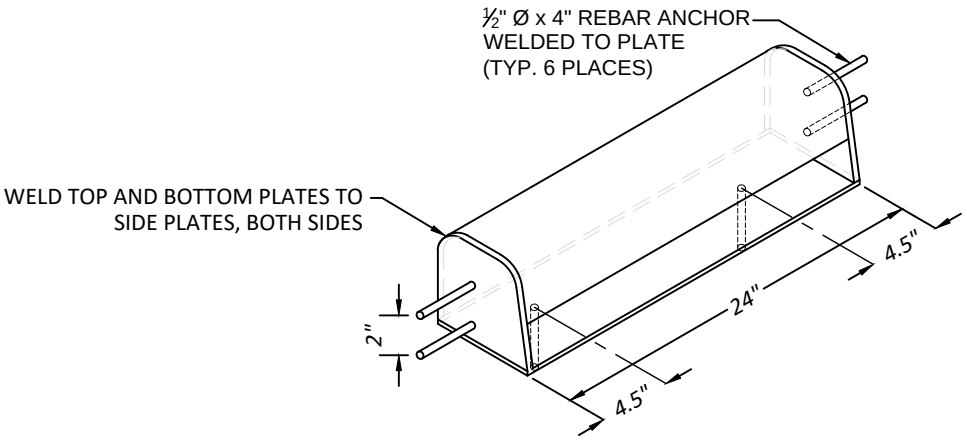
SECTION A - 26.2

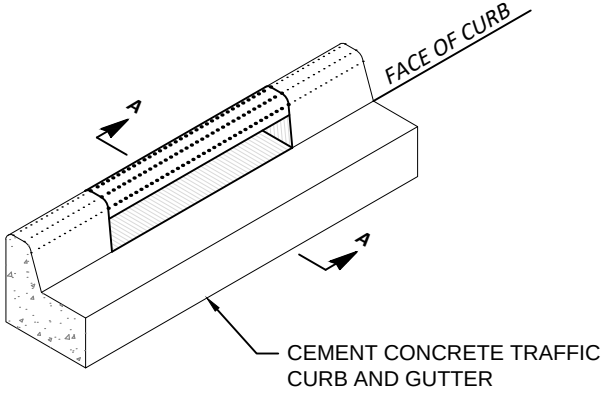
ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



SECTION A-A
N.T.S.





CURB FACE INLET
N.T.S.

CURB FACE GENERAL NOTES

1. WELD AT ALL MEETING SURFACES ON INSIDE AND OUTSIDE.
2. HOT DIP GALVANIZE AFTER FABRICATION PER ASTM A123.
3. CURB FACE INLET PRE-APPROVED SUPPLIER "OLYMPIC FOUNDRY" OR APPROVED EQUAL.
4. CURB FACE INLET SHALL BE CAST INTO CEMENT CONC. TRAFFIC CURB AND GUTTER SECTION WHERE SHOWN IN PLAN OR DESIGNATED BY ENGINEER.

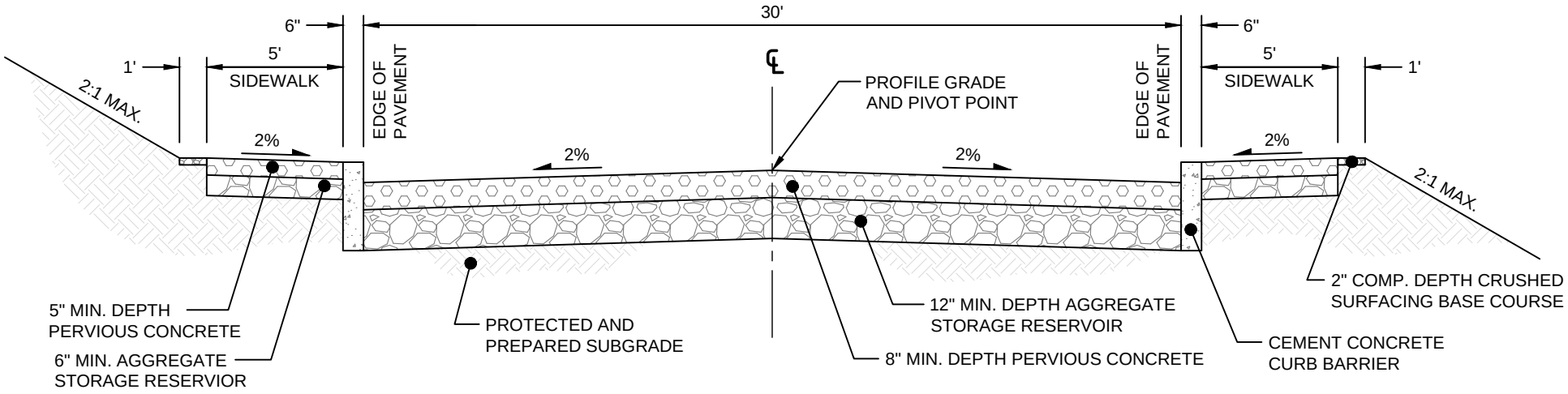
Pierce County
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2401 S 35th St.
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THROUGH CURB INLET

SECTION A - 26.3

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

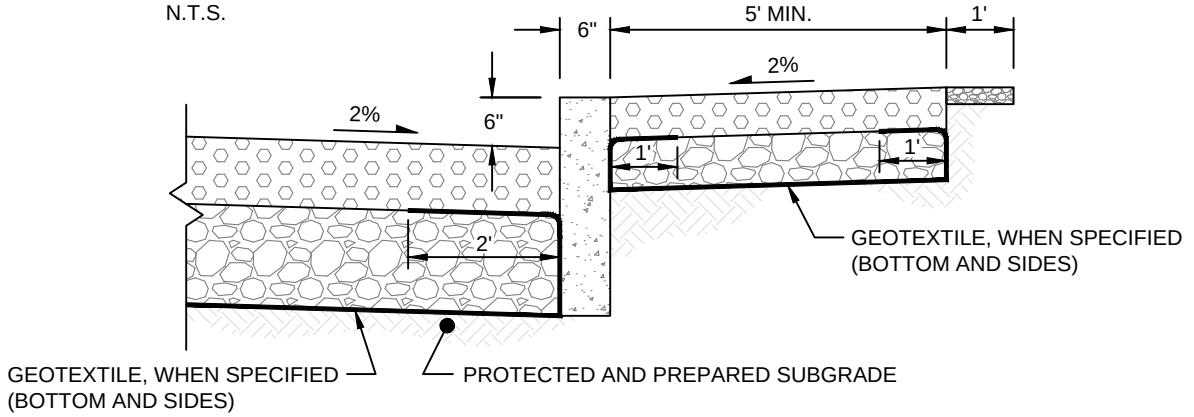


ROADWAY / SIDEWALK SECTION

N.T.S.

NOTES:

1. SIDEWALKS SHALL MEET AMERICANS WITH DISABILITIES ACT REQUIREMENTS.



BARRIER CURB / GEOTEXTILE DETAIL

N.T.S.

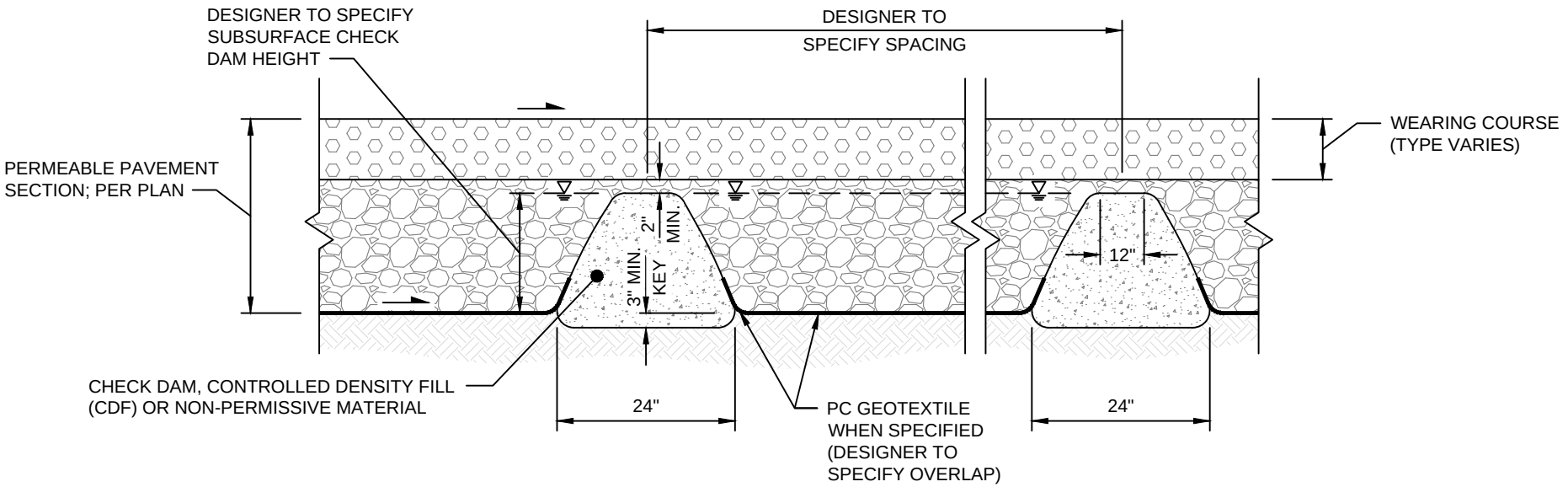
Pierce County
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2401 S 35th St.
Tacoma, Washington 98409

PERVIOUS CONCRETE ROADWAY AND SIDEWALKS

SECTION A - 27.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



SECTION VIEW

N.T.S.

Pierce County

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SUBSURFACE PERMEABLE PAVEMENT CHECK DAM

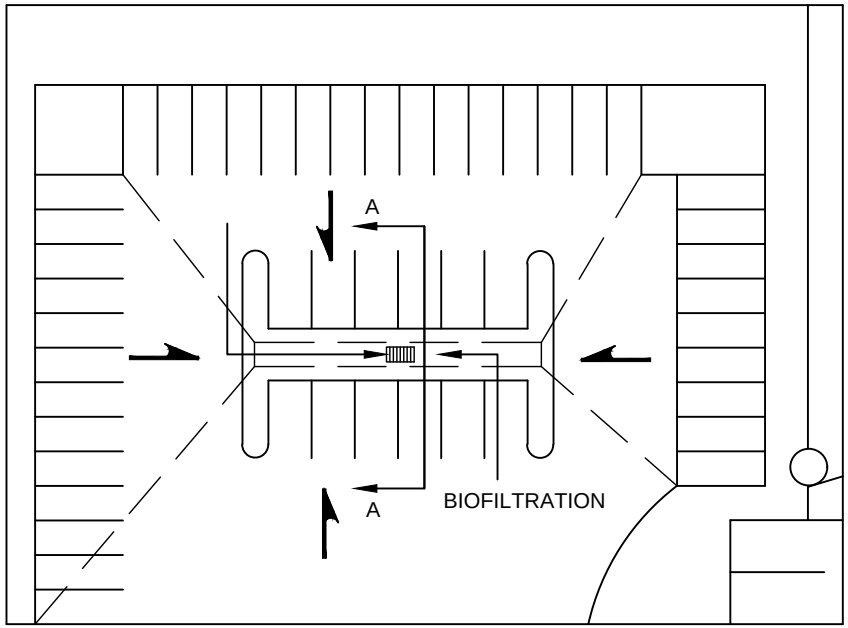
SECTION A - 27.1

ORDINANCE: 2021-45

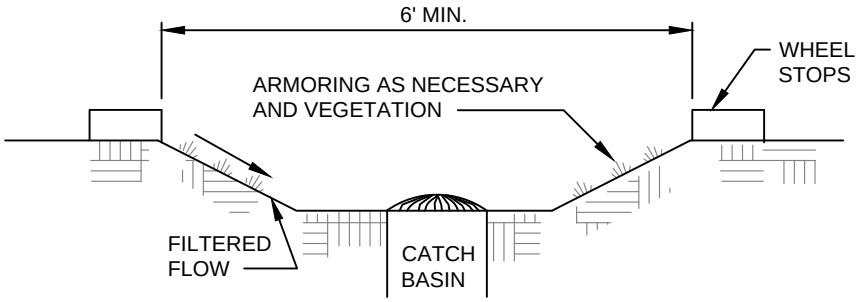
EFFECTIVE DATE: 7/1/2021

Section B - Quality Design Details

Detail	Heading
1.0	Parking Lot Conveyance System
2.0	Water Quality Biofiltration Swale
3.0	Typical Wet Pond
4.0	Typical Wet Pond - Type Detention BMP - Schematic
5.0	Wet Pond (Nutrient Control)
6.0	Presettling Basin - Schematic
7.0	Basin Configurations with Baffles
8.0	Isolation/Diversion Structure - Schematic
9.0	Isolation/Diversion Structure - Schematic
10.0	Perforated Riser Pipe Outlet Structure w/Trash Rack - Schematic
11.0	Gravel Cone W/Riser Detail
12.0	Sand Filtration System - Configuration
13.0	Sand Filtration System - Schematic
14.0	Water Quality Infiltration Trench System - Schematic
15.0	Oil/Water Separation w/Orifice Control and w/Notch Control



PLAN



NOTE: USE BEEHIVE OR A-FRAME GRATE ON CATCH BASIN.

SECTION A-A

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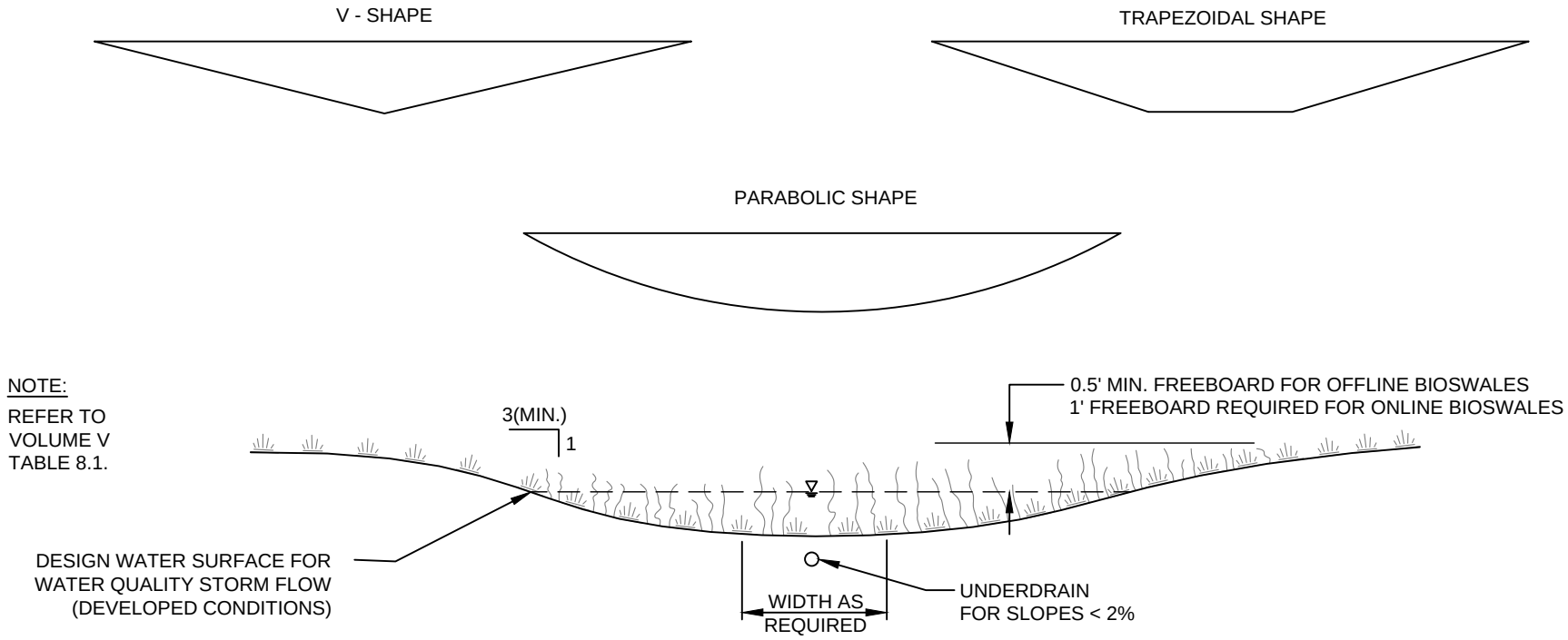
PARKING LOT CONVEYANCE SYSTEM

SECTION B - 1.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

TYPICAL CHANNEL SECTION



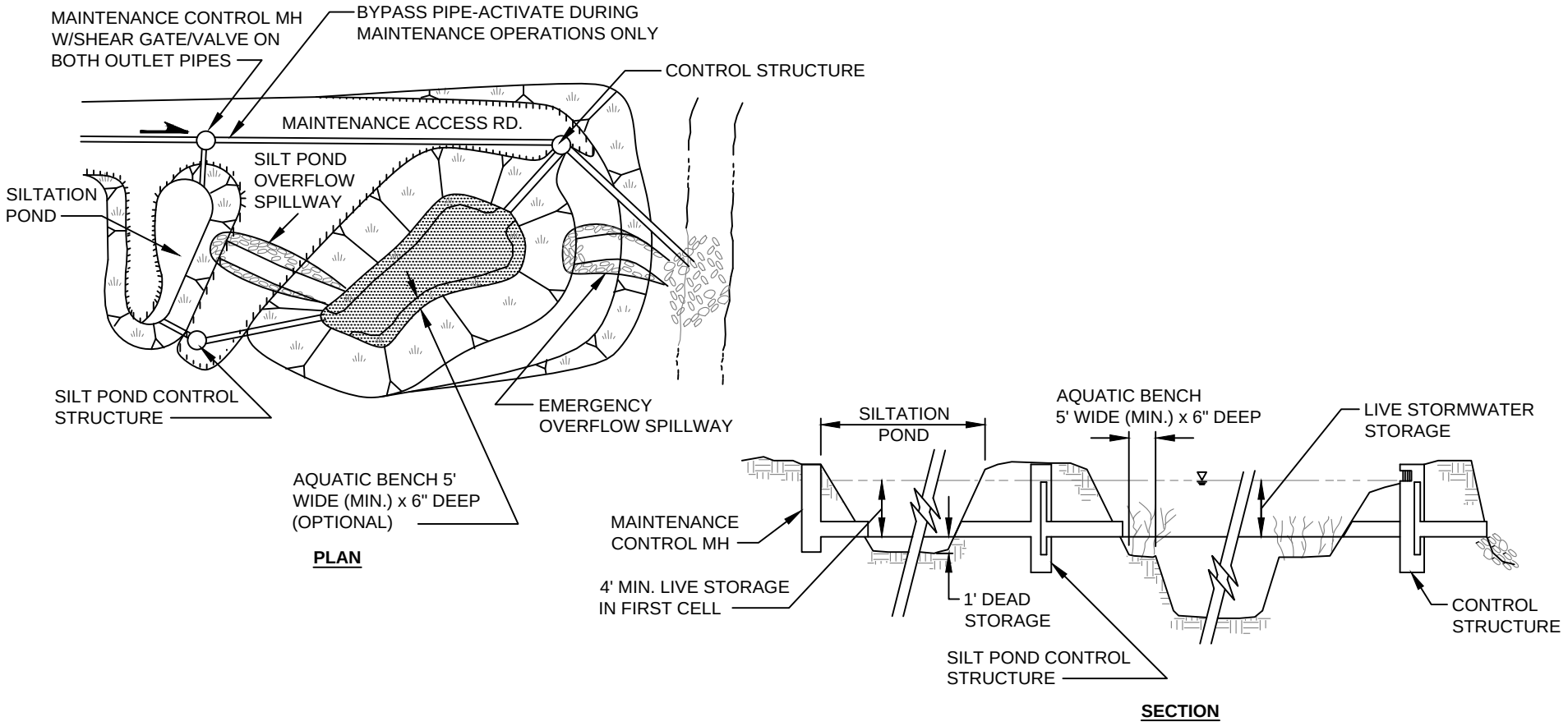
Pierce County
Planning and Public Works
2401 S 35th St.
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WATER QUALITY BIOFILTRATION SWALE

