



CITY OF PORTLAND 2014 Stormwater Management Manual

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INTRODUCTION

This *Stormwater Management Manual* (SWMM) is a technical document that outlines the City of Portland's stormwater management requirements. The requirements defined in this manual apply to all development and redevelopment projects within the City of Portland on both private and public property and the right-of-way.

The City of Portland's approach to stormwater management emphasizes the use of vegetated surface facilities to treat and infiltrate stormwater on the property where the stormwater runoff is created. Infiltrating stormwater onsite with vegetated surface facilities is a multi-objective strategy that provides a number of benefits, including but not limited to pollution reduction, volume and peak flow reduction, and groundwater recharge. These benefits play a critical role in protecting stormwater infrastructure and improving watershed health.

Summary of Changes in the 2014 Revised SWMM

The SWMM was initially adopted in 1999 and was most recently revised in 2008. For this 2014 revision, the overall structure of the SWMM remains the same. The SWMM was edited and reorganized to clarify the requirements, eliminate duplication, and improve the overall presentation of the information.

Chapter 1 provides the stormwater infiltration, discharge, flow and volume control, and pollution reduction **requirements and related policies** that all development and redevelopment projects in the City of Portland must comply with.

Chapter 1 changes:

- *A pollution reduction exemption was added for discharge to new or existing UICs under specific criteria.*
- *The Bureau of Development Services transferred authority for review and inspection of onsite stormwater management facilities to the Bureau of Environmental Services. References to approval procedures have been updated to reflect the appropriate Bureau assignment.*

Chapter 2 provides the **design guidelines and specifications for stormwater management facilities** required in order to meet the City’s requirements. Projects may choose the **Simplified Approach**, the **Presumptive Approach**, or the **Performance Approach** to select and design stormwater facilities.

Chapter 2 changes:

- *The Presumptive Approach requires use of prescribed presumptive stormwater sizing calculations or an approved stormwater sizing calculator. The City will maintain a list of approved stormwater sizing calculators.*
- *Tree credit as an impervious area reduction technique can also be used on private property.*
- *Downspout extension and curb extensions were added as distinct stormwater facility types with design criteria.*
- *The depth to groundwater distance for Underground Injection Control facilities was reduced to 5 feet in accordance with revised DEQ requirements.*

Chapter 3 provides the **operations and maintenance requirements** that all projects must comply with.

Chapter 3 changes:

- *Chapter 3 was updated to provide consistency with the recently adopted Maintenance Inspection Program Administrative Rules and to incorporate current best practices, such as shifting from a prescribed maintenance timeframe to describing visual indicators that trigger maintenance requirements.*
- *Operations and Maintenance plans are now required for all soakage trenches and drywells.*

Chapter 4 provides the **source control requirements** that all projects must comply with if they are classified as high risk because of certain site characteristics or activities.

Chapter 4 changes: None.

The **Definitions** section defines the technical terms and acronyms used in the manual.

Definition Changes: The definitions were revised to add new terms, delete unused terms, and update existing terms as necessary.

Appendix A includes **policies** that direct the Bureau of Environmental Services to implement and revise the SWMM. It includes related administrative rules and design guidelines.

Appendix A changes: The policy and revision procedures were updated to provide clarity around the update and amendment process.

Appendix B includes new **requirements** for manufactured stormwater treatment technologies.

Appendix B changes: Appendix B has been revised to incorporate new minimum standards and submission requirements, including a new application form. Manufactured stormwater treatment technologies must be certified for general use level designation under the Washington State Department of Ecology Technology Assessment Protocol prior to application to the City of Portland. Application and appeal fees have been established to cover the cost of evaluating these devices.

Appendix C provides the technical support documentation for the **Santa Barbara Urban Hydrograph (SBUH) method**, including the Simplified Approach and Presumptive Approach sizing methodologies.

Appendix C changes: The Presumptive Approach Calculator can now be found in the approved list of stormwater sizing calculators.

Appendix D includes **submittal guidance** and all the **forms** necessary for permitting stormwater management plans.

Appendix D changes: All forms have been reformatted and updated to provide consistency with changes made throughout the SWMM. Application, appeal and offsite management fees can now be found online in the council-approved Sewer and Drainage Rates and Charges.

Appendix E documents the **pollution reduction methodologies** used to formulate Portland's water quality treatment requirements.

Appendix E changes: None.

Appendix F provides **landscape technical specifications**, including depth to groundwater and infiltration testing procedures, stormwater facility blended topsoil specifications, and plant lists.

Appendix F changes: The infiltration testing procedures were updated to meet Bureau standards. The blended topsoil specification was updated to match the City construction specifications.

Appendix G includes **typical construction details** for the stormwater facilities included in this manual, available online in both .pdf and CAD .dwg files.

Appendix G changes: All Green Street Details were consolidated into Appendix G.3. The Green Street Checklist was moved to Appendix G.4. All details received minor clerical fixes and clarifications.

Looking Ahead

BES is committed to gathering ongoing input from City staff, the development community, and other stakeholders that will be considered in the next revision process. To provide suggestions for the next revision, please send an email to BESStormManual@PortlandOregon.gov.

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Chapter 1 REQUIREMENTS AND POLICIES

This chapter outlines the City of Portland’s stormwater management requirements and the related regulations and policies. It includes the following sections.

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1.1 PURPOSE OF THE STORMWATER MANAGEMENT MANUAL

As the City of Portland is developed, impervious surfaces create increased amounts of stormwater runoff during rainfall events, disrupting the natural hydrologic cycle. Without stormwater management, these conditions erode stream channels and prevent groundwater recharge. Parking lots, roadways, rooftops, and other impervious surfaces increase the pollution levels and temperature of stormwater that is transported to streams, rivers, and groundwater resources. Implementing the requirements in this manual will help protect Portland's water resources, which in turn will provide great benefit to human health, fish and wildlife habitat, recreational resources, and drinking water.

Stormwater management is also critical in terms of protecting Portland's sanitary and stormwater infrastructure. Increased runoff contributes to combined sewer overflows (CSOs) and basement sewer backups. Implementing onsite infiltration and flow control measures will conserve the existing and future conveyance capacity of storm sewers and combined sewers.