SECTION B - 2.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



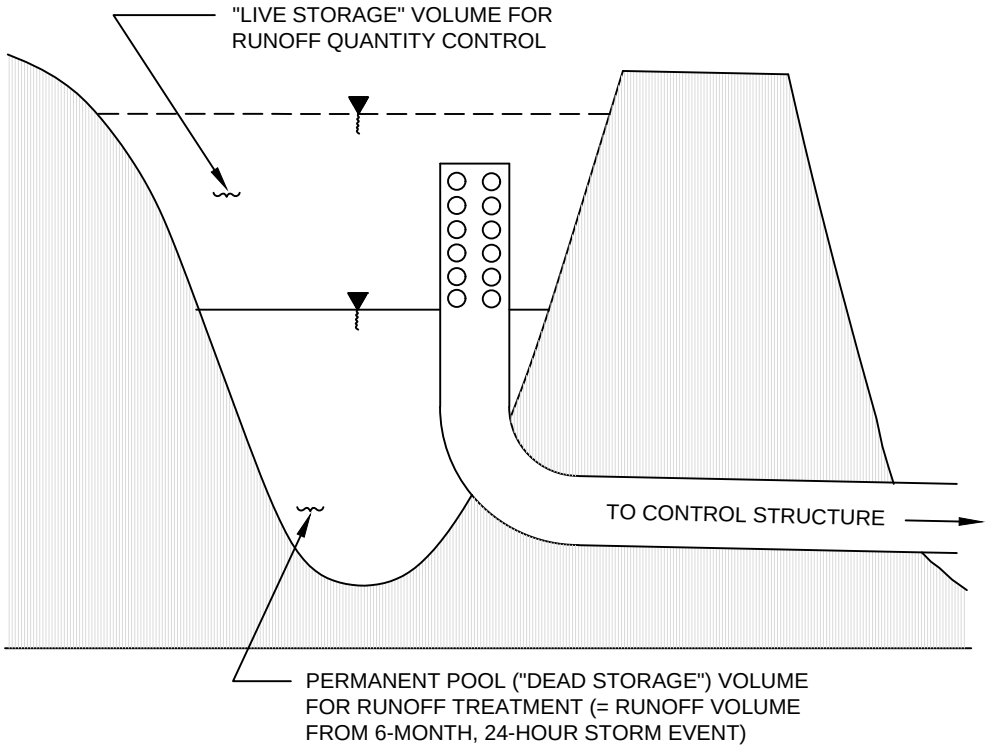
Pierce County
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TYPICAL WET POND

SECTION B - 3.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



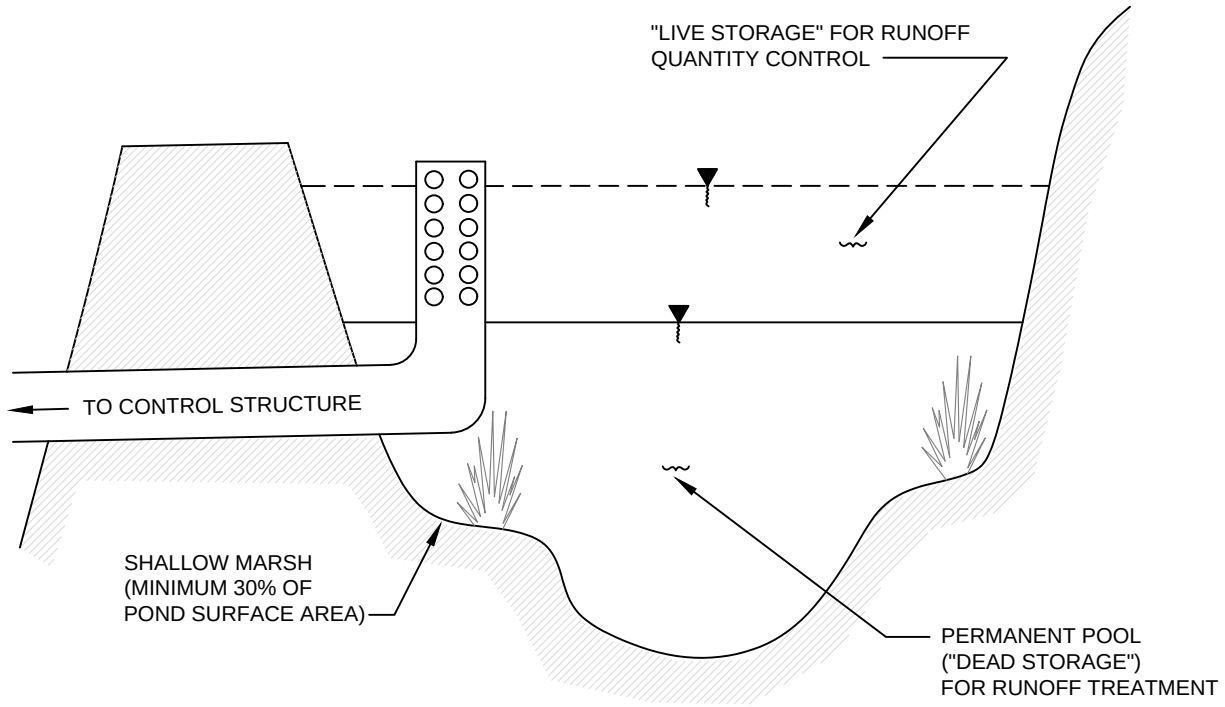
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TYPICAL WET POND - TYPE DETENTION BMP

SECTION B - 4.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



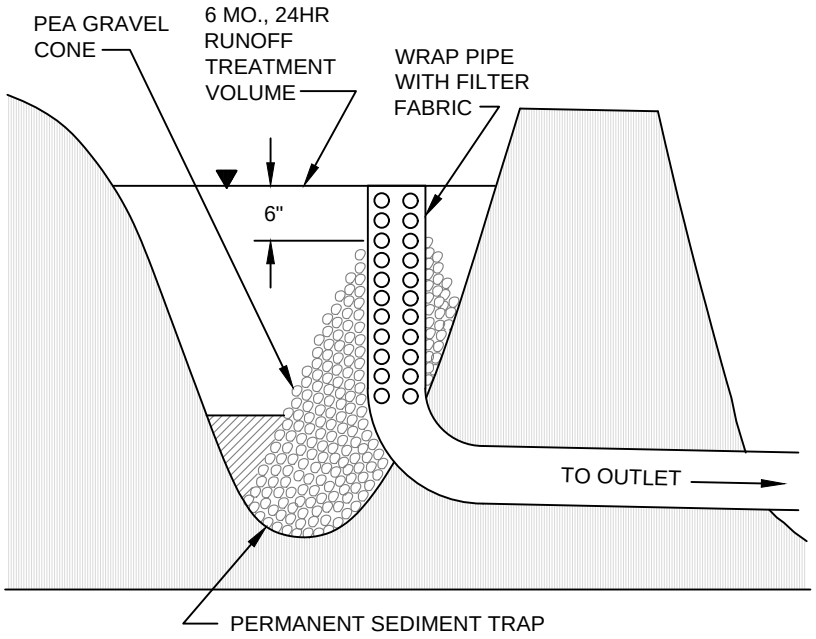
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WET POND (NUTRIENT CONTROL)

SECTION B - 5.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



NOTE:

NO RUNOFF QUANTITY CONTROL IS PROVIDED BY THIS BMP.

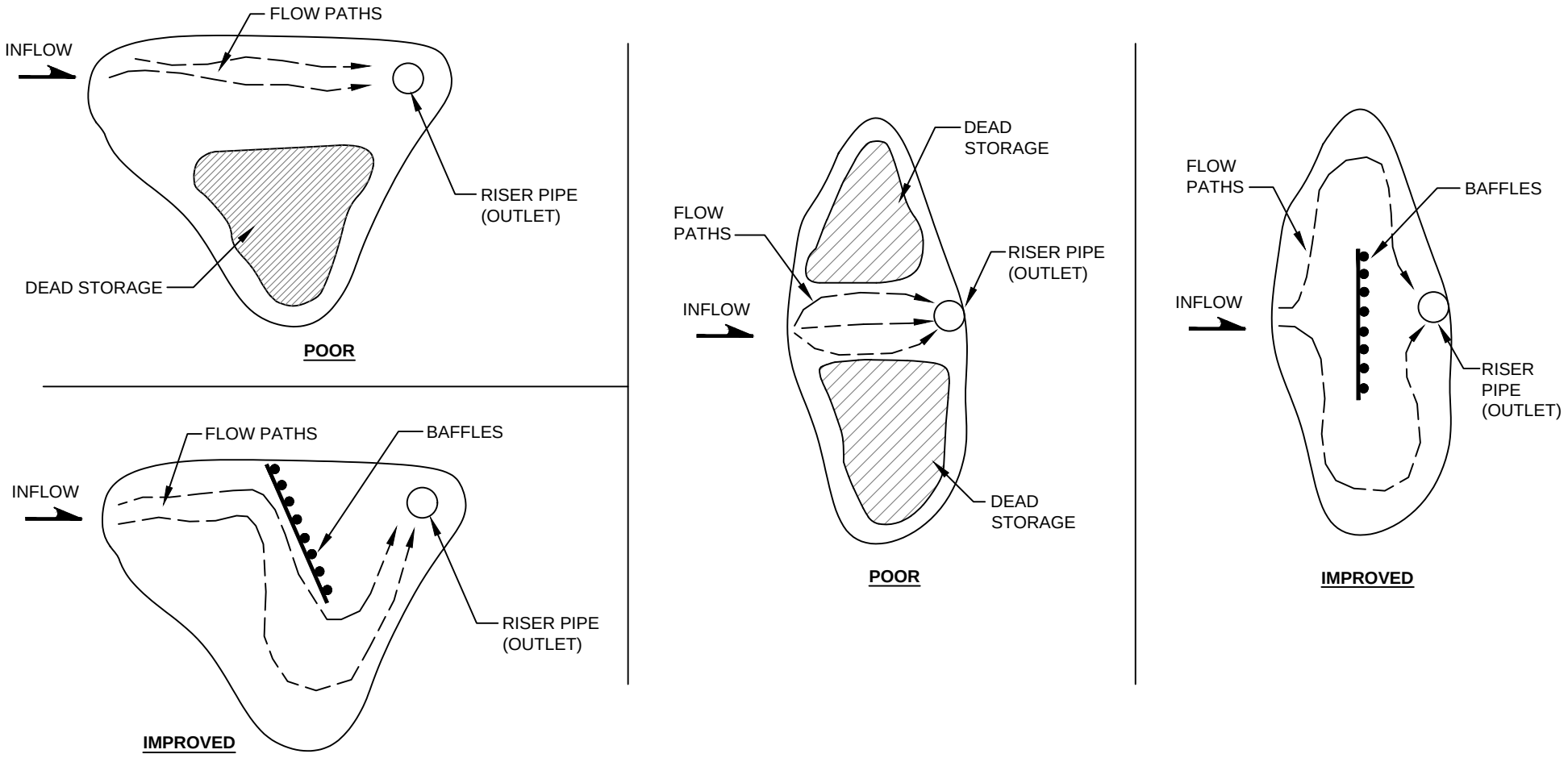
Pierce County
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2401 S 35th St.
Tacoma, Washington 98409

PRE-SETTLING BASIN

SECTION B - 6.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



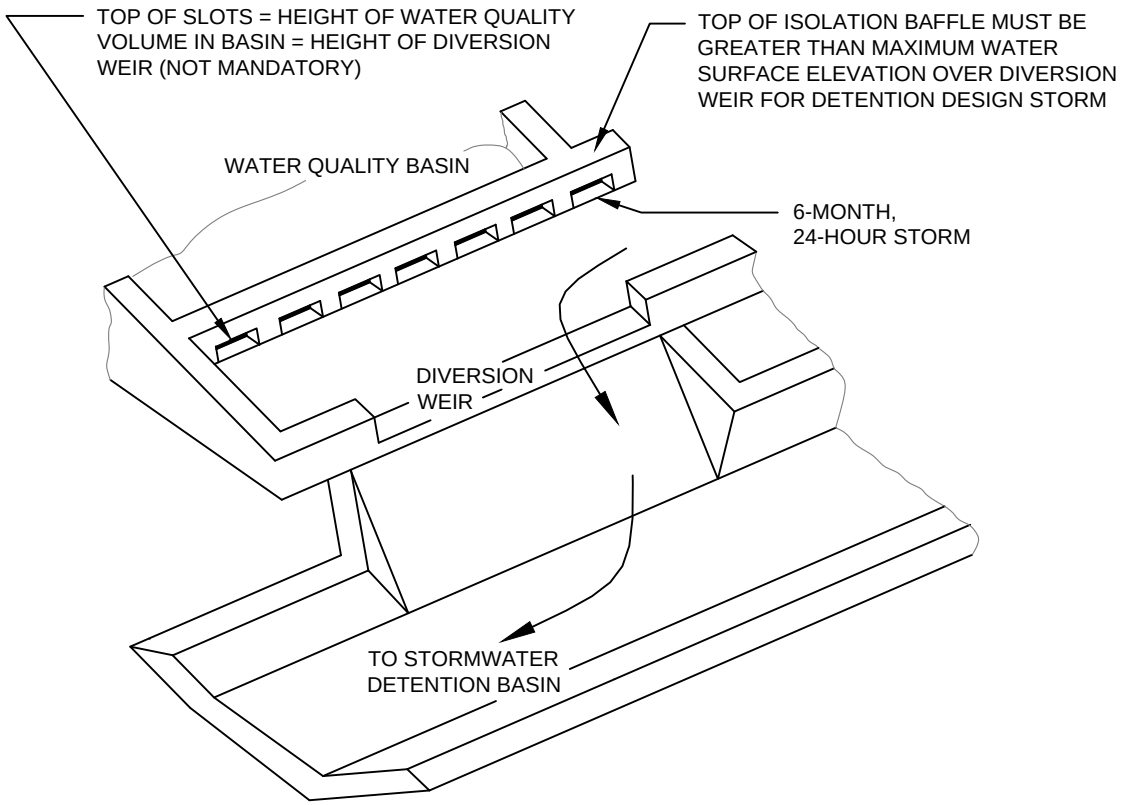
Pierce County
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BASIN CONFIGURATIONS WITH BAFFLES

SECTION B - 7.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



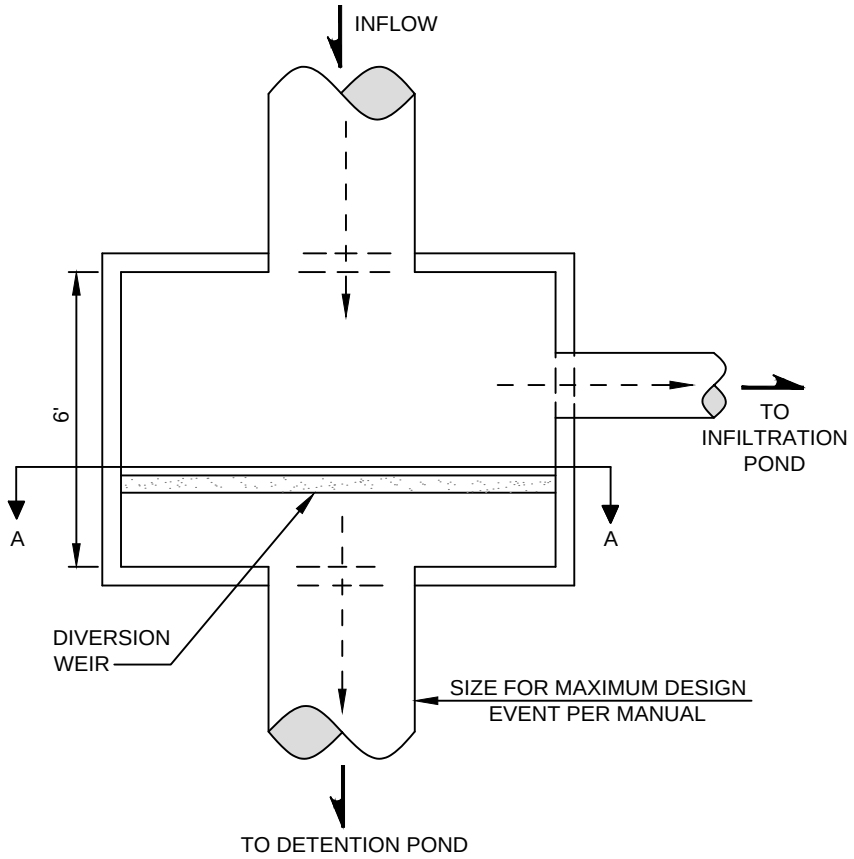
Pierce County
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ISOLATION / DIVERSION STRUCTURE

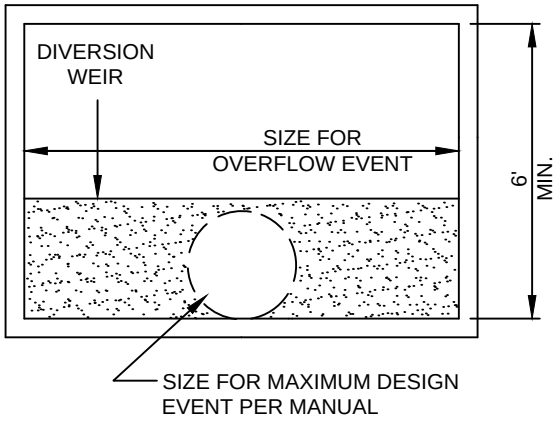
SECTION B - 8.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



INSIDE PLAN VIEW



SECTION A-A

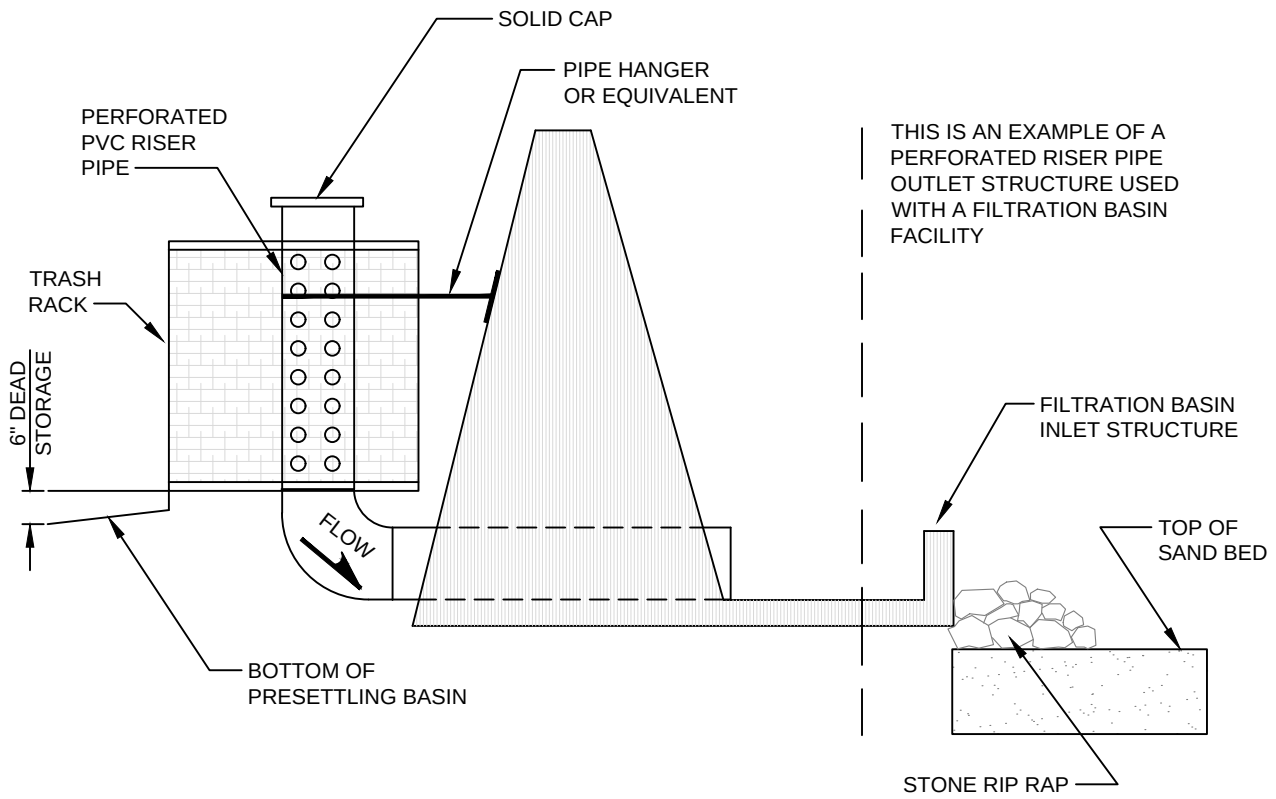
Pierce County
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ISOLATION / DIVERSION STRUCTURE

SECTION B - 9.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



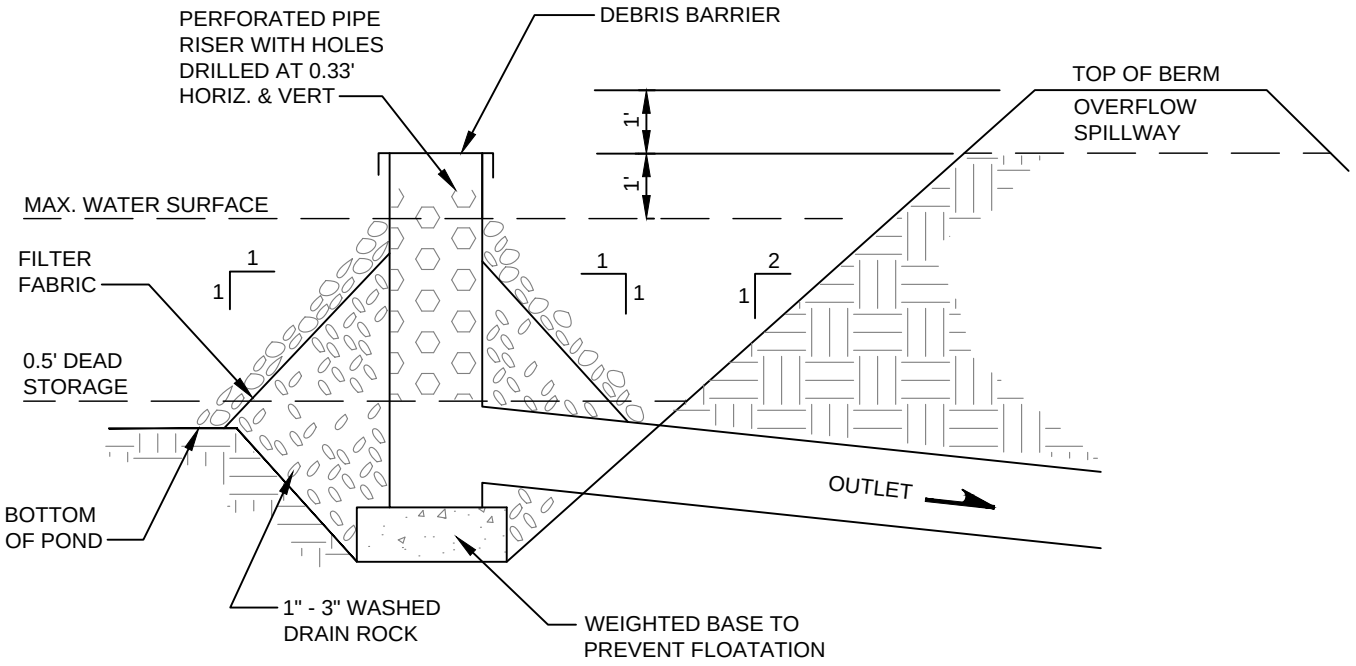
Pierce County
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PERFORATED RISER PIPE OUTLET STRUCTURE WITH TRASH RACK

SECTION B - 10.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



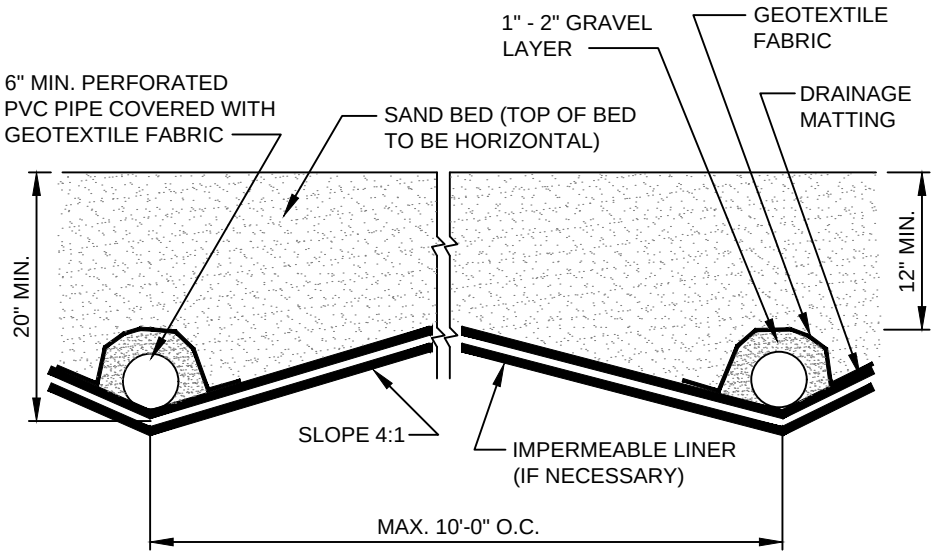
Pierce County
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GRAVEL CONE WITH RISER

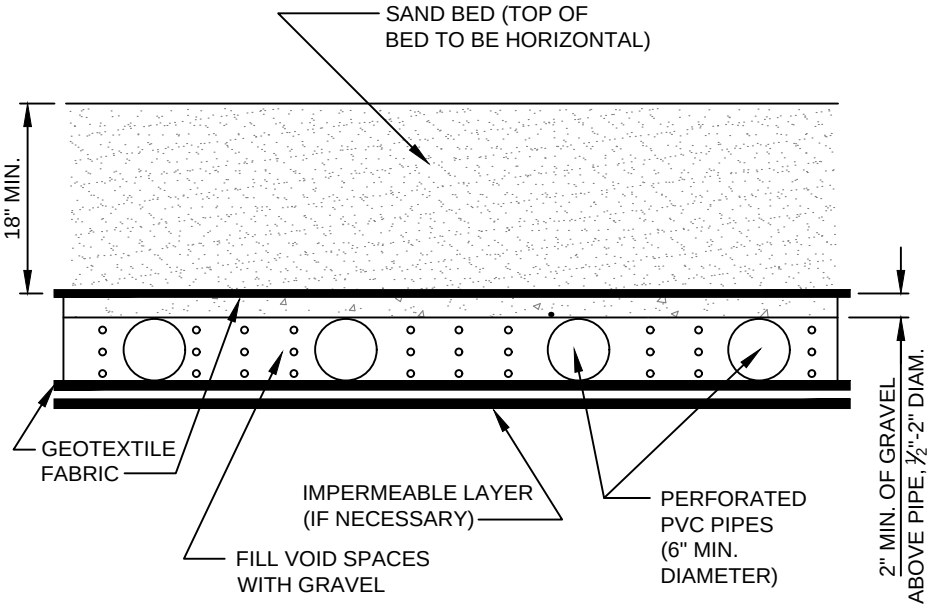
SECTION B - 11.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



B. SAND BED (TRENCH DESIGN)



A. SAND BED (WITH GRAVEL LAYER)

NOTE: PERFORATIONS TO BE ⅜". MAXIMUM SPACING BETWEEN ROWS OF PERFORATIONS WILL NOT EXCEED 6 INCHES.

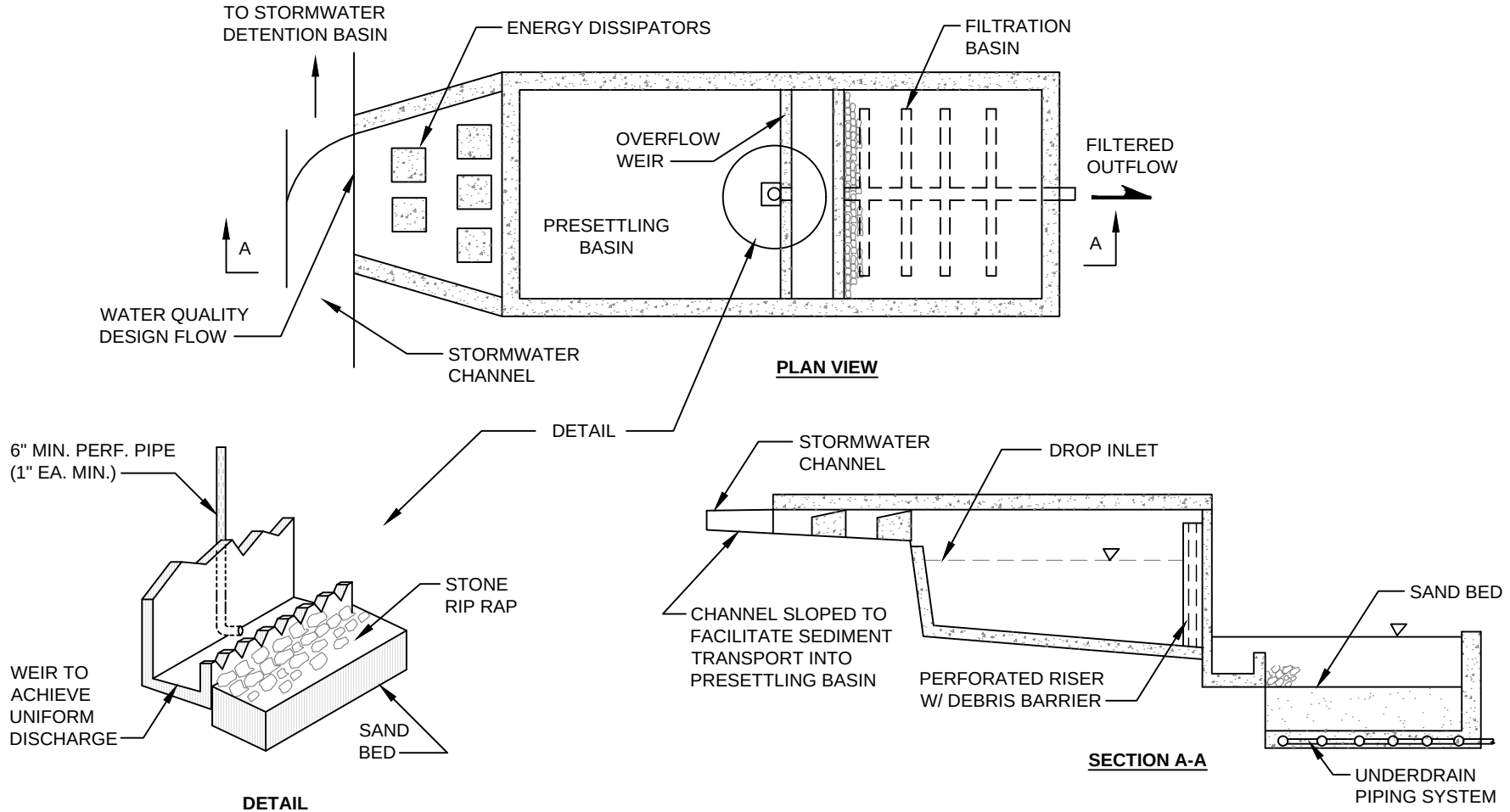
Pierce County
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SAND FILTRATION SYSTEM CONFIGURATION

SECTION B - 12.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



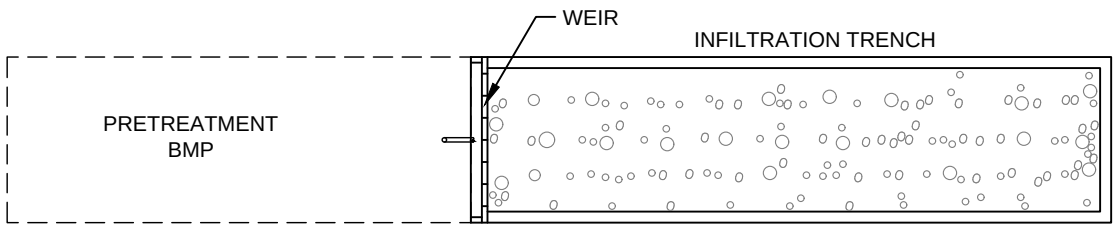
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SAND FILTRATION SYSTEM

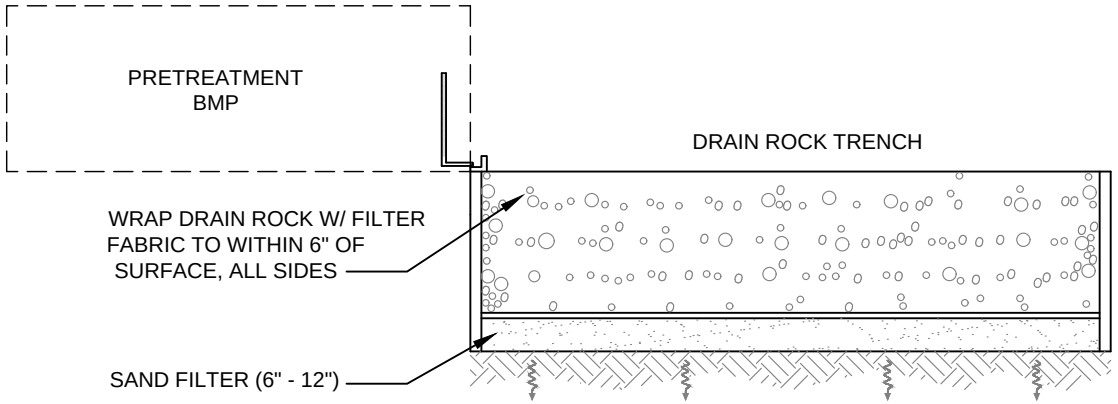
SECTION B - 13.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



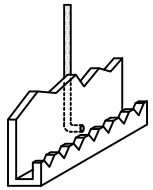
TOP VIEW



FILTERED RUNOFF EXFILTRATES THROUGH UNDISTURBED SOIL.

SIDE VIEW

WEIR OVERFLOW SPREADS
RUNOFF OVER TRENCH



NOTE: INFILTRATION
TRENCH TO BE PRECEDED
BY A PRETREATMENT BMP

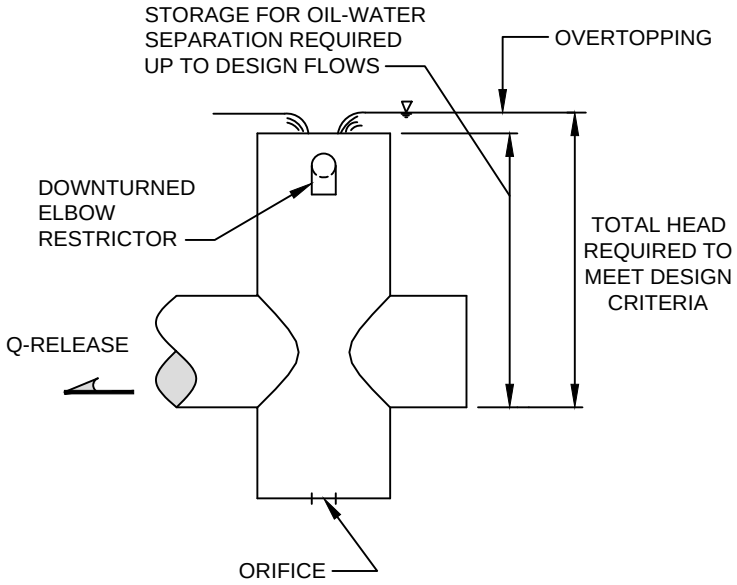
Pierce County
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WATER QUALITY INFILTRATION TRENCH SYSTEM

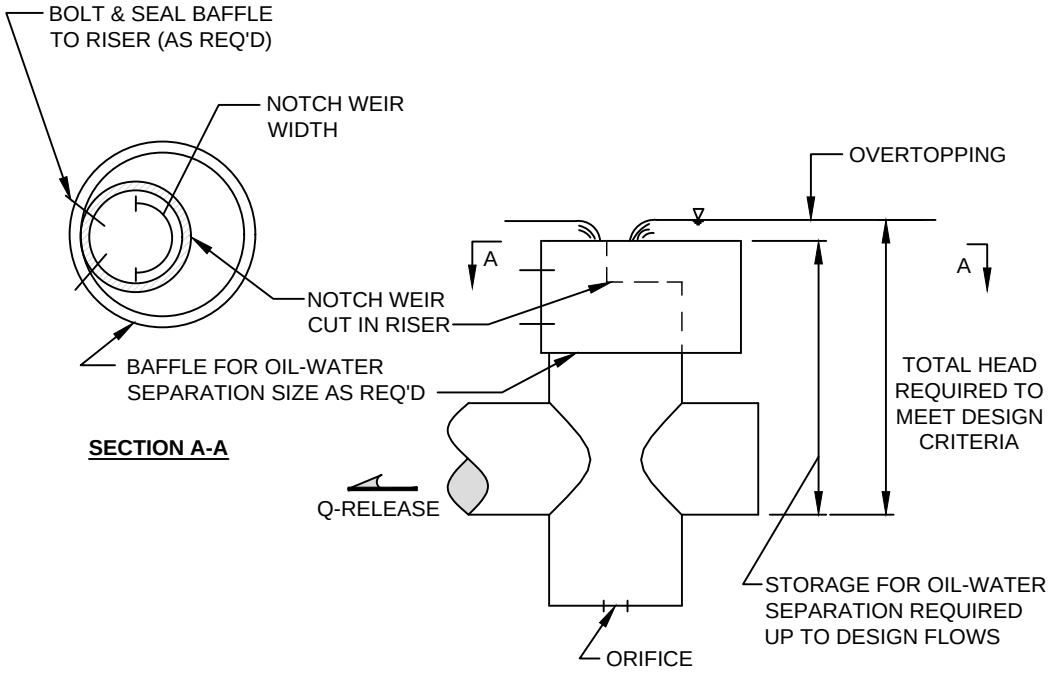
SECTION B - 14.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



OIL / WATER SEPARATION W/ ORIFICE CONTROL
N.T.S.