Strategies for meeting the requirements in this manual depend on a number of site factors, including infiltration capacity, available infrastructure, proposed development plans, and the drainage basin the proposed development is in. The applicant's ability to effectively use the design standards in this manual depends on a demonstrated understanding of the development site's ecology and of the upstream and downstream impacts resulting from stormwater management improvements. The standards addressed in this manual are intended to make site-specific improvements to properties across the City and to comprehensively manage stormwater by watershed.

Stormwater management is critical to maintaining and enhancing the City's livability and improving watershed health. The *Stormwater Management Manual* allows the City of Portland to protect both watershed resources and infrastructure investments with every land improvement. As each development and redevelopment project meets the requirements of this manual, it will contribute to achieving these important citywide goals.

Regulatory Mandates

In response to the impacts of urbanization on water quality, Congress passed the Clean Water Act of 1972 (amended in 1987), which prohibits the discharge of pollutants into waters of the United States unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. The permit requirements, published in 1990, require large (Phase I) cities such as Portland to obtain an NPDES permit for their municipal separate storm sewer system (MS4) discharges.

Compliance with the NPDES MS4 permit requires the cities to establish a comprehensive stormwater management program, including establishing controls on post-development stormwater runoff and source controls for industrial facilities that contribute substantial pollutant loading to the MS4 system. Portland established this citywide regulatory program in 1999, which includes water quality and flow control design standards for onsite stormwater management facilities. The program focuses on low-impact development practices, structural source control devices, and maintenance and operational best management practices (BMPs) designed to improve stormwater quality. The source control requirements included in this manual are designed to help meet the NPDES Industrial Stormwater Discharge Permit requirements for those facilities required to have permit coverage and for those sites without discharge permits that have high-risk characteristics. Within this regulatory context, developers and municipal agencies are required to implement controls that reduce pollution carried in runoff. This *Stormwater Management Manual* is part of Portland's NPDES MS4 stormwater management program to improve the quality of Portland's waters.

In addition, the federal Safe Drinking Water Act (SDWA) of 1974 provides a comprehensive framework to ensure the quality and safety of drinking water supplies. Within the state of Oregon, the Department of Environmental Quality (DEQ) regulates stormwater discharges to underground injection control (UIC) systems under the SDWA. UICs are used to infiltrate stormwater runoff from both public and private properties. DEQ issued a water pollution control facility (WPCF) permit to the City in 2005 for approximately 9,000 public UICs used to discharge stormwater runoff from publicly owned streets. As part of the compliance, the City was required to establish a comprehensive UIC management plan that includes structural, nonstructural, and institutional controls to ensure the protection of groundwater as a drinking water resource. This *Stormwater Management Manual* assists with the implementation of Portland's UIC management plan.

The purpose of this manual is to respond to these regulatory mandates by providing stormwater management principles and techniques that help preserve or mimic the natural hydrologic cycle, minimize sewer system problems, and improve water quality. The manual provides developers and design professionals with specific requirements for reducing the impacts of stormwater from new development and redevelopment.

Relationship to the **Sewer and Drainage Facilities Design Manual**

Both the *Stormwater Management Manual* and the *Sewer and Drainage Facilities Design Manual* (Environmental Services) are under the authority of the Bureau of Environmental Services (BES) and adopted by City Council as an administrative rule. They are complementary documents that share features related to the hydrology and hydraulic design of drainage facilities.

The *Sewer and Drainage Facilities Design Manual* is the primary reference for designing public sewers. It is referenced for the design of pipelines, drainage channels, and other public facilities that convey and dispose of sanitary sewage, stormwater, and combined sewage flows. The *Stormwater Management Manual* should not be used to design any public sewer conveyance facility presented in the *Sewer and Drainage Facilities Design Manual*.

The content of the two manuals may overlap while addressing different aspects of system infrastructure design. Designers must reference both manuals when working in the City of Portland to determine the appropriate standards that apply to a project. Before finalizing any design, it is the responsibility of the project engineer to contact the City to resolve any conflicts between the documents.

1.2 APPLICABILITY

All development and redevelopment¹ proposals are subject to the requirements of the *Stormwater Management Manual* during a number of review and permit processes. These processes generally include land use reviews and zoning, site development, and building permits. Each development proposal will have a unique set of reviews and permits, based on what is proposed and the location. **Exhibit 1-1** provides a general overview of the development review process and shows when stormwater management requirements apply.

The thresholds for proposals that are subject to the requirements are as follows:

- Properties that propose new offsite discharges or new connections to the public system are required to comply with stormwater requirements for the impervious area draining to the discharge point.
- Projects that develop or redevelop over 500 square feet of impervious surface are required to comply with stormwater requirements for the impervious area at the site.