OIL / WATER SEPARATION W/ NOTCH CONTROL
N.T.S.

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Tacoma, Washington 98409

OIL/WATER SEPARATION WITH ORIFICE AND NOTCH CONTROL

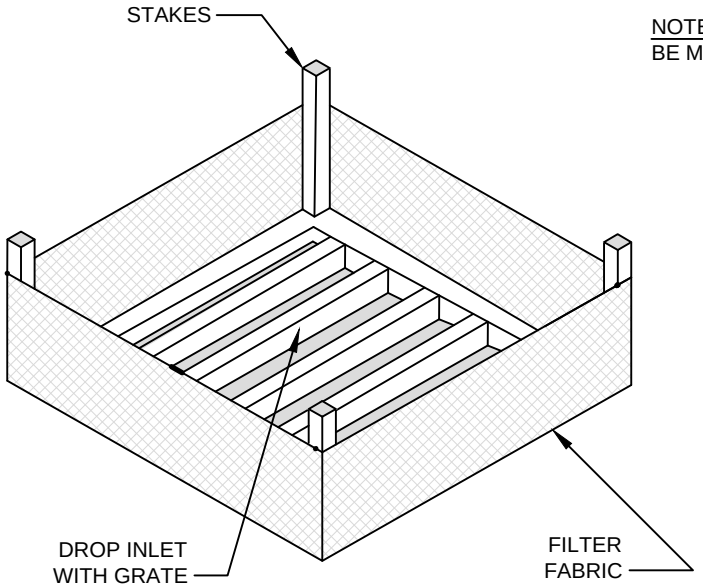
SECTION B - 15.0

ORDINANCE: 2021-45

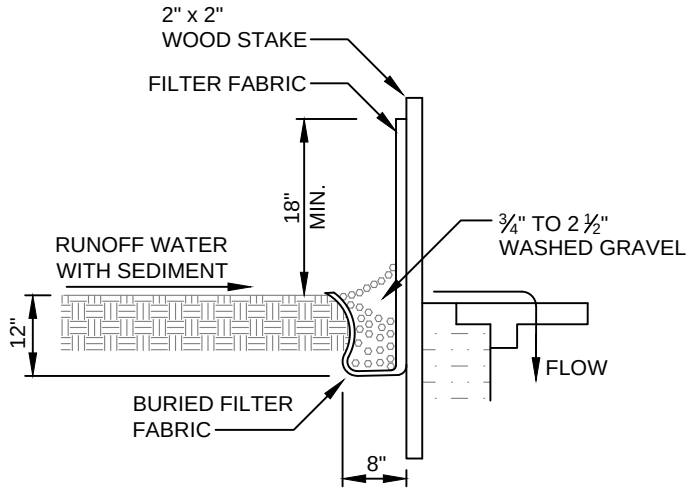
EFFECTIVE DATE: 7/1/2021

Section C - Erosion and Sediment Control Plan Details

Detail	Heading
1.0	Inlet Fabric Fence Filter
2.0	Inlet Block & Gravel Filter - Schematic
3.0	Temporary Sediment Control Inlet Gravel & Wire Mesh Filter
4.0	Construction Entrance Rock Pad
5.0	Sediment Pond - Example
5.1	Sediment Pond Cross-Section
5.2	Riser Detail
6.0	Permanent Sediment Trap for Presettling Basin - Schematic
7.0	Placement of Temporary Sedimentation Pond Baffles - Schematic
8.0	Silt Fence Detail
9.0	Typical Erosion Control Practices for SFR
10.0	*reserved for future use*
11.0	Brush Barrier - Schematic
12.0	Gravel Filter Berm
13.0	Sandbag Berm
14.0	Triangular Sediment Dikes
15.0	Pipe Slope Drains
16.0	Erosion Control Blankets - Schematic
17.0	Temporary Interceptor Dikes & Swales - Schematic
18.0	Temporary Gravel Outlet Structure
19.0	Rock Check Dams
20.0	ESC Structural Practices - Schematic
21.0	Sediment Trap
22.0	Sediment Trap Outlet



NOTE: ALL FILTER FABRIC SHALL BE MIRAFI 140NS OR EQUAL



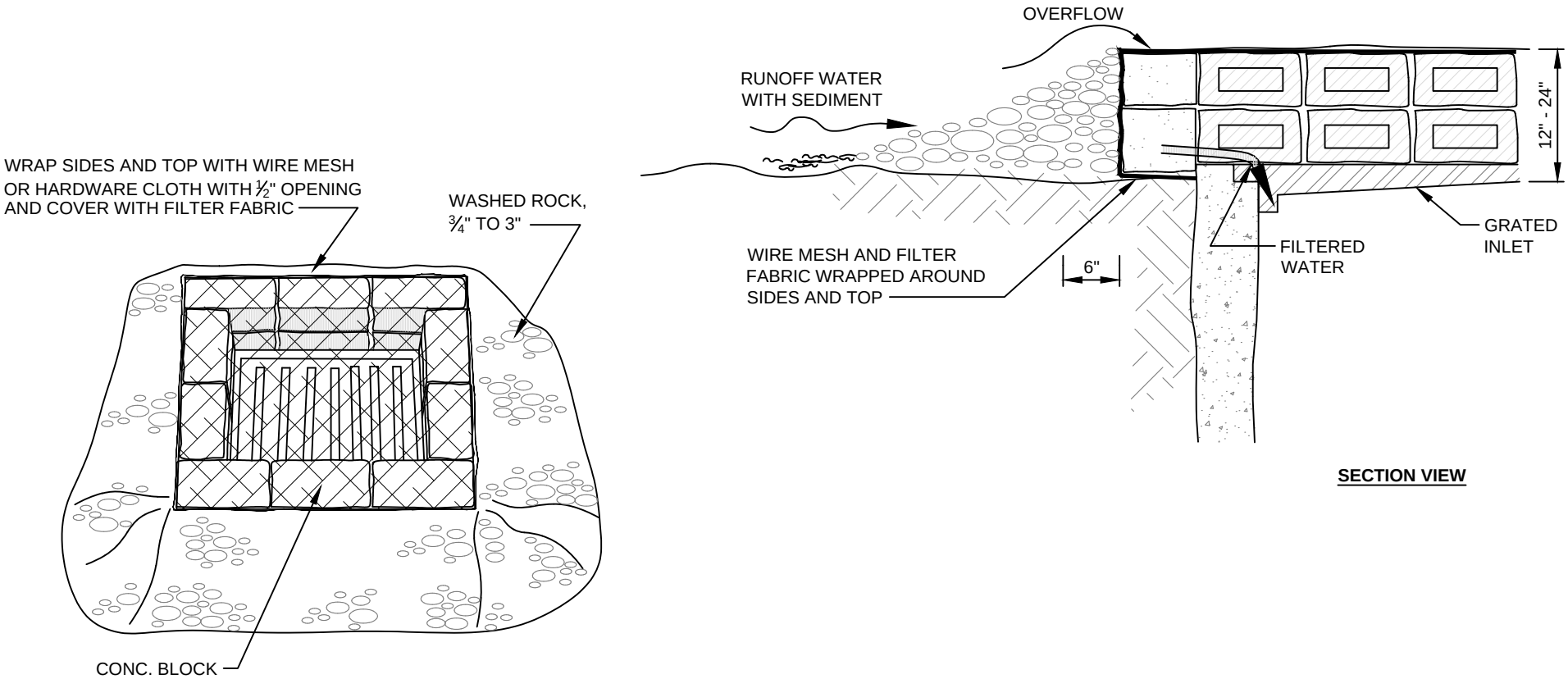
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INLET FABRIC FENCE FILTER

SECTION C - 1.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



SECTION VIEW

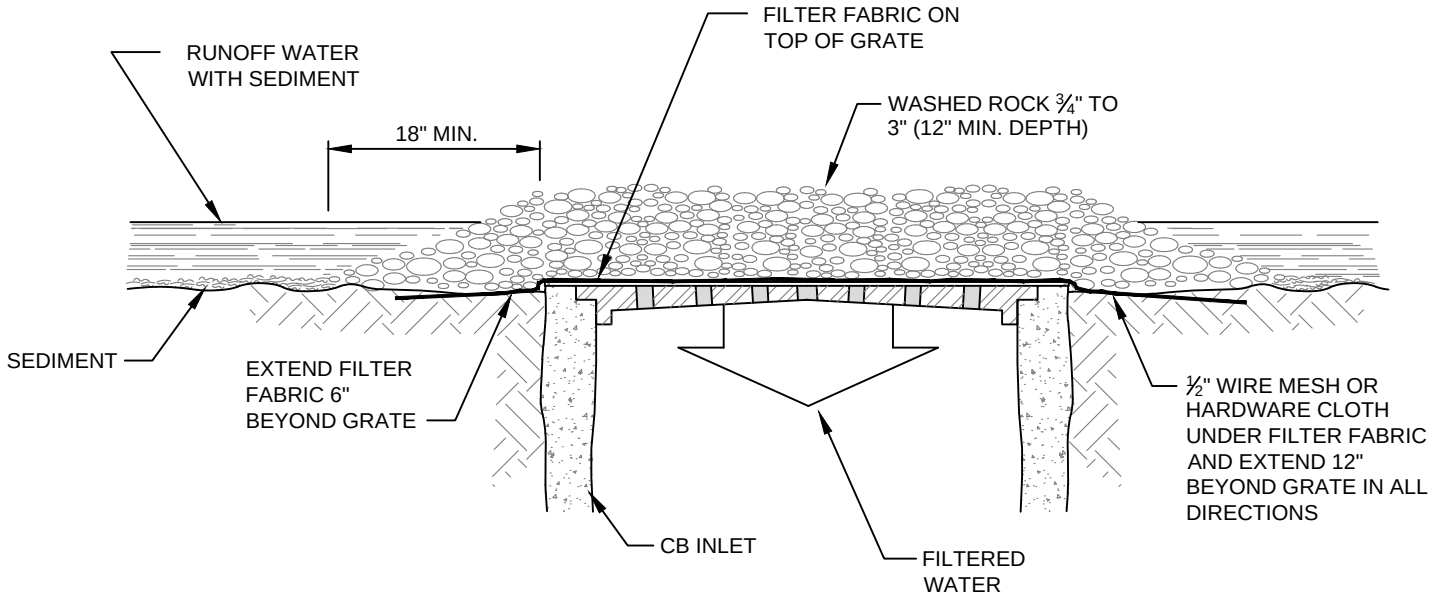
Pierce County
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Tacoma, Washington 98409

INLET BLOCK AND GRAVEL FILTER

SECTION C - 2.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



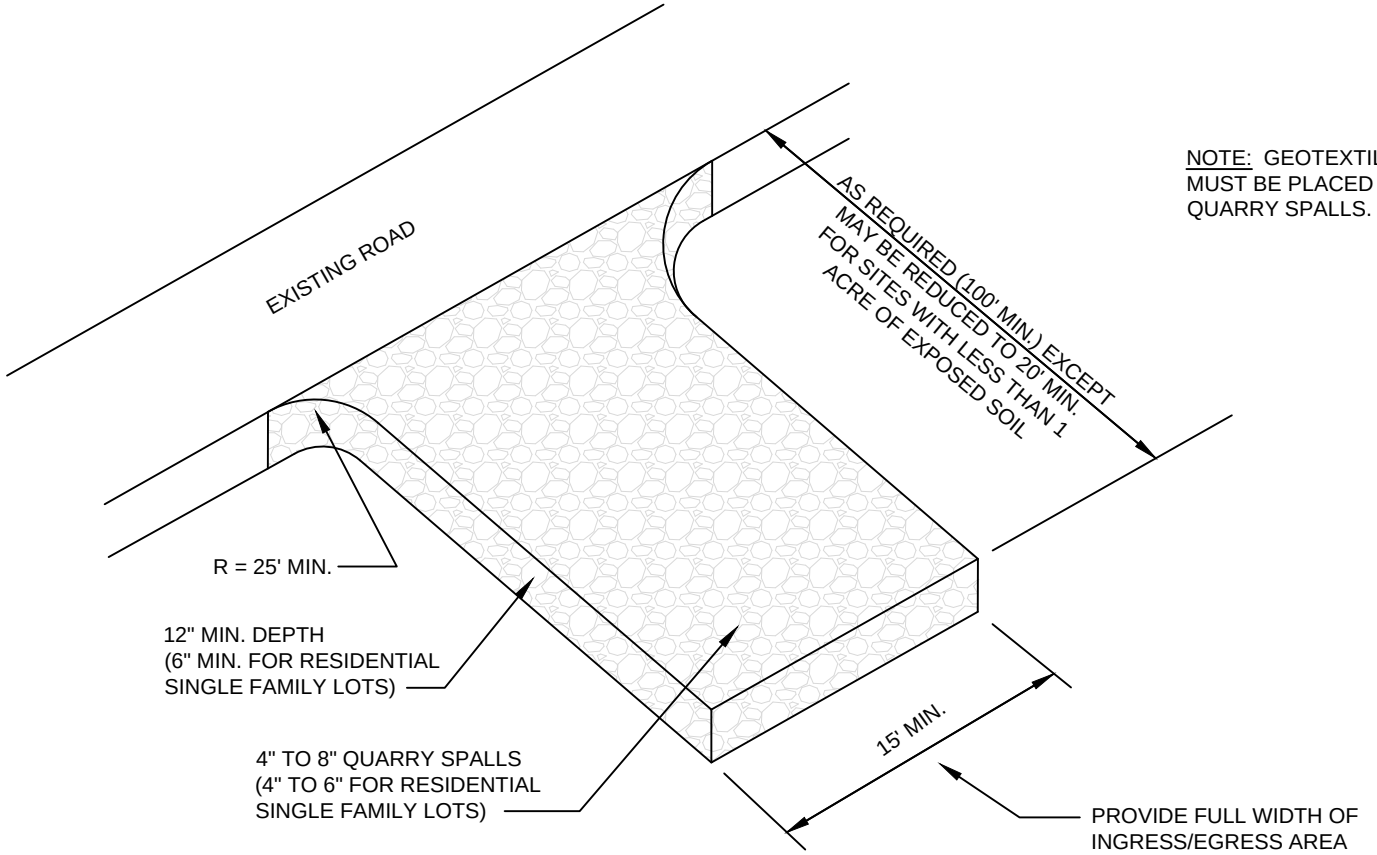
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Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

TEMPORARY SEDIMENT CONTROL INLET GRAVEL AND WIRE MESH FILTER

SECTION C - 3.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



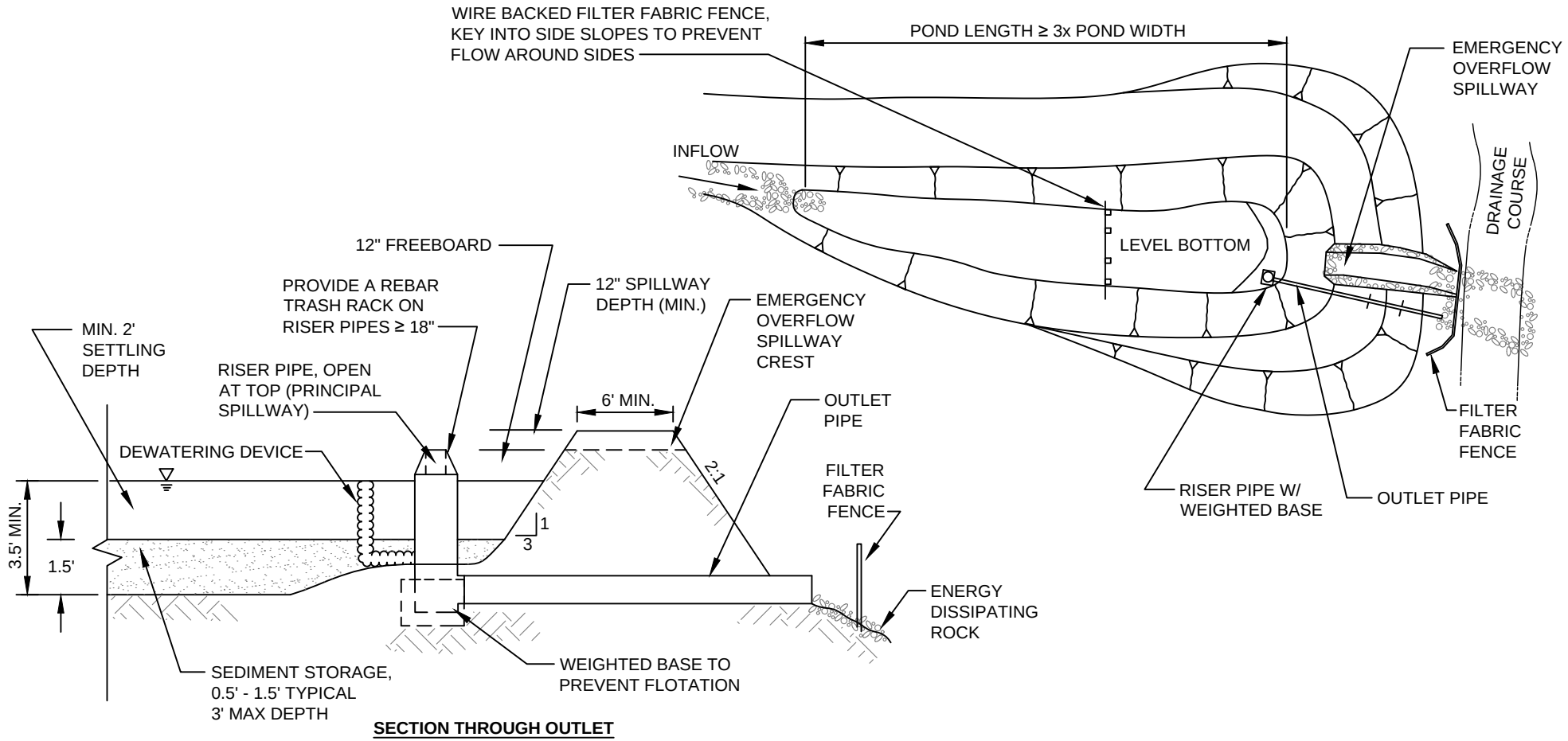
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

CONSTRUCTION ENTRANCE ROCK PAD

SECTION C - 4.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



SECTION THROUGH OUTLET

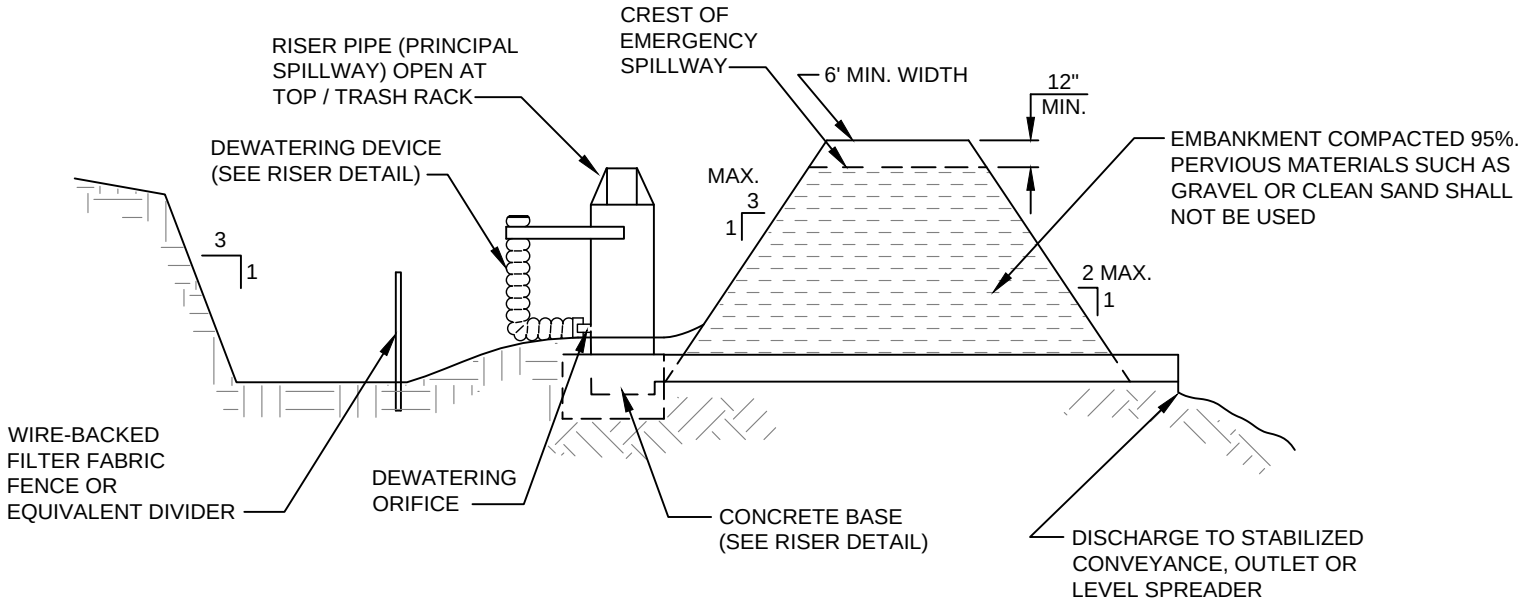
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

SEDIMENT POND - EXAMPLE

SECTION C - 5.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



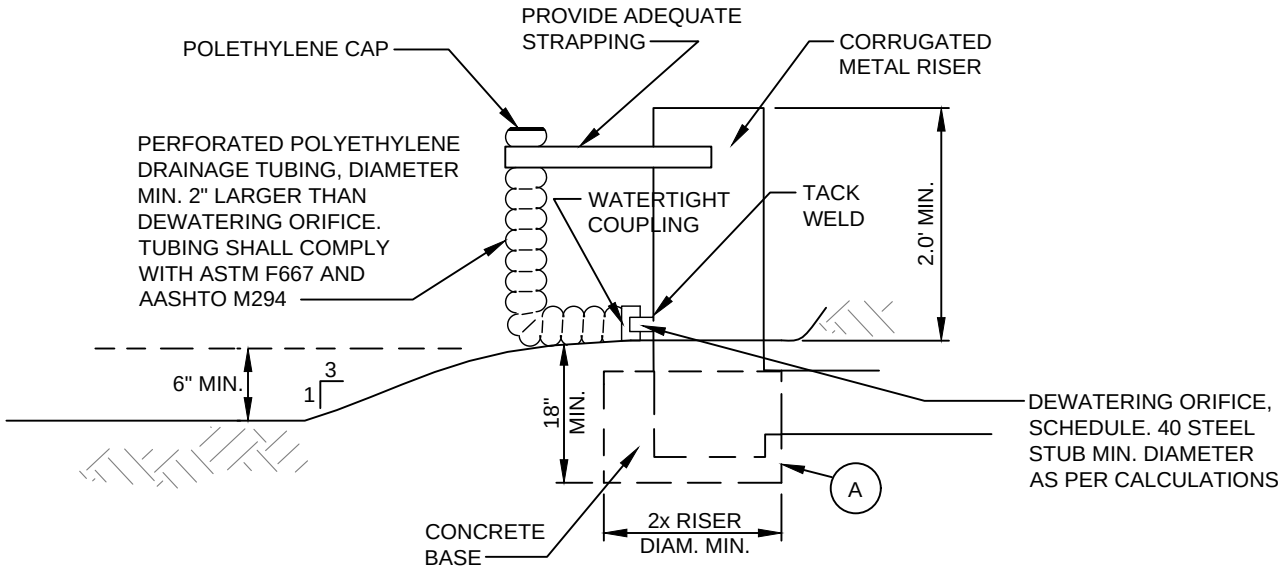
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

SEDIMENT POND CROSS-SECTION

SECTION C - 5.1

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



MAINTENANCE STANDARDS:

1. SEDIMENT SHALL BE REMOVED FROM THE POND WHEN IT REACHES 1' IN DEPTH.
2. ANY DAMAGE TO THE POND EMBANKMENTS OR SLOPES SHALL BE REPAIRED.

(A) ALTERNATIVELY, METAL STAKES AND WIRE MAY BE USED TO PREVENT FLOTATION

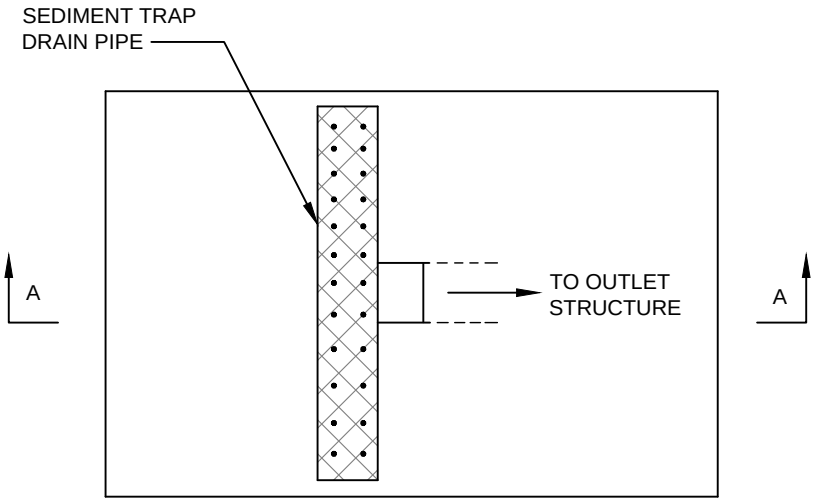
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

RISER DETAIL

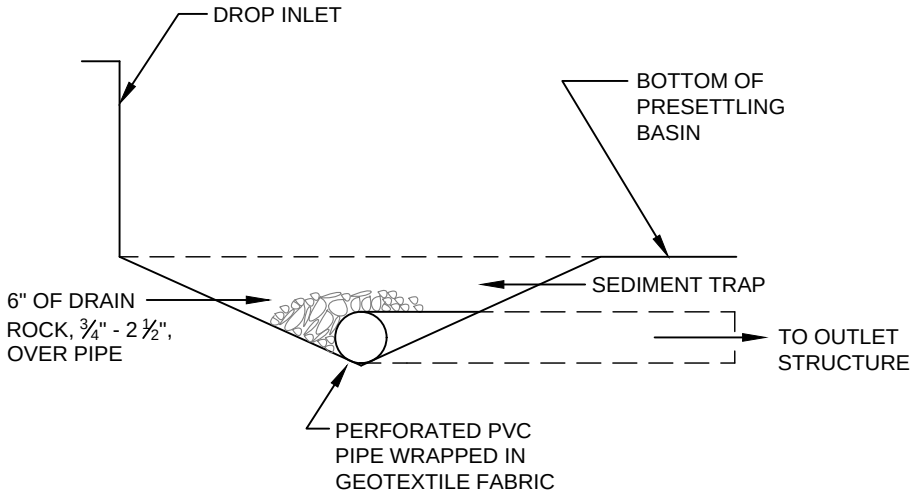
SECTION C - 5.2

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



PLAN VIEW
(GRAVEL NOT SHOWN)



SECTION A-A

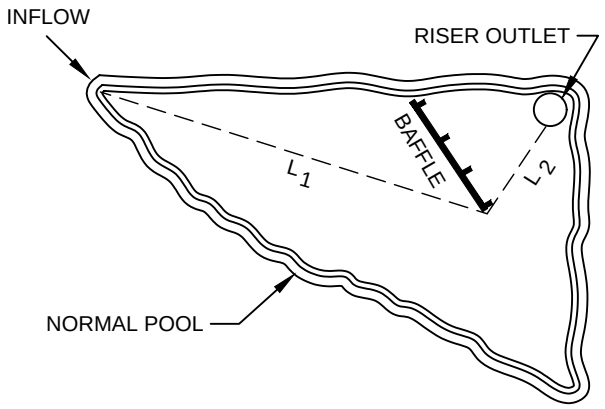
Pierce County
Planning and Public Works
2401 S 35th St.
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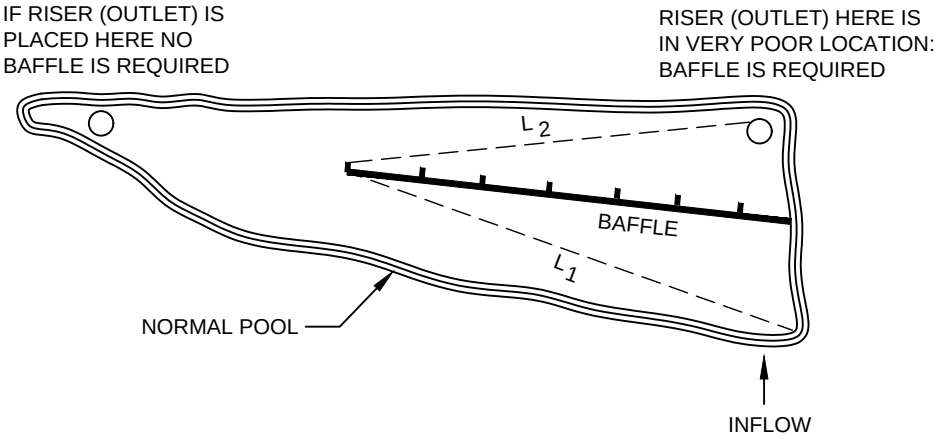
PERMANENT SEDIMENT TRAP FOR PRE-SETTLING BASIN

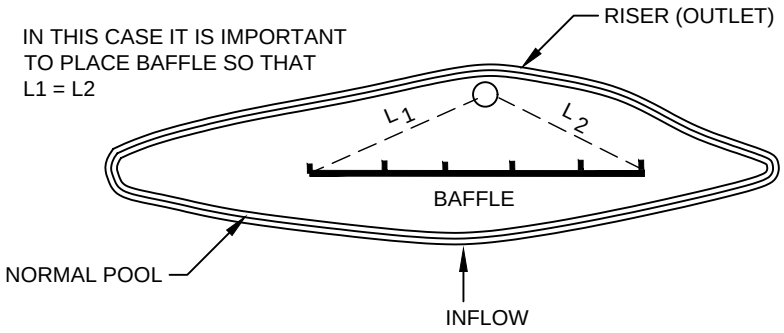
SECTION C - 6.0

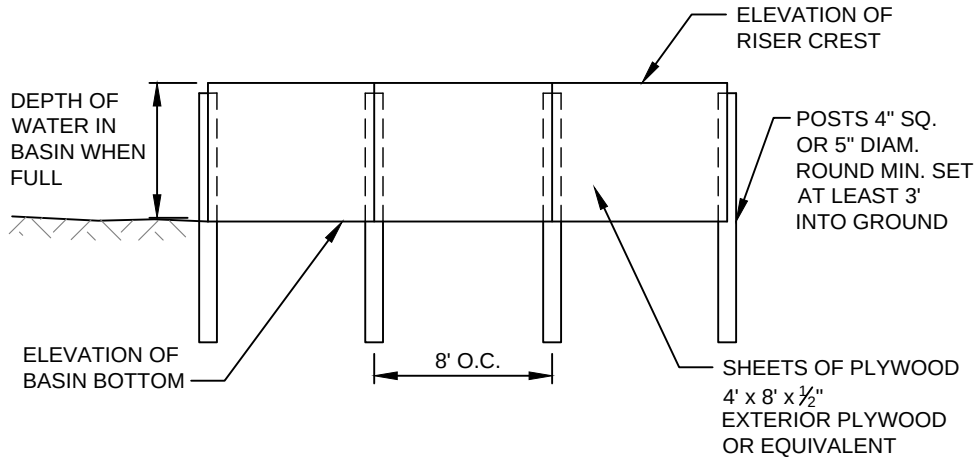
ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021









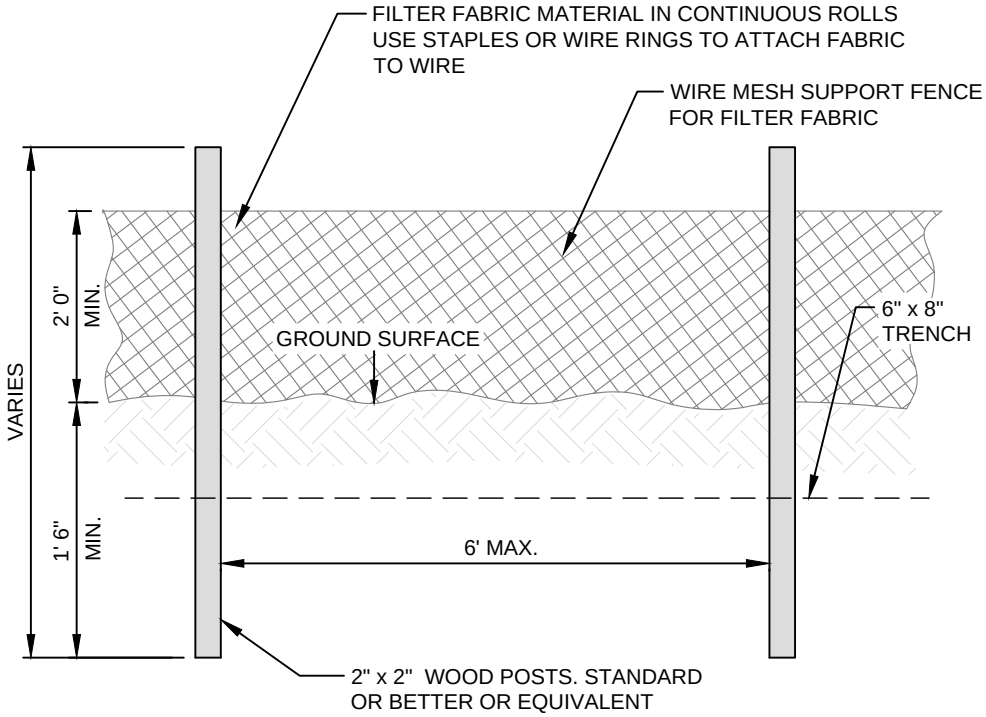
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2401 S 35th St.
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PLACEMENT OF TEMPORARY SEDIMENTATION POND BAFFLES

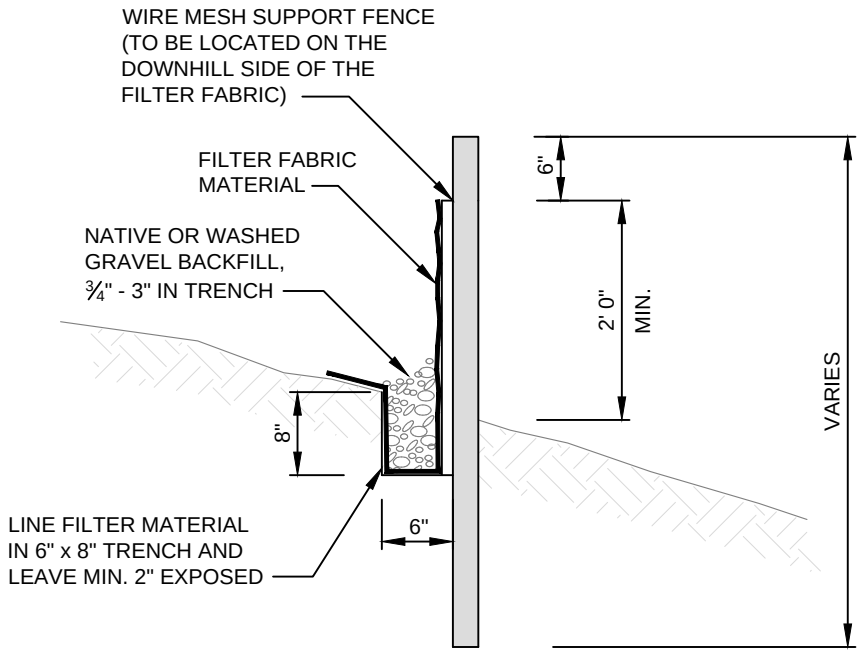
SECTION C - 7.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



SECTION



SECTION

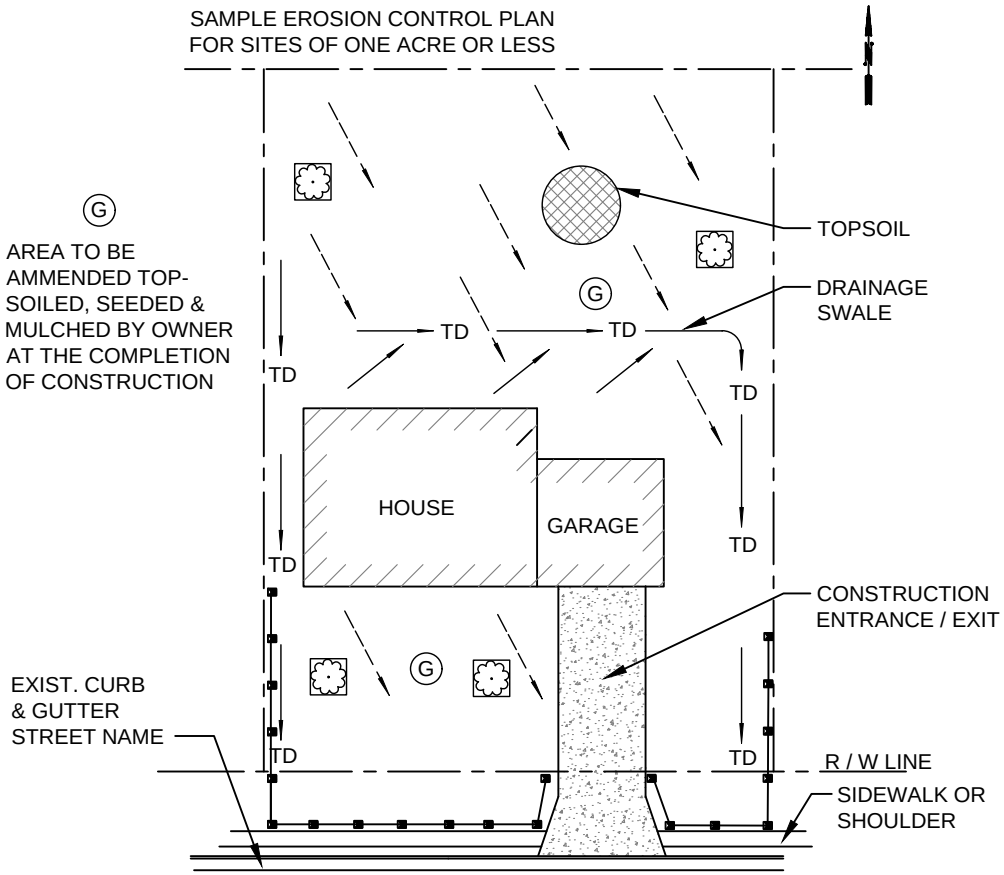
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Tacoma, Washington 98409