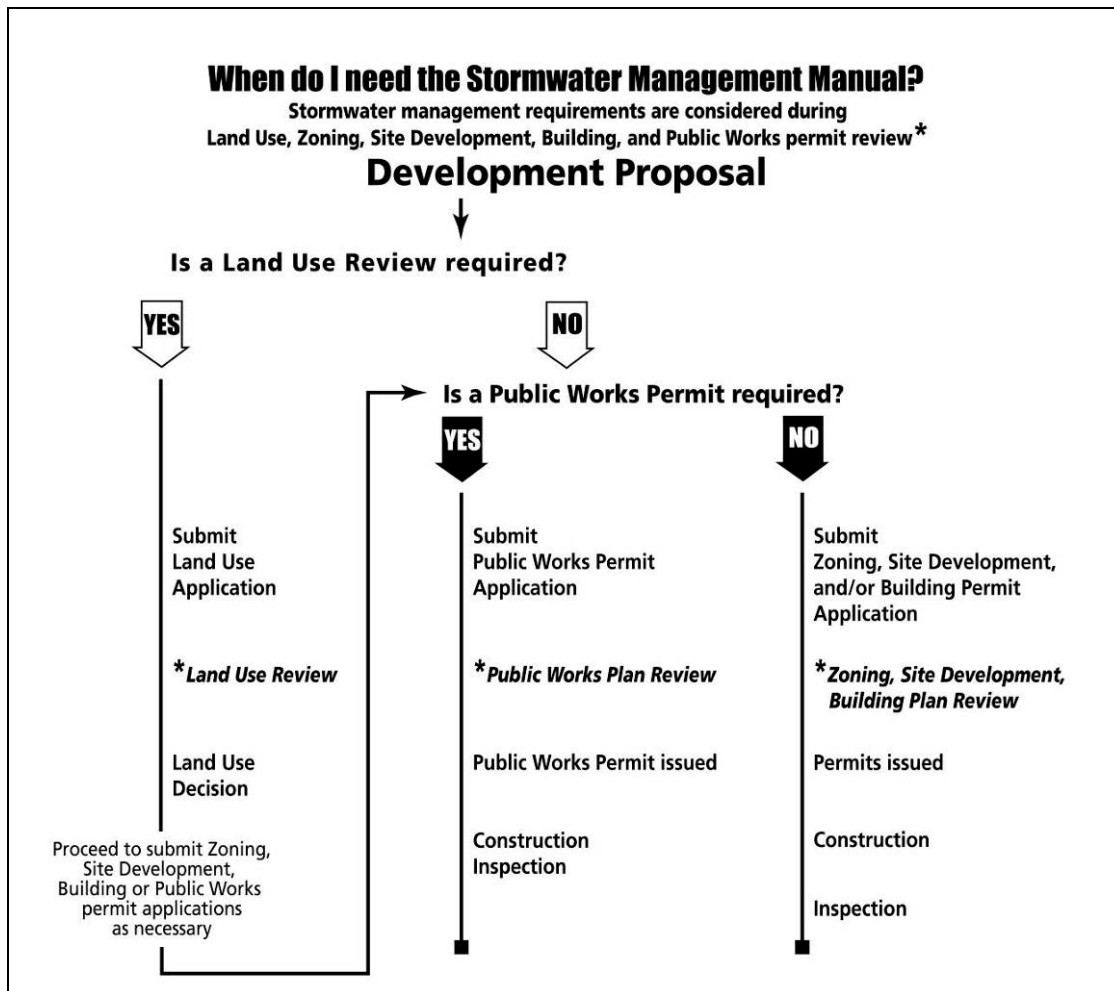
Proposals meeting these thresholds must comply with stormwater **infiltration and discharge** requirements, as specified in the stormwater hierarchy described in **Section 1.3.1**, the **flow and volume control** requirements specified in **Section 1.3.2** and the **pollution reduction** requirements specified in **Section 1.3.3**. All projects must also comply with **Chapter 3**, which discusses operations and maintenance (O&M) requirements.

Source Control Requirements

Some site characteristics and uses may generate specific pollutants of concern or levels of pollution that are not addressed solely through implementation of the pollution reduction requirements in Section 1.3.3. Chapter 4, Source Controls, defines these characteristics and uses and identifies structural source controls that must be implemented to manage the pollutants at their source. **Any project of any size** that introduces these site characteristics or uses must comply with the requirements of Chapter 4. This includes new development; redevelopment; tenant improvements; and changes to site uses or activities, including changes to specific site or activity areas, even if no impervious area is added or replaced.

¹ See the **Definitions** (which follow Chapter 4) for a definition of “development,” “redevelopment,” and other terms used in this manual. “Redevelopment” does not include maintenance activities, such as re-roofing. However, if an ecoroof or other stormwater management facility is added as part of a maintenance activity, the requirements for voluntary stormwater retrofits would apply (see **Appendix A.5**).

Exhibit 1-1: Stormwater Management Requirements in the Development Review Process



The Bureau of Development Services administers the development review process, including land use reviews as well as building and trade permits for **private** improvements. BES reviews, approves, and inspects stormwater facilities on private property within the development permitting process. Public works permits are required for **public** infrastructure improvements, which are generally located in the public right-of-way and are administered by the City's service bureaus, including Transportation, Environmental Services, and Water.

For more information about the City of Portland's development review and permit processes, refer to: <http://www.portlandoregon.gov/bds>.

For more information about the City of Portland's public works permit process, refer to: <http://www.portlandoregon.gov/publicworks>.

Projects on Private and Public Property

Stormwater management requirements apply projects on both private and public property, including all roofs, streets, alleys, driveways, and sidewalks. Stormwater that is generated from private property must be managed on private property, in privately maintained facilities. Stormwater that is generated from public property must be managed on public property, in publicly maintained facilities.

Exceptions

An applicant may propose to construct a “shared facility” that is designed to manage stormwater from private and public property. A shared facility may be in the right-of-way or on private property. This may be considered if one the following criteria is met:

1. Public street improvements require the construction of a public stormwater management facility, and there is an opportunity for a private facility to accept public runoff that cannot be managed effectively in the right-of-way.
2. The applicant clearly demonstrates that private stormwater management facilities cannot be constructed on private property (for example, when minimum zoning requirements cannot be met), and there is sufficient area in the right-of-way to construct a facility that can manage stormwater from both the street and the private property.

Both BES and City Council must approve an agreement for a shared facility. In addition, the private property owner must share in the ongoing operations and maintenance (O&M) costs of the facility in proportion to the property’s stormwater contribution. Shared facilities in the right-of-way will require review or permits from the Portland Bureau of Transportation.

Sidewalks and Driveways

Applicants are required to size and construct stormwater facilities in the right-of-way to manage stormwater from all the impervious area within the right-of-way, including sidewalks and driveway aprons. Where it is not feasible for sidewalks to drain into a stormwater facility or landscape strip in the right-of-way, applicants are encouraged to use street trees as an impervious area reduction technique (see [Section 2.3.3](#) for specifications). Applicants may also consider pervious pavement for sidewalks with preapproval from the Bureau of Transportation.

Stormwater facilities in the right-of-way are **not** sized to treat stormwater from private driveways. Stormwater from private driveways must be managed on private property. Applicants are encouraged to use vegetated filter strips to manage driveway runoff where possible (see [Section 2.3.3](#) for specifications). Under the appropriate site conditions, applicants may consider pervious pavement for driveways.

On projects where the total impervious area is over 500 square feet, but the sidewalk and residential driveway is less than a total of 500 square feet, a separate stormwater facility will not be required for the sidewalk and residential driveway.

Stormwater Management Retrofits

Stormwater retrofits help the City incrementally provide stormwater management for existing development. [Appendix A.5](#) summarizes the regulations within this manual that apply to both voluntary and mandatory stormwater retrofits.

1.3 STORMWATER MANAGEMENT REQUIREMENTS

Section 1.3.1 addresses the infiltration and discharge requirements, **Section 1.3.2** the flow and volume control requirements, and **Section 1.3.3** the pollution reduction requirements. **Section 1.3.4** outlines the requirements that apply in the Columbia South Shore area, and **Section 1.3.5** provides a summary of all stormwater management requirements.

Vegetated Facilities Meet Multiple Requirements

While it is necessary to describe each stormwater requirement separately, the response to meet the requirements need not be separate. The City's stormwater management approach relies on the use of vegetated surface infiltration facilities to comprehensively meet multiple requirements. Vegetated facilities allow the applicant to meet pollution reduction, flow and volume control, and infiltration requirements.

Impervious Area Reduction Techniques

Impervious area reduction techniques can help mitigate the impacts of development by reducing the amount of stormwater runoff generated. Impervious area reduction techniques can mimic the passive treatment of pre-development conditions. Ecoroofs, trees and pervious pavement can reduce the amount of impervious area that requires stormwater management by intercepting rainfall directly and should be considered first as site conditions allow.

1.3.1 Infiltration and Discharge

Prior to development, most native soils have a sufficient duff layer and permeability to absorb and infiltrate rainwater. This is because of a combination of factors, including the structure of the soil, the connected pores and channels created by plant roots, and the presence of leaf litter and other organic matter. Because most rain storms are not large enough to exceed the soil permeability and completely saturate the native and undisturbed soil, only a small percentage of water collects on the surface. Under these conditions, water that accumulates at the surface typically collects in rivulets that combine to form creeks, streams, and rivers.

Urbanization results in the loss of native soil conditions as a result of soil compaction and the creation of impervious surfaces, which disrupts the hydrologic cycle. Impacts include increased stormwater flow rates and volumes as well as decreased groundwater recharge and, consequently, low base flows into streams.

Portland's infiltration and discharge requirements are designed to:

- protect watershed health by requiring onsite infiltration wherever feasible in order to mimic pre-development hydrologic conditions
- protect the capacity of downstream infrastructure and minimize CSOs and basement sewer backups within the combined sewer system.
- protect groundwater resources by preventing and removing pollutants from stormwater before discharging it into a UIC

Feasibility

Stormwater must be infiltrated onsite to the maximum extent feasible, before any flows are discharged offsite. The appropriate use of infiltration depends on a number of factors, including soil type, soil conditions, slopes, and depth to groundwater. The point of discharge is also site-specific and dependent on the availability and condition of public and private infrastructure. The feasibility of infiltration and the discharge point have a direct impact on the pollution reduction and flow control requirements for a site. Therefore, it is critical to determine the feasibility of infiltration and the point of discharge before designing a stormwater facility.

While many of the stormwater management facilities presented in [Chapter 2](#) aim to maximize infiltration, not every site can infiltrate all of the stormwater from large, intense rainfall events. Unless complete infiltration of the 10-year storm (3.4 inches of rainfall over 24 hours) can be accomplished, an offsite discharge point must be identified.

BES has the authority to approve or deny requests to infiltrate onsite and offsite discharges from private and public properties, including the public right-of-way.

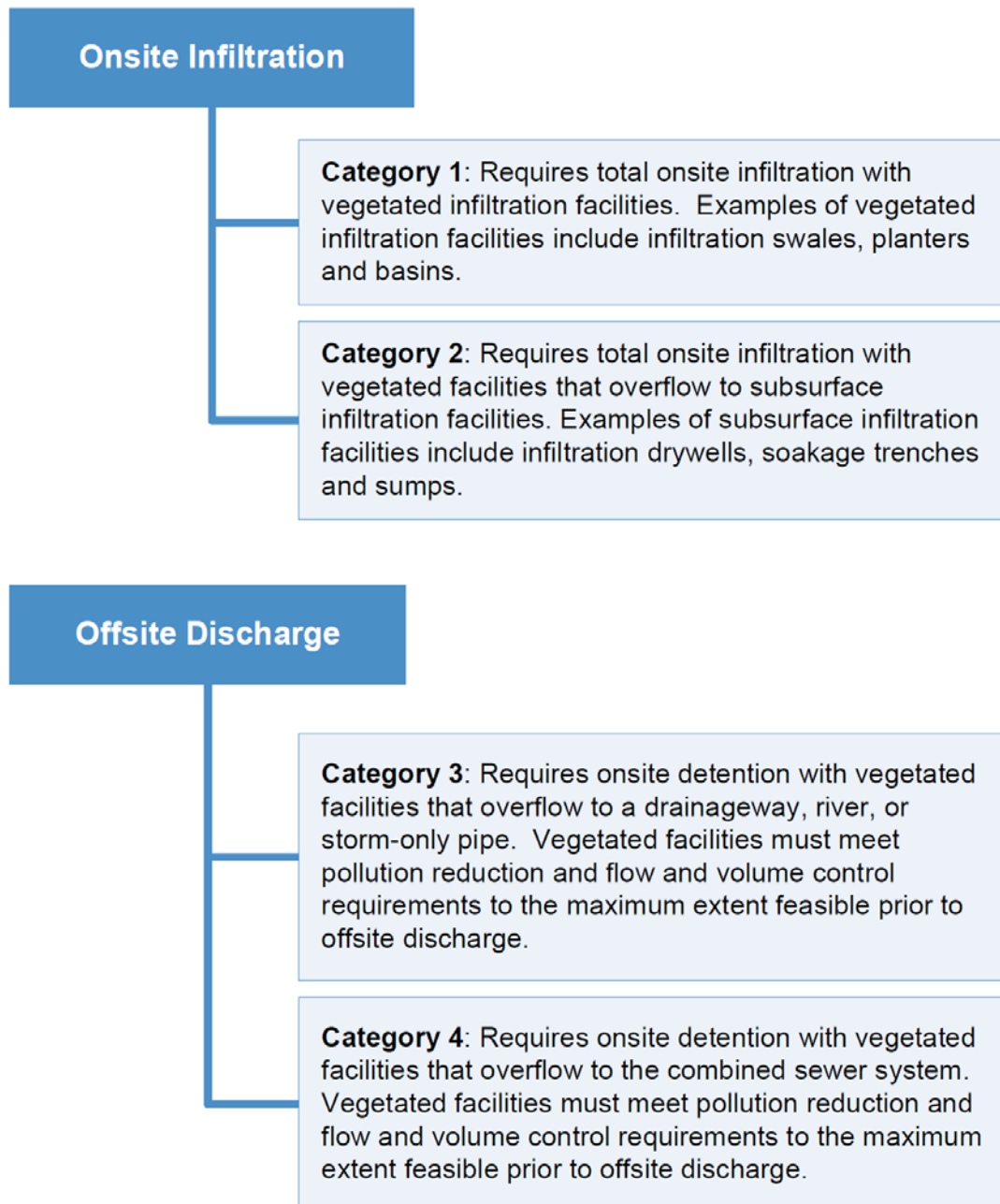
Infiltration Facility Prerequisites

To use an infiltration facility, the following prerequisites must be met:

1. Seasonally high groundwater must be more than 5 feet below the lowest elevation of a UIC.
2. All site and slope setbacks must be met pursuant to [Chapter 2](#). Setbacks are measured from the center or edge of the stormwater facility to the adjacent boundary, structure, slope, or facility. All setback requirements are minimums and can be increased, based on the discretion of City of Portland staff.