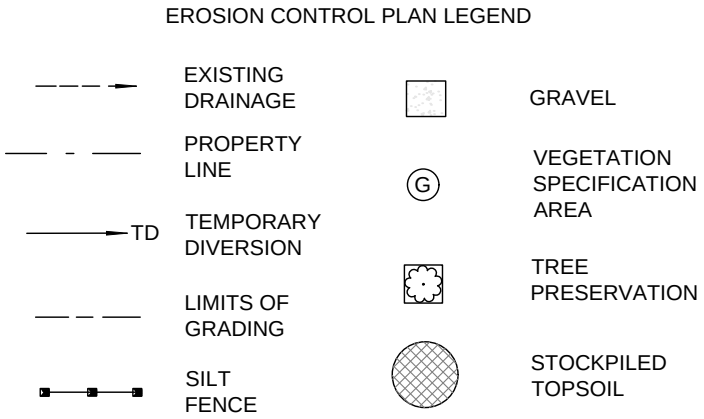
SILT FENCE

SECTION C - 8.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021





PROJECT LOCATION:	
PROPERTY OWNER:	
CONTRACTOR:	
PREPARED BY:	DATE:

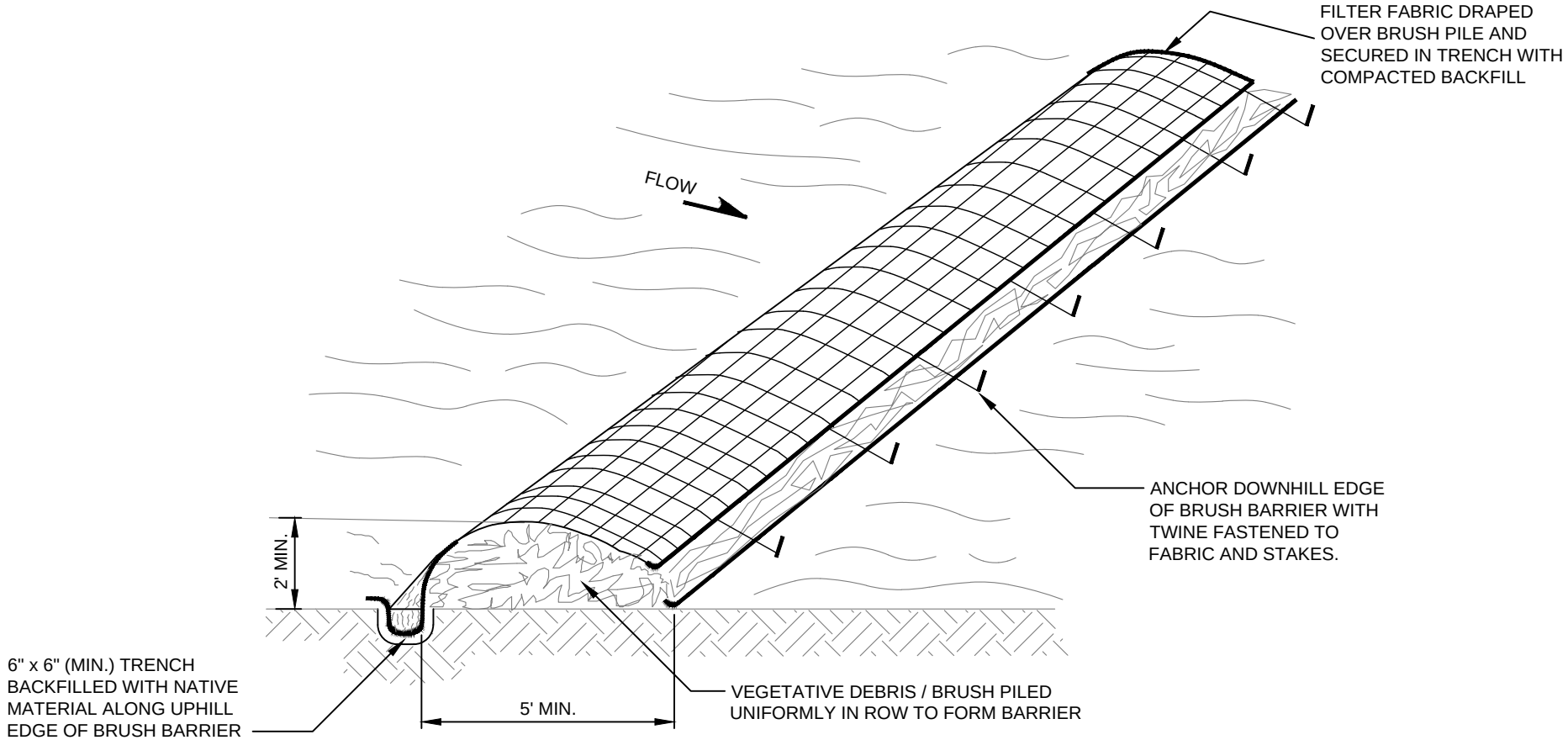
Pierce County
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Tacoma, Washington 98409

TYPICAL EROSION CONTROL PRACTICES FOR SINGLE FAMILY RESIDENCES

SECTION C - 9.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



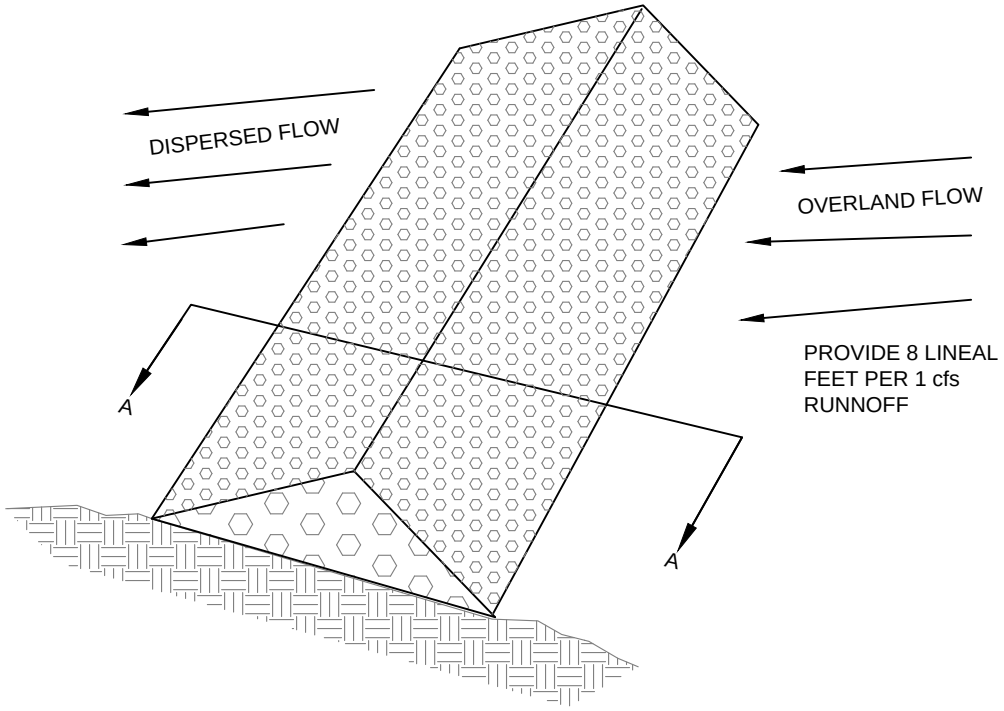
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Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

BRUSH BARRIER

SECTION C - 11.0

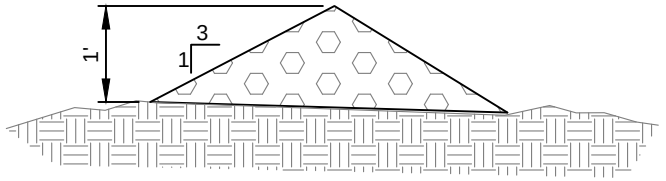
ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



NOTE: MAXIMUM DRAINAGE AREA TO BERM IS 5 ACRES

¾" - 3" WELL GRADED GRAVEL OR CRUSHED ROCK



CROSS SECTION OF GRAVEL FILTER BERM

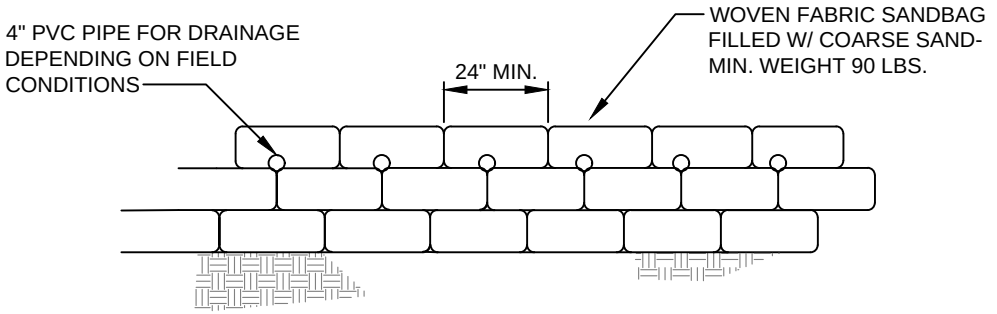
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GRAVEL FILTER BERM

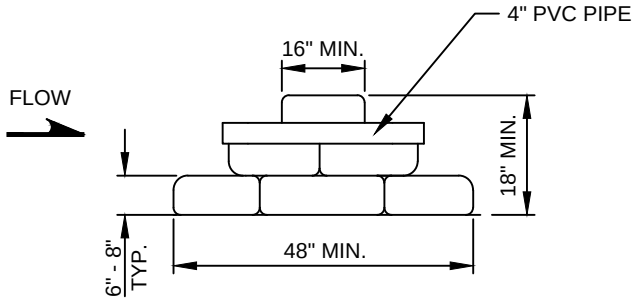
SECTION C - 12.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



FRONT VIEW



CROSS SECTION

NOTES:

1. WHEN SANDBAG IS FILLED WITH COARSE GRADE SAND MATERIAL, THE OPEN END SHOULD BE STAPLED OR TIED WITH NYLON OR POLY CORD. THE WEIGHT SHALL BE 90 - 125 LBS.

2. SANDBAGS SHOULD BE STACKED IN AT LEAST THREE VERTICAL ROWS ABUTTING EACH OTHER, AND IN STAGGERED ARRANGEMENT. (REFER TO FRONT VIEW).

3. THE BASE OF THE BERM SHOULD BE AT LEAST 3 SANDBAGS DEEP AND CAN BE REDUCED TO 2 AND 1 BAG IN THE SECOND AND THIRD ROWS RESPECTIVELY. (REFER TO CROSS SECTION).

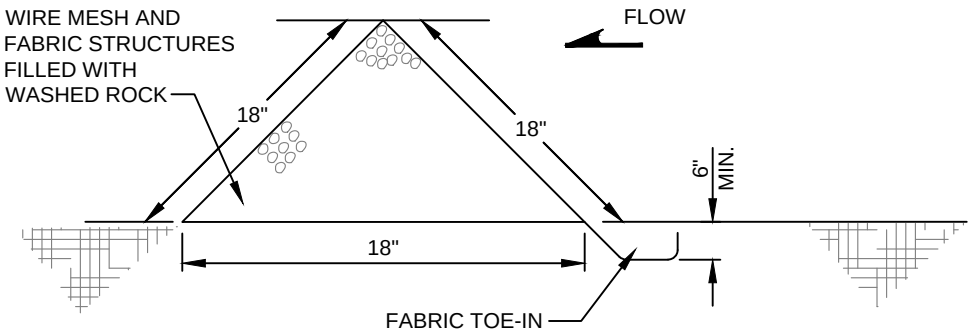
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Tacoma, Washington 98409

SANDBAG BERM

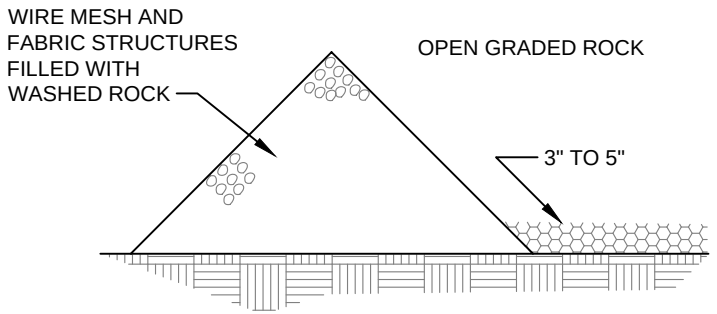
SECTION C - 13.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



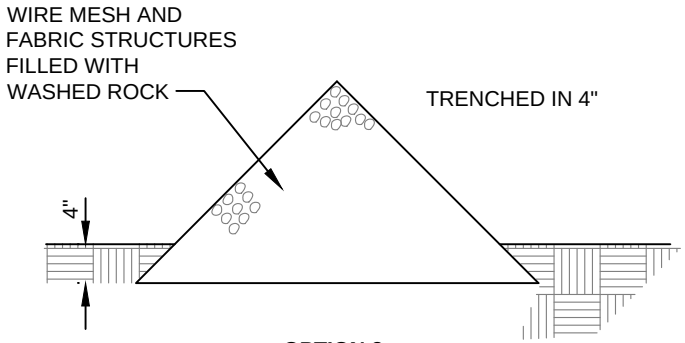
OPTION 1



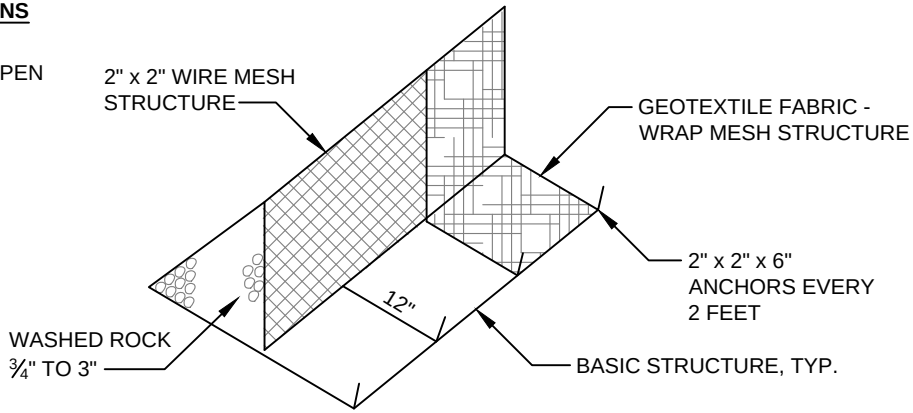
OPTION 2

INSTALLATION DETAIL OPTIONS

1) TOE-IN 6" MIN.
2) WEIGHTED WITH 3"-5" OPEN GRADED ROCK
3) TRENCHED IN 4"



OPTION 3



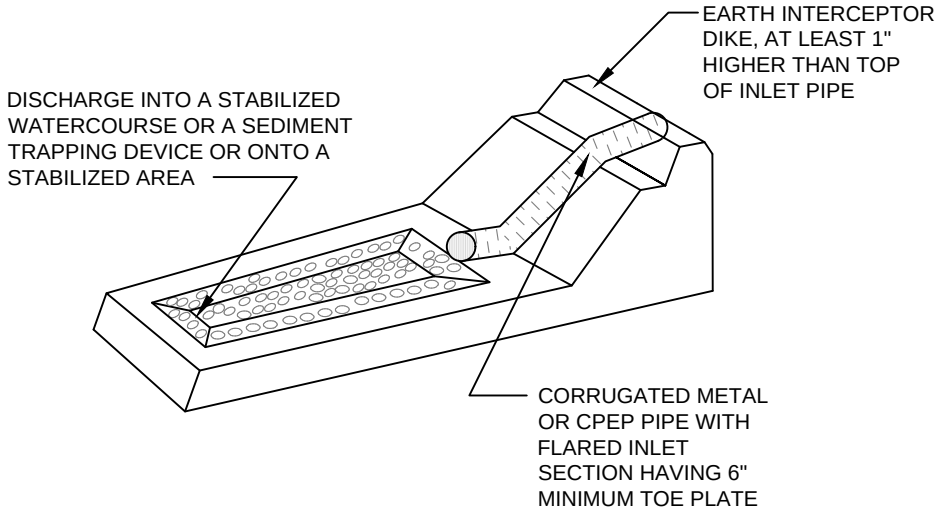
Pierce County
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Tacoma, Washington 98409

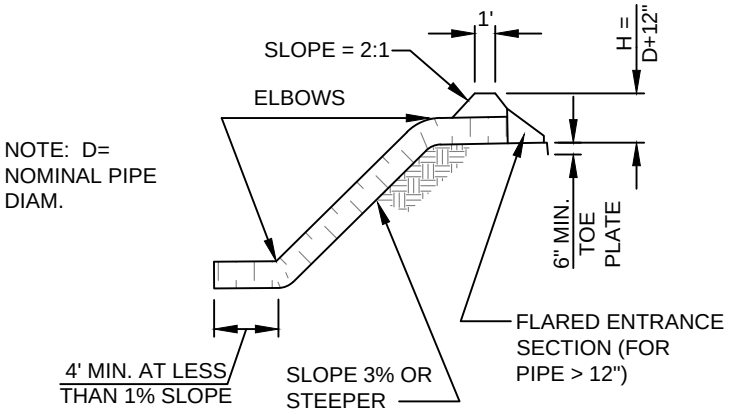
TRIANGULAR SEDIMENT FILTER DIKES

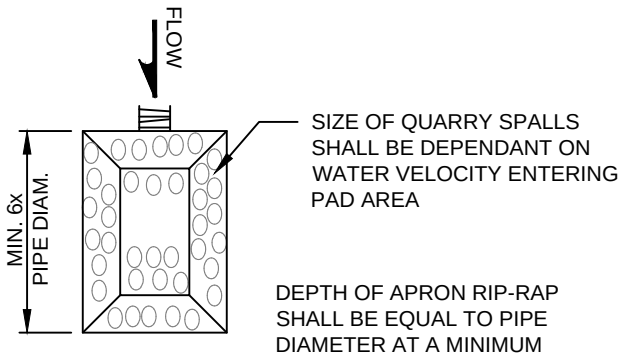
SECTION C - 14.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021







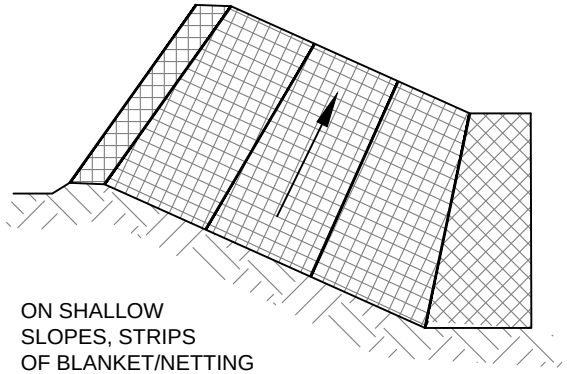
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

PIPE SLOPE DRAINS

SECTION C - 15.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

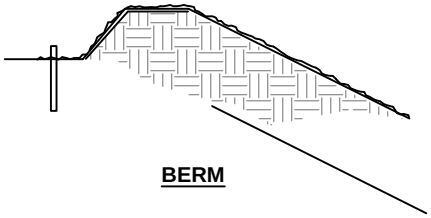


ON SHALLOW SLOPES, STRIPS OF BLANKET/NETTING MAY BE APPLIED ACROSS THE SLOPE (SLOPES UP TO 1:1)

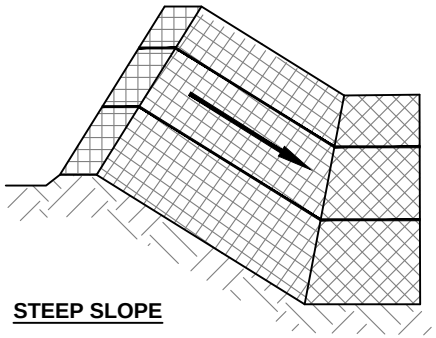
SHALLOW SLOPE

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

WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE BLANKET/NETTING OVER THE BERM AND ANCHOR IT BEHIND THE BERM LINE.