Stormwater Infiltration and Discharge Hierarchy

Impervious area reduction techniques: Applying an impervious area reduction technique can affect which design approach is required and can reduce the amount of impervious area that requires stormwater management. Examples of impervious area reduction techniques include ecoroofs, trees, and pervious pavement.

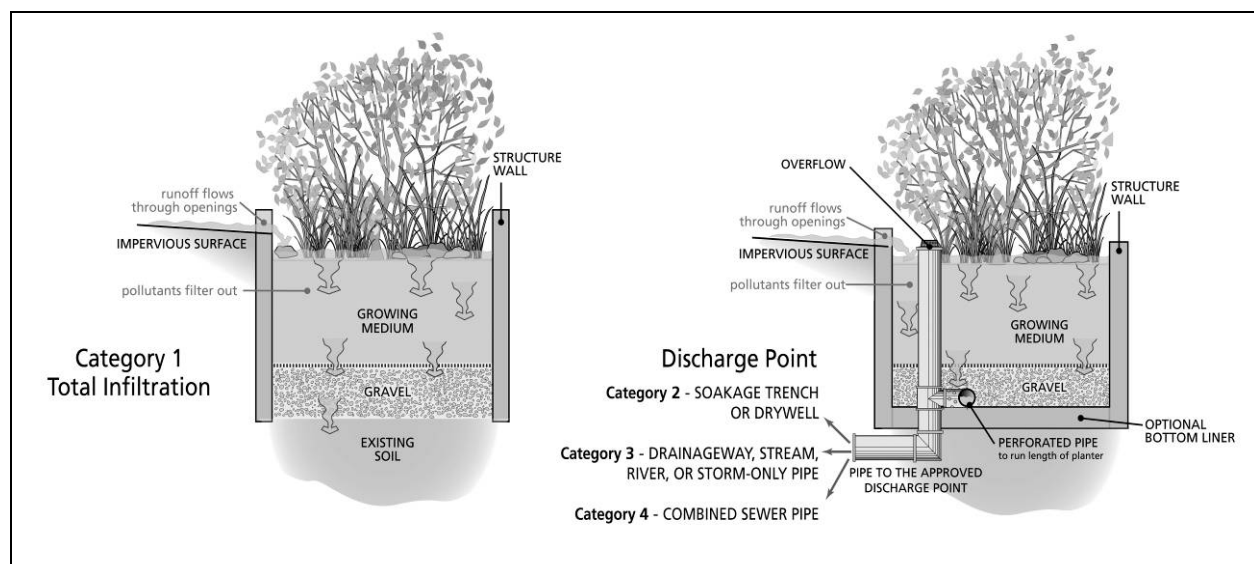


Stormwater Hierarchy

Decisions regarding the degree of onsite infiltration and the discharge point (when complete onsite infiltration is not feasible) are based on the stormwater hierarchy, as shown in [Exhibit 1-2](#)² and [Exhibit 1-3](#). Following any use of impervious area reduction techniques, the highest technically feasible category must be used (1 = highest, 4 = lowest). Applicants must provide the appropriate technical analysis and evaluation to demonstrate the need to move from Category 1 through each consecutive category. Infiltration testing is required to determine the feasibility of onsite infiltration and the existing infiltration rate.

Roof runoff is exempt from pollution reduction requirements and may drain directly to a UIC. See [Section 1.4](#) for further clarification of UIC requirements.

Exhibit 1-3: Stormwater Hierarchy Illustration



² The stormwater hierarchy is based on the City's WPCF permit with DEQ regarding onsite infiltration and offsite discharge. The hierarchy is how the City satisfies the requirements of Oregon Administrative Rules (OAR) 340-040 for the protection of groundwater.

Stormwater Hierarchy Exemptions

The following circumstances may qualify a site to move to the next category of the stormwater hierarchy. These circumstances are evaluated on a site-by-site basis. It is the responsibility of the applicant to justify moving from one category to the next, based on technical issues or competing code requirements. All circumstances are subject to BES review and approval and may require an appeal.

- The site is located within a wellhead protection area and must meet the Water Bureau's requirements for protection of groundwater resources (see [Section 1.3.4](#)).
- The site has high groundwater, poor infiltration rates (less than 2.0 inch per hour design rate as proven by infiltration testing), or steep slope conditions. The City may require a certified geotechnical engineer or engineering geologist to demonstrate and recommend that this exception applies to a site.
- Contamination is present at the site, as determined by DEQ. Sites that have contaminated soils conditions must be evaluated by DEQ to determine if areas on the property are suitable for infiltration without the risk of mobilizing contaminants in the soil or groundwater. Documentation showing DEQ's contamination assessment and determination must be submitted to BES at the time of permit application.
- There is a conflict with required source controls for high-risk sites (as identified in [Chapter 4](#)).
- Space constraints may prohibit the construction of onsite infiltration facilities. Code requirements such as minimum density, minimum lot coverage, and required zero-lot-line setback for urban districts may exempt the use of onsite retention facilities. (**Note:** Maximum density allowed by the zoning code does not exempt the applicant from stormwater requirements. In this case, technical requirements for infrastructure must be met before the development is approved.)

Infiltration Standards

Where complete onsite infiltration is feasible, the following standards apply:

- **Surface infiltration facilities (public or private).** Surface infiltration facilities must demonstrate the ability to infiltrate the 10-year, 24-hour storm. When full, the facility drawdown time shall not exceed 30 hours. [Chapter 2](#) provides detailed facility sizing and design procedures.

- **Public infiltration sump systems.** The peak flow rate from a 10-year storm must be calculated using the Rational Method ($Q=C \times I \times A$), with a safety factor of 2 applied. The intensity must correspond to the calculated time of concentration (5-minute minimum). See the *Bureau of Environmental Services Sewer and Drainage Facilities Design Manual* for rainfall intensity charts. For 5-minute time of concentration, Intensity = 2.86 in./hr).
- **Private drywells and soakage trenches.** Drywell sizing charts or soakage trench sizing guidelines found in [Section 2.3.3](#) must be used. When full, the facility drawdown time shall not exceed 30 hours. Drywells and soakage trenches must be able to meet boundary, site, slope, building, and structure setbacks.

Discharge Standards³

Offsite Discharge to Surface Flow

Where stormwater is discharged to an offsite surface flow conveyance facility, such as a ditch, drainageway, stream, or river, the following standard applies:

Beginning at the point of discharge from the site, the surface conveyance facility must have the capacity to convey flows from the 25-year storm from all contributing upstream drainage areas. The 25-year storm flow rate must be calculated using the Rational Method ($Q=C \times I \times A$), with intensity corresponding to the calculated time of concentration (5-minute minimum) or another approved hydrologic modeling method for conveyance.

Offsite Discharge to Piped Flow

Where stormwater is discharged to an offsite piped conveyance facility, such as a storm sewer or combined sewer, the following standards apply:

- **For new development or redevelopment with an increase in net impervious area.** Beginning at the point of discharge from the site, the piped conveyance facility must have the capacity to convey flows from the 10-year storm from all contributing upstream drainage areas without surcharge. The piped conveyance facility may surcharge during the 25-year storm, but the hydraulic grade line must remain below ground surface level. Combined sewers, or sewers in the Cascade Station/Portland International Center and Columbia South Shore Plan Districts (see [Exhibit 1-8](#)), must have the capacity to convey flows from the 25-year storm without surcharge. The 10-year and 25-year storm flow rates must be calculated using the Rational Method ($Q=C \times I \times A$), with intensity corresponding

³ The discharge and conveyance information contained in this section is provided for general reference. Please refer to the *BES Sewer and Drainage Facilities Design Manual* for the complete list of approved hydrologic modeling methods, rainfall intensity charts, and allowable surcharge criteria.

to the calculated time of concentration (5-minute minimum) or another approved hydrologic modeling method for conveyance.

- **For redevelopment with no net increase in impervious area.** Existing downstream pipe conveyance facilities may be allowed to surcharge under certain circumstances.

Discharge to Existing Stormwater Management Facilities

A development may discharge to an existing **publicly** operated stormwater facility if **all** of the following criteria are met:

- The applicant illustrates that private onsite infiltration facilities have been thoroughly considered and applied where feasible.
- The stormwater management facility was adequately designed to include the proposed development area and meet current requirements. For infiltration facilities, the discharging property must have been included in the assumed drainage basin when the existing facility was sized.
- The conveyance system and facility to which the development will discharge will be adequate and manage for relevant requirements, as approved by BES.
- Stormwater runoff from development on private property must not discharge into any public infiltration sump systems.
- Drainage from City rights-of-way with more than 1,000 vehicle trips per day (TPD) cannot be discharged to public UICs that receive drainage primarily from public rights-of-way with less than 1,000 TPD.

In addition to publicly owned and operated stormwater management facilities, many private facilities exist. A development may discharge to an existing **private** stormwater management facility if **all** of the following criteria are met:

- The stormwater management facility was adequately designed to include the proposed development area and meets current *Stormwater Management Manual* requirements and standards.
- The conveyance system and facility to which the development will discharge will have adequate capacity.
- The development's owner enters into a written legal agreement with the owner of the private stormwater management facility for O&M that meets the

requirements of [Chapter 3](#). BES must review and approve this agreement, and the owners must record it as an easement on both properties.

- The private stormwater facility meets design and O&M standards as determined by BES staff. BES may choose to conduct a site investigation to determine if the existing facility is being maintained adequately.

Escape Route

All projects must demonstrate that in the event the stormwater facility fails or rainfall exceeds the facility design capacity, that flows will be routed to maintain public safety and avoid property damage. Depending on site conditions, this may include an overflow structure or storage in parking lot, street, or landscaping areas. Applicants must describe where the flow will be routed on a basin site plan to illustrate where flood conditions or ponding is expected to occur.

1.3.2 Flow and Volume Control

As discussed in the previous section, urbanization decreases the infiltration capacity and permeability of native soils and increases the amount of impervious area. Combined, these circumstances create increased stormwater flow rates and volumes.

The basic concept for flow and volume control (detention and retention) is that water from developed areas is managed with a variety of techniques and released to downstream conveyance systems at a slower rate and lower volume. Managing flows in this way attempts to mimic the natural rainfall runoff response of the site prior to development, protecting downstream properties, infrastructure, and natural resources from the increases in stormwater runoff peak flow rates and volumes that result from development.

- **Detention facilities** store stormwater and release the water slowly. In the case of surface vegetated detention facilities, stormwater is evaporated or used by vegetation, reducing the total volume of water released by the facility.
- **Retention facilities** also store stormwater. Rather than storing and releasing the entire runoff volume, however, the facility permanently retains a portion of the water onsite. The water infiltrates and recharges the groundwater aquifer and, in the case of surface retention facilities, evaporates or is absorbed and used by vegetation. In this way, retention facilities reduce the total volume of water released by the facility.

In the past, flow control efforts often relied solely on detention facilities such as ponds, tanks, or vaults that control peak flow rates. These facilities, however, allow the duration of high flows in creek systems to increase, causing the potential for increased

erosion downstream. For example, after development with detention, the magnitude of the 2-year peak flow rate may not increase, but the amount of time (duration) that the flow rate occurs will increase, and the frequency with which the 2-year peak flow rate occurs will also increase.