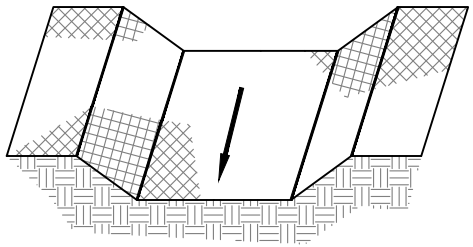
BERM



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

STEEP SLOPE

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



SHALLOW SLOPE

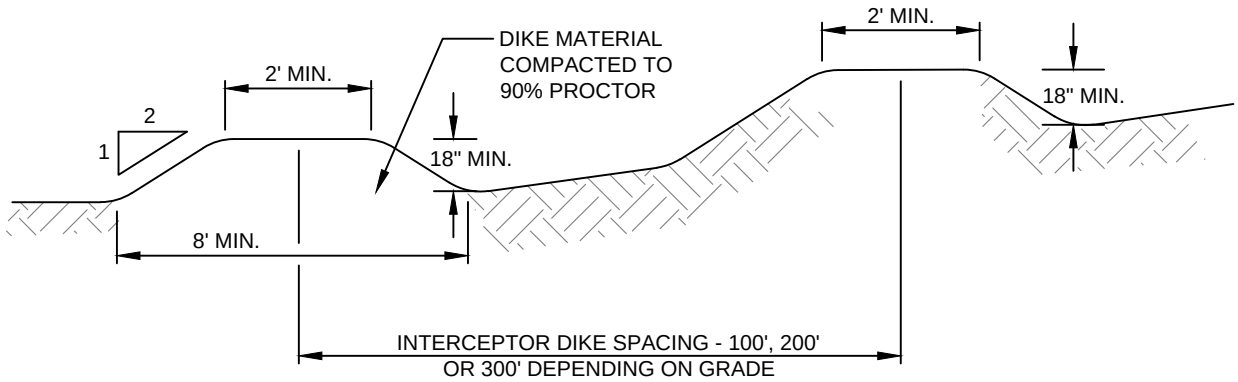
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Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

EROSION CONTROL BLANKETS AND NETTING

SECTION C - 16.0

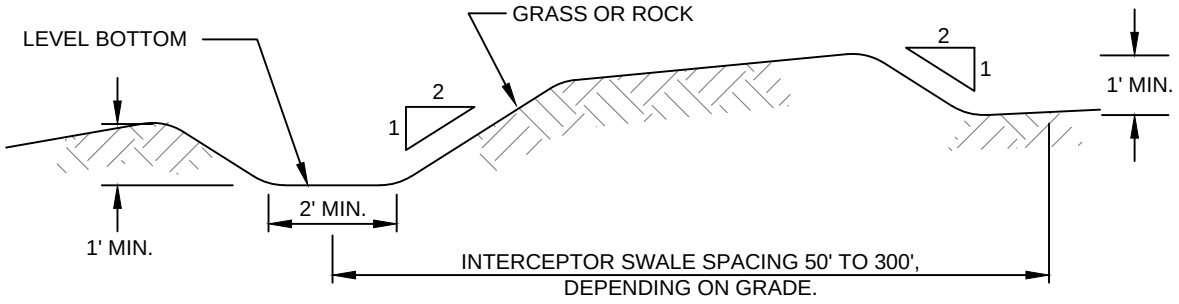
ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



(A) INTERCEPTOR DIKES

SECTION



(B) INTERCEPTOR SWALES

SECTION

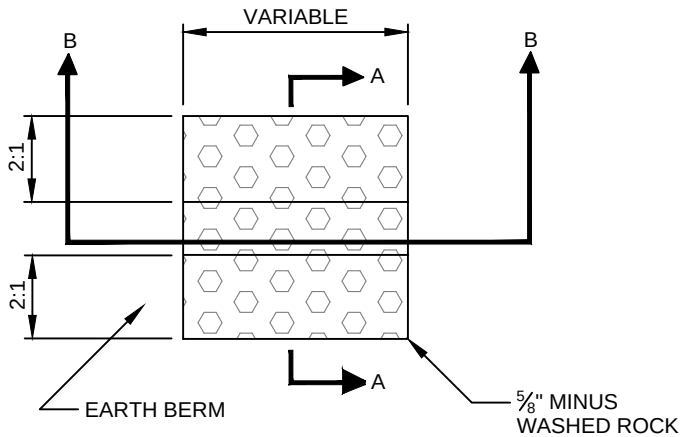
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

TEMPORARY INTERCEPTOR DIKES AND SWALES

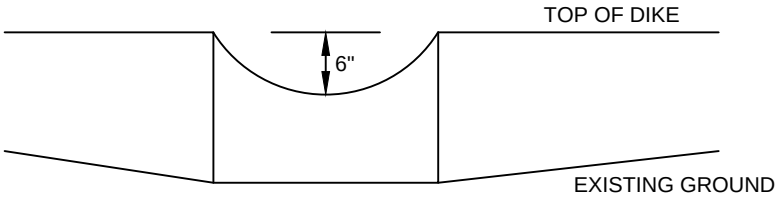
SECTION C - 17.0

ORDINANCE: 2021-45

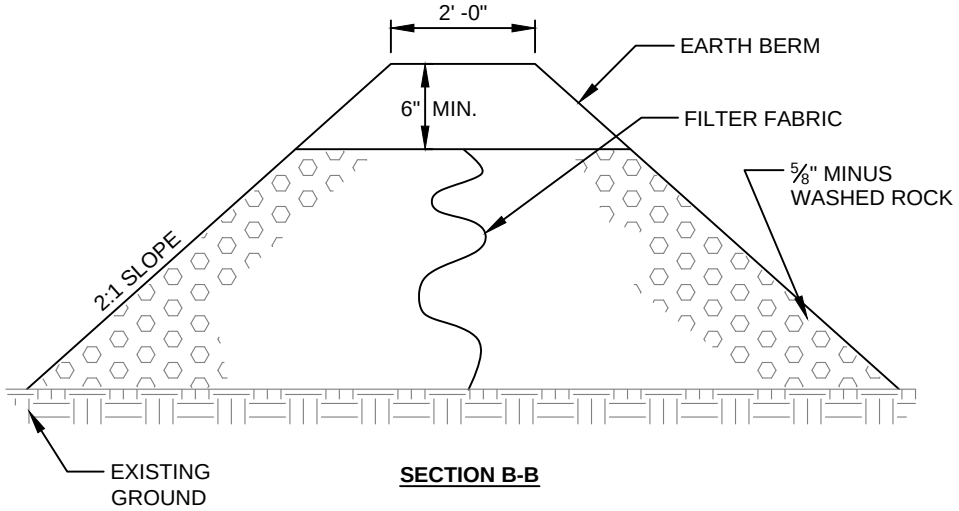
EFFECTIVE DATE: 7/1/2021



PLAN



SECTION A-A



SECTION B-B

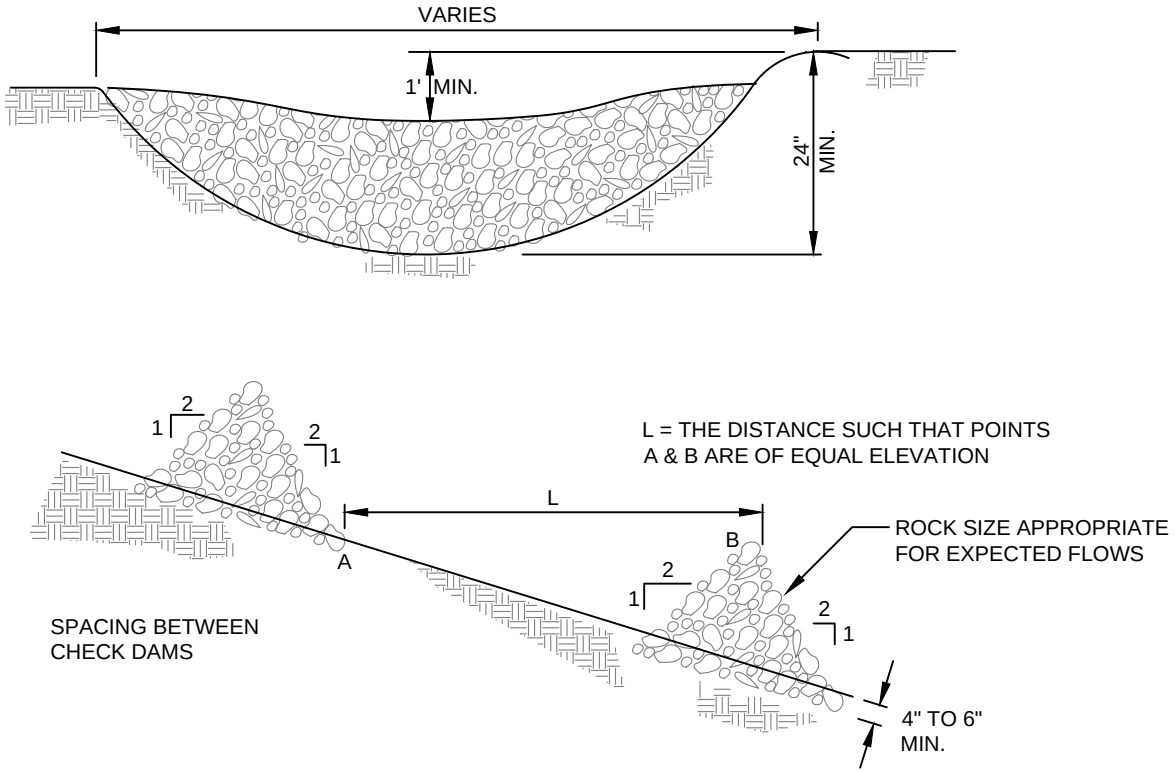
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

TEMPORARY GRAVEL OUTLET STRUCTURE

SECTION C - 18.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



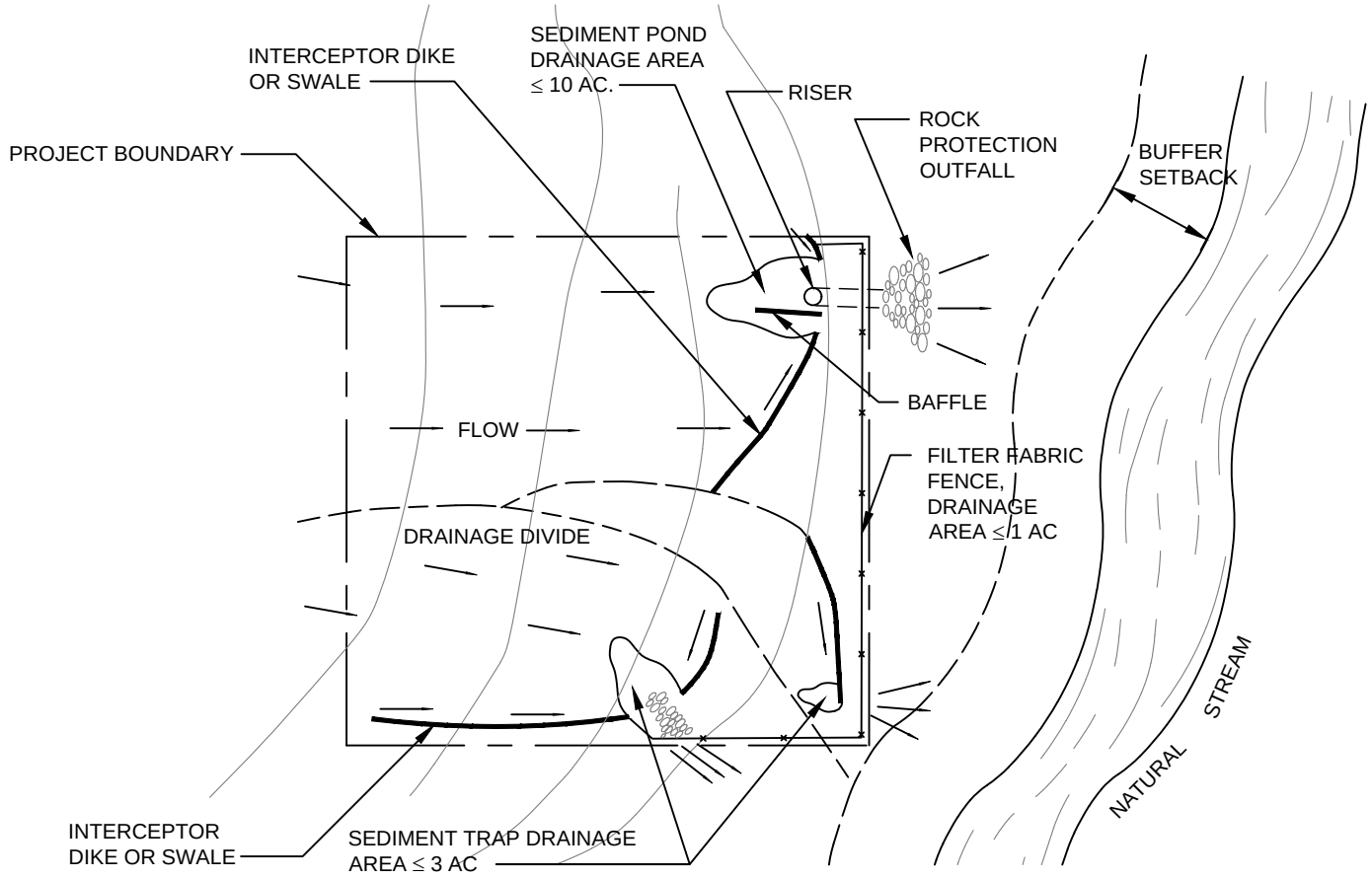
Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

ROCK CHECK DAMS

SECTION C - 19.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



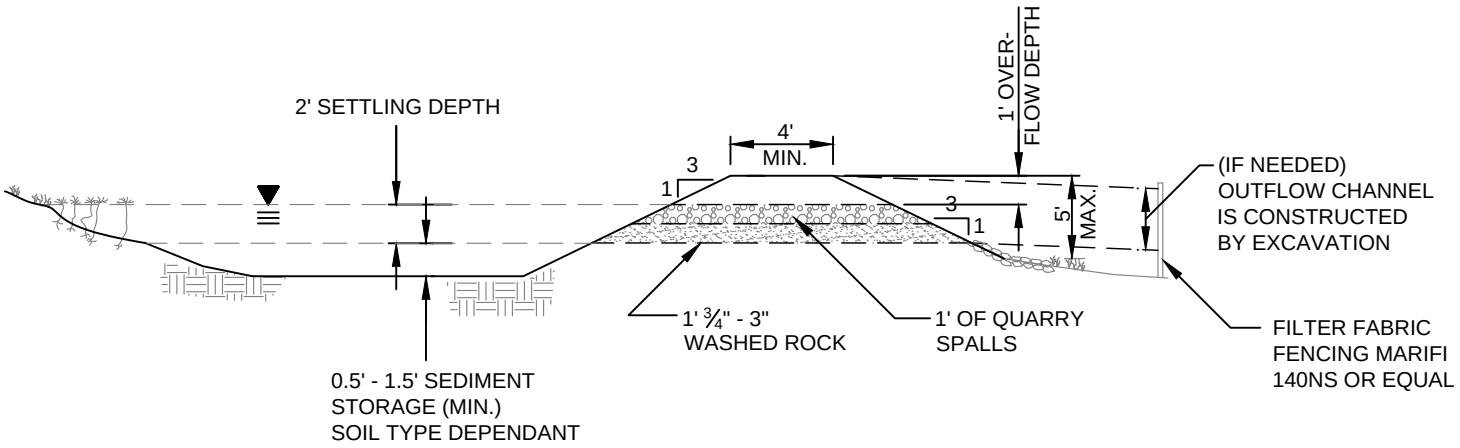
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Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

ESC STRUCTURAL PRACTICES

SECTION C - 20.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



CROSS SECTION

SEE DETAIL 22.0

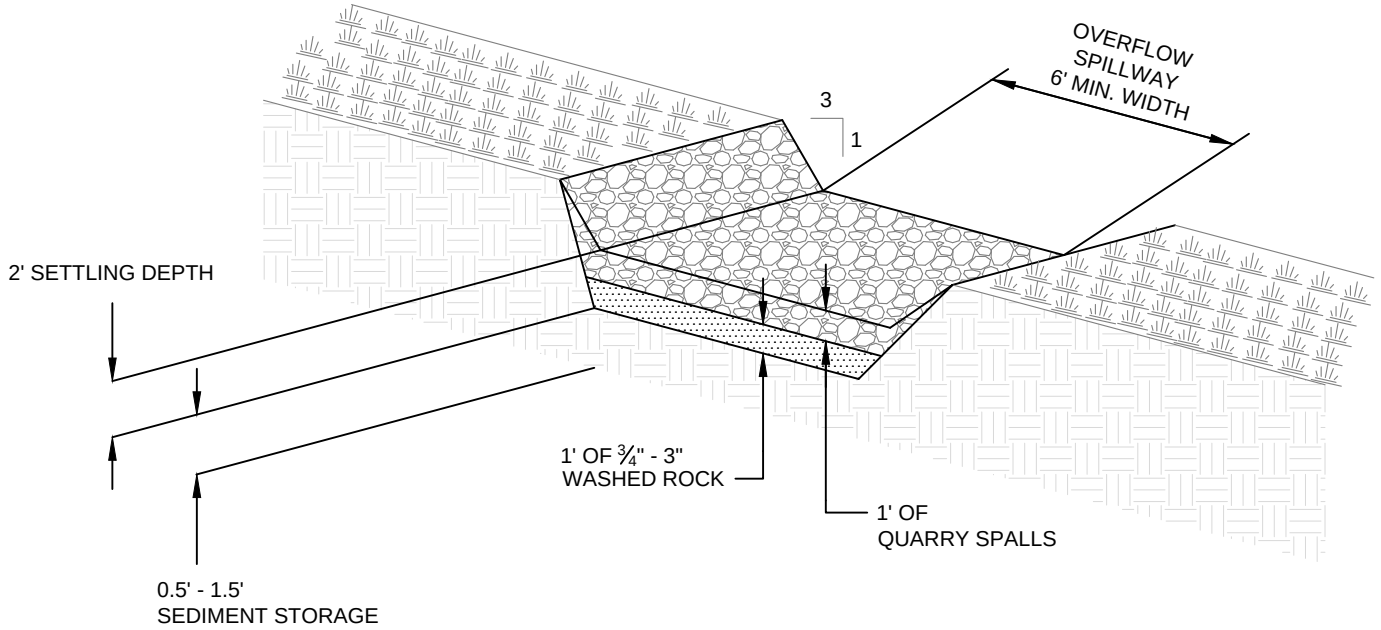
Pierce County
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2401 S 35th St.
Tacoma, Washington 98409

SEDIMENT TRAP

SECTION C - 21.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021



SEE DETAIL 21.0

Pierce County
Planning and Public Works
2401 S 35th St.
Tacoma, Washington 98409

SEDIMENT TRAP OUTLET

SECTION C - 22.0

ORDINANCE: 2021-45

EFFECTIVE DATE: 7/1/2021

Section D - Soil Evaluation Report Forms

Preparer: Please read all instructions first	Staff use only

Soil Evaluation Report
Form 1: General Site Information

Project Title:	Sheet: of
Project Number:	Date:
Prepared by:	
1. Site Address or Legal Description:	
2. Project Description:	
3. Site Description:	
4. Summary of Soils Work Performed:	
5. Additional Soils Work Recommended:	
6. Findings (including pre-development site percolation rate):	
7. Recommendations:	
I hereby state that I prepared this report, and conducted or supervised the performance of related work. I state that I am qualified to do this work. I represent my work to be complete and accurate within the bounds of uncertainty inherent to the practice of soil science, and to be suitable for its intended use. Signed: Date:	

Instructions for completing Form 1: Soil Evaluation Report

Form 1 is the cover page for all projects that require a soil evaluation report. One copy of Form 1 must accompany all soil evaluation reports. Certain information may be omitted for soil evaluations completed for small projects (e.g., single-family residences, duplexes).