In contrast, systems such as pervious pavement, ecoroofs, planters, swales, and other surface vegetated facilities are particularly effective in lowering the overall runoff volume and reducing the amount of time (duration) and frequency of the peak flow rate. Therefore, stream systems that require erosion protection, including salmonid habitat streams, warrant the use of retention systems. In addition, by infiltrating and evaporating stormwater, vegetated retention systems recharge groundwater that serves as the base flow for streams during the dry season. Where retention systems cannot be used, detention systems that control the duration of the geomorphically significant flow (i.e., flow capable of moving sediment) must be used. Such detention systems lower release rates and must be designed to protect the stream channel. Similarly, capacity limitations in the combined sewer system may require specific flow rate or volume control requirements. Where code requires minimum density, minimum lot coverage, and zero-lot-line setback for urban districts, ecoroofs can retain and evaporate stormwater effectively to manage flow rates and volumes at their source.

Time of concentration (the time it takes rainfall to accumulate and run off a site) is another important factor in determining hydraulic impacts created by development further in the receiving system. Flow rates and volume from individual sites may be controlled, but when they are combined quickly in fast-flowing conveyance pipes, the effect will still be increased in-stream flow rates and volumes in the receiving system. Breaking flow patterns up into retention systems helps increase a site's time of concentration and lessens impacts on the receiving system.

The City's flow and volume control requirements aim to ensure that post-development storm flows leaving the site:

- do not exceed the capacity of the receiving system or water body
- do not increase the potential for stream bank and stream channel erosion
- do not add significant volume to an existing closed depression, such as Holgate Lake or other similar geologic features found throughout the City
- do not create or increase any upstream or downstream flooding problems
- do not create or increase the occurrence of sewer releases, including CSOs and basement sewer backups

Flow and Volume Control Requirements

To meet flow and volume control requirements, ecoroofs, pervious pavement, planters, swales, and other stormwater management facilities are required to manage stormwater to the maximum extent feasible.

Flow and volume control standards vary, depending on the point of discharge. The base standard must be sufficient to maintain peak flow rates at their predevelopment levels for the 2-year, 5-year, and 10-year, 24-hour runoff events. Note that for redevelopment projects, predevelopment condition is defined as undeveloped land (see [Definitions](#)).

Applicants proposing to discharge stormwater offsite must evaluate the capacity of the offsite receiving system (storm sewer, combined sewer, ditch, drainageway, etc.) with regard to the discharge requirements presented in [Section 1.3.1](#). BES staff may determine that additional onsite flow or volume control is required if the offsite receiving system does not have sufficient capacity to accept the proposed flows.

Flow Control Requirements When Discharging to a Stream

Most tributary streams in Portland show evidence of excessive stream bank and channel erosion. Any development that discharges stormwater offsite that eventually flows to a tributary stream must be designed to a more restrictive requirement to reduce the potential for further aggravation of in-stream erosion problems. This applies to all tributaries and storm sewers that drain to streams or overland storm drainage systems within the Portland area except the Columbia Slough, which is regulated by Multnomah County Drainage District.

Flow control in these areas should aim to avoid discharging flows that will cause channel erosion. Channel-eroding flow varies from stream to stream. Unless more specific data are available, the City assumes that channel-eroding flow is one-half of the 2-year, 24-hour pre-developed (Lewis & Clark era) peak flow, and the requirements of this manual are based on that assumption. Specifically, the more restrictive flow control requirement is to limit the 2-year, 24-hour post-development peak flow rate to the predevelopment erosion-initiating rate (one-half of the 2-year, 24-hour flow rate). The facilities must also control the post-development flows from the 5-, 10-, and 25-year, 24-hour peak flows to the predevelopment 5-, 10-, and 25-year, 24-hour levels.

Flow and Volume Control Requirements in Combined Sewer Areas

Substantial stormwater volumes in the combined sewer system may result in sewer releases to surface water, streets, and basements. Stormwater that enters the combined sewer system during low-flow periods is treated at the City's wastewater treatment plants using energy and other resources. For these reasons, it is important to limit the quantity of stormwater entering the combined sewer system. Development projects in combined sewer areas are required to **infiltrate stormwater onsite to the maximum extent feasible**.

For developments that are served by combined sewers but are unable to achieve Stormwater Hierarchy Categories 1 and 2, the following requirements apply:

1. BES will review development and redevelopment plans to ensure that discharge to a combined sewer system will not increase the risk of an overflow event or basement sewer backups. Additional requirements may apply depending on the scope and location of the project.
2. Detention facilities must be designed to control post-development flows from the 25-year peak flow to the pre-developed 10-year peak flow rate.
3. For projects in the right-of-way, if full volume control can not be achieved, tree credit or pervious pavement should be considered prior to a Special Circumstances application for a request to pay an offsite management fee.

Exhibit 1-4 summarizes the City's flow control requirements.

Flow Control Exemptions

New development and redevelopment projects may be exempt from flow control requirements if they discharge stormwater runoff directly into the Willamette River, Columbia River, or Columbia Slough through a private storm sewer, separated public storm sewer, or Multnomah County Drainage District system with available capacity.

- This exemption is for flow control only; the pollution reduction requirements presented in **Section 1.3.3** still apply.
- Development must still properly dispose of stormwater using approved methods in accordance with **Section 1.3.1**.

When flow control is not required, facilities may be downsized to meet pollution reduction requirements only. (This exemption does not apply to facilities sized with the Simplified Approach.) When facilities are downsized to meet pollution reduction requirements only, flows above the pollution reduction design flow must be routed around the facility with an approved diversion structure, unless otherwise approved by BES.

Temporary Structures

Temporary structures (see **Definitions**) are exempt from **flow control** requirements, subject to BES review. Exemptions will not be allowed in circumstances where permits or other municipal regulations may be violated if the requirement(s) are lifted.

Exhibit 1-4: Summary of the City’s Flow Control Requirements

Onsite infiltration is required to the maximum extent feasible. Where complete onsite infiltration is not feasible, vegetated onsite retention facilities, ecoroofs, and pervious pavement are required to the maximum extent feasible.

After the stormwater infiltration and discharge requirements from [Section 1.3.1](#) have been applied and the point of stormwater discharge is determined, the flow control requirements below apply.

Piping systems that provide conveyance from a site to an approved discharge point must have adequate capacity, per the *Sewer and Drainage Facilities Design Manual*; if not, additional onsite flow control may be required.