1. Provide project name and address or legal description. Attach a legible 8.5" by 11" map showing site and major landmarks (e.g., roadways and surface waters) within an approximate ¼-mile radius around site.
2. Provide acreage, parcel dimensions, type of development proposed, and approximate proposed coverage of impervious surfaces.
3. Describe site topography, geomorphology, terrain, and natural cover. Distinguish among areas of the site with significantly different characteristics.
4. Provide description and purpose of soils work done. List methods used to expose, sample, and test soils. Give number of test holes logged. Describe field and lab tests performed. Attach an 8.5" by 11" scaled map of good accuracy showing locations of soil logs by number. Except small projects, using soil log results, divide map area into sub-areas according to hydrologic group (A through D).
5. Describe soils work still needed. For example, more work may be needed to obtain accurate percolation or infiltration rates for stormwater facilities not yet constructed.
6. Describe results of soil logs and tests and compare with expected soils from SCS Soils maps. As appropriate for the project, give your best estimate of the (a) overall predeveloped site infiltration rate, (b) the saturated infiltration rate for the above-ground stormwater facility, or (c) the saturated percolation rate for the below-ground stormwater trench or drywell. Discuss soils factors related to erosion control, infiltration, percolation, and placement of buildings, as these vary on the site.
7. Describe the recommended general approach for managing stormwater on the site. For example, if stormwater can be infiltrated or percolated, indicate where and at what depth. If erosion, soil stability, or high ground water are problems, can these problems be avoided or mitigated?

Sign the form and affix any relevant professional seal (e.g., P.E., ARCPACS). The form becomes the cover page to one or more copies of form 2, which has soil logs for each test hole evaluated.

Preparer: Please read all instructions first	Staff use only

Soil Evaluation Report
Form 2: Soil Log Information

Project Title:	Sheet: of
Project Number:	Date:
Prepared by:	
Soil log:	
Location:	

1. Types of tests done:	2. SCS soil series:	3. Land form:
4. Deposition history:	5. Hydrologic soil group:	6. Depth to seasonal high water:
7. Current water depth:	8. Depth to impervious layer:	9. Miscellaneous
10. Potential for: Erosion	Runoff	Ponding

11. Soil profile description:

Horz	Depth	Texture	%CL	STR	MOT	IND	ROO	⟨X⟩	FSP

12. Site percolation rate:
13. Findings & Recommendations:

Instructions for completing Form 2: Soil Log Information

Form 2 is the detailed record of soil information obtained on the development site. One copy of Form 2 must be completed for **each soil location where testing has been done**. For tests other than soil logs for which the scientist wants to submit numerical results, please attach a separate sheet and briefly describe the results under "Findings and recommendations." The summary information that heads the sheet should be self-explanatory. Regarding location, reference the location to features that are permanent and static, such as roads or property lines.

1. State briefly tests that were done. Indicate whether tests were field, laboratory, or other.
2. Determine the soil series from the maps provided in the Soil Conservation Service (SCS) *Soil Survey of Pierce County*. Then, indicate what soil series was mapped as a result of the soil testing done.
3. Indicate land form (e.g., till plain).
4. Indicate depositional history (e.g., alluvial plain).
5. Indicate SCS hydrologic soil group (e.g., letter designation A through D).
6. Indicate seasonal high water table depth based upon the presence of mottling, gleying, or other evidence. Indicate how you determined this value under "Findings..." section. If information available is inadequate, state value to be "greater than" bottom of hole depth.
7. Indicate current water table depth based upon observation. If saturated conditions are not observed, state value to be "greater than" bottom of hole depth.
8. Indicate depth to impervious layer (e.g., basal till). If information is inadequate, state value to be "greater than" bottom of hole depth.
9. Space for other miscellaneous observations regarding setting of site (e.g., concave, convex, swale, hillslope).
10. Indicate susceptibility of area to erosion, runoff, and ponding problems. The susceptibility should be rated based upon relevant physical characteristics and development operations planned for the area, such as shape of the area (e.g., concave, convex, flat) removal or addition of fill, time of year, existing and planned vegetative cover, degree of soil compaction, etc.
11. The profile description provides the minimum information on the physical attributes of the soil. Additional factors may be assessed at the option of the scientist, but data on these factors should be tabulated separately and summarized briefly in the "Findings and recommendations" section.

    All information provided for the profile shall use standard SCS nomenclature and abbreviations. The following are the factors to be addressed, with brief examples of acceptable responses. Further information on most of these is provided in the SCS Soil Survey of Pierce County.

    a. Hor(izon): A layer of soil with distinct characteristics, labeled A, AB, B, C, Ccw, etc.
    b. Depth: Starting at 0" (surface), depth and interval of horizon.
    c. Textur(al class): Class that best describes relative percentages of sand, silt, and clay in horizon, such as sandy loam (SL).

d. %Cl(ay): Clay percentage is very useful as a guide to determining the drainage capability of a soil.

e. Str(ucture): Describes size and shape of soil “clods”.

f. Mot(tling): Where present, describe using three-letter abbreviation to indicate abundance, size, and contrast, such as CFD (common, fine, distinct).

g. Ind(uration): Physical compaction of a layer such as a glacial till. Where present, describe as weak, mod(erate), or str(ong).

h. Roo(ts): Where present, describe using two-letter abbreviation to indicate abundance and size, such as CF (common, fine).

i. Generalized range of infiltration rates from SCS Soil Survey.

j. F(ield) S(aturated) P(ercolation rate): Using all available information, estimate the field saturated percolation rate. This rate should be a single number, and may vary from that range (see pervious column) published in the SCS Soil Survey due to horizon-specific factors.

12. Provide overall site (location) field-saturated percolation rate. Rate should reflect effects of the entire soil column. Alternate rates may be provided if placement of the infiltration surface beneath finer surface soils (in coarser subsoils) would increase the rate. If the type of stormwater system to be employed is known (e.g., pond or trench, and depth), factor this knowledge into the assessment.

13. Discuss results of tests done on soil. Indicate features of soil that most affect stormwater management at this location. Provide recommendations to the Project Engineer on soil-related factors such as problems and controls, and for additional work needed (if necessary).

Section E - Standard Stormwater Notes

Standard Stormwater Notes

These notes shall be placed on all plans for construction:

1. All workmanship and materials shall be in accordance with County standards and the most current copy of the State of Washington Standard Specifications for Road, Bridge and Municipal Construction (WSDOT/APWA) and as amended by the County or the State.
2. Temporary erosion/water pollution prevention measures shall be required in accordance with the Pierce County Stormwater Management Manual and the Dept. of Ecology's Construction Stormwater General Permit.

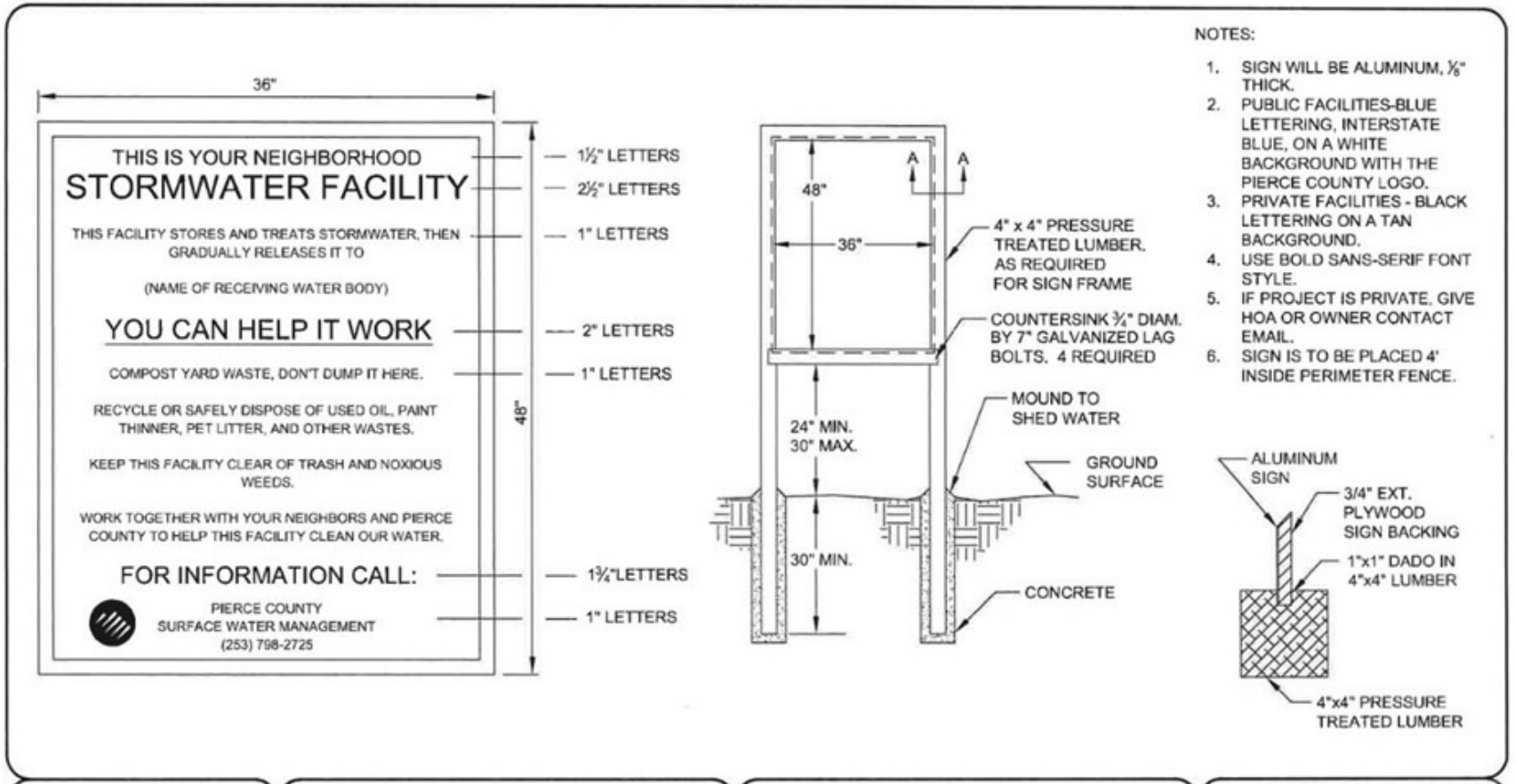
   Should the temporary erosion and sedimentation control measures as shown on this drawing not prove adequate to control erosion and sedimentation, the applicant/ contractor shall install additional facilities as necessary to protect adjacent properties, sensitive areas, natural water courses, and/or storm drainage systems.
3. Call the underground locate line 1-800-424-5555 a minimum of 48 hours prior to any excavations.
4. The storm drainage system shall be constructed according to approved plans on file with the County. Any significant deviation from the approved plans will require written approval from the County.
5. A copy of the approved Construction Stormwater Pollution Prevention Plan and stormwater plans must be on the job site whenever construction is in progress.
6. All erosion control and stormwater facilities shall be regularly inspected and maintained by the designated Certified Erosion and Sediment Control Lead (CESCL) during construction.
7. It shall be the sole responsibility of the contractor to obtain street use and other related or required permits prior to any construction activity in the Municipality's right-of-way. It shall also be the responsibility of the contractor to obtain all required permits prior to any construction. The contractor shall abide by all requirements for traffic control & safety when working in the road right-of-way.
8. The Contractor shall notify the Project Engineer in the event or discovery of poor soils, standing groundwater, or severe discrepancies from soil log descriptions as noted on the plans.
9. For public systems, the contractor shall call for inspection 48 hours prior to covering any drainage structure.
10. All drainage structures, such as catch basins and manholes, not located within a traveled roadway or sidewalk, shall have solid locking lids. All drainage structures associated with a permanent retention/detention facility shall have solid locking lids.

Section F - Stormwater Facility Informational Sign Specifications

Stormwater Facility Informational Sign Specifications

The Proponent is responsible for obtaining and installing a metal sign for the stormwater facility. Verify with the County what receiving water names(s) and contact department name and telephone numbers to be affixed to the sign.

The sign shall be installed on the street side of the stormwater facility, or in a location highly visible to passers-by. The sign may be affixed to a pressure-treated wood post and placed in concrete in the ground or may be firmly attached to a pole or fence adjacent to the stormwater facility. It is the Proponents responsibility or it's successors in interest (the Homeowners Association) to ensure the sign is on the site and to replace same if necessary due to loss, vandalism or theft.



Pierce County
Public Works
Surface Water Management Division
2702 S 42nd Street, Suite 201
Tacoma, Washington 98409-7322

DATE	REVISION	APPR'D	DRAWN
6/2015	2015 SWMM UPDATE	HPH	RUTKOSKY
6/2012	2012 SWMM UPDATE	HPH	RUTKOSKY
5/2008	PUBLISH DATE	HPH	RUTKOSKY

HANS P. HUNGER, P.E.
C.I.P. MANAGER

Surface Water Management Division

ALUMINUM PROJECT SIGN

(NOT TO SCALE)

1.0

Storm Water Manual Details - Section F

Section G - Covenants Forms

Covenants

P.1 Maintenance Covenants

Whenever storm drainage facilities are to be maintained by a property owner's association within a subdivision, a covenant stating the property owners' specific maintenance responsibilities must be recorded on the plat and recorded against each lot in the subdivision. The covenant shall include the following or substantially similar language:

Maintenance Covenant

> Easements are hereby granted for the installation, inspection, and maintenance of utilities and drainage facilities as delineated on the plat for subdivision _____. No encroachment will be placed within the easements shown on the plat which may damage or interfere with the installation, inspection, and maintenance of utilities. Maintenance and expense thereof of the utilities and drainage facilities shall be the responsibility of the property owners association as established by covenant recorded under Auditor's file number _____.

P.2 Sanctions for Failure to Maintain

If a property owner's association is to maintain drainage facilities, then the following or substantially similar words shall appear in the document creating the property owner's association:

> In the event _____ (Project Proponent name) (or successors or the Property Owners Association), in the judgment of the County, fails to maintain drainage facilities within the plat, or if the Proponent or successors willfully or accidentally reduce the capacity of the drainage system or render any part of the drainage system unusable, the Proponent or successors agree to the following remedy: After a 30-day notice by registered mail to the Proponent or successors, the County will assess financial sanctions (P.C.C. 18C.10.120) and /or initiate enforcement proceedings. In the event the County determines the lack of maintenance has resulted in a situation of imminent danger to life, limb or property, the County will correct the problem as necessary to restore the full design capacity of the drainage system. In this event, the County will bill the owners of the facility for all costs associated with such work to include engineering, administration, legal fees, construction, equipment and personnel. Costs or fees incurred by the County, including attorney's fees and expert's fees should legal action be required to collect such payments, shall be borne by the Proponent or successors.

Section H - Change Order Review Form

Change Order Review Form

The Change Order Review Form shall be used by the Contractor or Applicant whenever field construction revisions are needed to approved plans and specifications. This form shall be submitted to Pierce County for review and will be used as the basis for determining the magnitude of the change and subsequent requirements for re-submittal of the plans or allowance of field changes to proceed without additional submittals.

Pierce County reserves the right to require all, partial, or no re-submittal of approved plans and/or specifications depending upon the magnitude of the changes fiscally, environmentally, structurally, etc., or as otherwise determined by the County.

If changes are to be made to an engineered system, the submittal must include a certification from the design Professional Engineer verifying the adequacy of the proposed changes, i.e., changes in pipe grade, size, materials, pond size, infiltration modifications, etc.

Change Order Review Form

Date: _____ Project: _____

Site Address: _____ S/T/R: _____

App./Permit No(s):_____ File: _____

Design Engineer: _____ Firm: _____

Original approval date: _____

Request approval for the following change to the plans for the above mentioned project:

_____

Reason for change: _____

Revised Plan or additional information attached? ( ) Yes ( ) No

Requested By: _____ Of: _____

Address: _____

Phone: _____ Signature: _____

Inspector Action

Change is: ( ) Approved ( ) Referred to Review Eng. ( ) Disapproved

( ) Additional information required, see comments. ( ) As Built Plans Rqd.

Comments: _____

Signature: _____ Date: _____

Review Engineer Action

Change is: ( ) Approved ( ) Referred to Public Wks. ( ) Disapproved

( ) Additional information required, see comments. ( ) As Built Plans Rqd.

Comments: _____

Signature: _____ Date: _____

Traffic Action

Change is: ( ) Approved ( ) Disapproved

( ) Additional information required, see comments. ( ) As Built Plans Rqd.

Comments: _____

Signature: _____ Date: _____

Distribution: One each to Design Engineer, Applicant, Inspector and File.