1. Discharge Point	2. Retention Requirement	3. Detention Requirement
Direct discharge to Willamette River, Columbia River, or Columbia Slough, or discharge to a storm-only piping system or Multnomah Country Drainage District system (with capacity) that directly discharges to one of the above water bodies.	Use onsite retention (flow volume control) facilities and infiltrate onsite to the maximum extent feasible.	None.
Discharge to any other overland storm drainage system, including streams, drainageways, and ditches, or to any storm pipe system that eventually discharges to an overland drainage system.	Use onsite retention (flow volume control) facilities and infiltrate onsite to the maximum extent feasible.	Limit post-development peak runoff rates as follows: <ul style="list-style-type: none"> • 2-year post-development peak rate to one-half of the 2-year predevelopment peak rate • 5-year post to 5-year pre • 10-year post to 10-year pre • 25-year post to 25-year pre
Discharge to a combined sewer.	Use onsite retention (flow and volume control) facilities and infiltrate onsite to the maximum extent feasible.	Limit 25-year post-development peak runoff rate to 10-year predevelopment peak rate.
Base requirement for all other discharge points.	Use onsite retention (flow volume control) facilities and infiltrate onsite to the maximum extent feasible.	Maintain peak flow rates at their predevelopment levels for the 2-, 5-, and 10-year, 24-hour runoff events.

1.3.3 Pollution Reduction

Urbanization has serious impacts on the quality of surface water and groundwater. As land is developed, impervious areas interfere with the natural biological processes of soil that remove impurities from the water and also increase stormwater runoff. The increased flows pick up pollutants from impervious areas and transport them downstream to receiving waters and the City sewer system.

Pollutants of concern include:

- suspended solids (sediment)
- heavy metals (dissolved and particulate, such as lead, copper, zinc, and cadmium)
- nutrients (such as nitrogen and phosphorus)
- bacteria and viruses
- organics (such as oil, grease, hydrocarbons, pesticides, and fertilizers)
- floatable trash and debris

Vegetated Facilities and Pollution Reduction

Vegetated facilities, included in [Chapter 2](#) under the Simplified Approach or Presumptive Approach, are assumed to meet Portland's pollution reduction requirements. Vegetated facilities filter stormwater, removing pollutants as the water flows through the vegetation and soil.

Vegetation may be one of the most cost-effective and ecologically efficient means available to improve water quality. Vegetation shades water courses, which lowers water temperature; captures and absorbs water in leaves and roots, which reduces peak flows; and stabilizes soil by providing cover for disturbed soils. Vegetation also provides wildlife habitat and scenic and aesthetic benefits.

As stormwater enters a vegetated facility, the vegetation slows the water down, allowing sediments to be trapped on the surface of the facility. Typically, the surface area of the facility is designed to allow stormwater to pond and evaporate while sediments settle into a layer of mulch and then soil. The mulch prevents soil erosion and retains moisture for plant roots. It also provides a medium for biological growth and the decomposition or decay of organic matter. The soil stores water and nutrients to support plant life. Bacteria, nematodes, and other soil organisms degrade organic pollutants such as petroleum-based compounds. They also help mix organic material, increase aeration, and improve water infiltration and water-holding capacity. Bacteria and other beneficial soil microbes process the majority of pollutants.

Vegetated facilities are required to the maximum extent feasible. If a project proposes to use facilities other than those presented in [Chapter 2](#) for pollution reduction, the

applicant must demonstrate through the Performance Approach that the proposal meets or exceeds the pollution reduction requirements.

Pollution Reduction Requirements

The City of Portland has the following citywide pollution reduction requirements for all projects that develop or redevelop over 500 square feet of impervious area and all existing development that proposes to create new offsite stormwater discharges:

- Seventy percent removal of total suspended solids (TSS) is required from 90 percent of the average annual runoff. (See [Appendix E](#) for more detailed information about the formulation of Portland’s pollution reduction standards.)
- In watersheds that have established total maximum daily loads (TMDLs) or that are on DEQ’s 303(d) list of impaired waters ([Exhibit 1-5](#)), stormwater management facilities must be capable of reducing the pollutant(s) of concern, as approved by BES.

Total Suspended Solids (TSS) Requirements

TSS comprises particles that are too small or light to settle out from stormwater under high flow conditions. In many ways, TSS is a surrogate measure for water quality; therefore, the percentage of TSS removal from stormwater is an accepted standard to measure pollution reduction.

- Projects may use vegetated facilities from the Simplified Approach or Presumptive Approach (as specified in [Chapter 2](#)) to meet the 70 percent removal of TSS from 90 percent of the average annual runoff, without submitting additional data on TSS removal.
- If a project uses nonvegetated facilities for pollution reduction, the applicant must demonstrate through the Performance Approach (as specified in [Chapter 2](#)) that the development proposal meets the specific TSS removal requirements.

Total Maximum Daily Load (TMDL) and 303(d) List Requirements

- Development projects in watersheds with established TMDLs or on DEQ’s 303(d) list may use vegetated facilities from the Simplified Approach or Presumptive Approach (as specified in [Chapter 2](#)) without submitting additional data on pollutant removal.
- If a project in a watershed with established TMDLs or on the 303(d) list uses nonvegetated facilities for pollution reduction, the applicant must demonstrate through the Performance Approach (as specified in [Chapter 2](#)) that the

development proposal is consistent with specific TMDL or 303(d) requirements. The base requirement is to select and use a stormwater management facility that is capable of reducing the pollutants of concern, as approved by BES. TSS may be used as a surrogate for aldrin, chlordane, DDE, DDT, dieldrin, dioxin, and PCBs.

Exhibit 1-5: TMDL and 303(d)-Listed Parameters by Watershed as of January 2, 2014

TMDL Parameters						
Columbia River	Willamette River	Columbia Slough	Johnson Creek	Fanno and Ash Creek	Tryon Creek	Westside Streams
Total dissolved gas Dioxin	Bacteria Dioxin Temperature	Bacteria Phosphorus Lead PCB DDT/DDE Dieldrin Dioxin Temperature	Bacteria DDT Dieldrin Temperature	Bacteria Phosphorus TSS Temperature	Bacteria Temperature	Bacteria
Partial TMDL Parameter - Mercury⁴ (All watersheds)						

303(d)-Listed Parameters						
Columbia River	Willamette River	Columbia Slough	Johnson Creek	Fanno and Ash Creek	Tryon Creek	Westside Streams
Bacteria Dissolved oxygen pH DDT/DDE PCB Arsenic PAH Temperature	Mercury Manganese Iron DDT/DDE PCB Aldrin PAH Total chlordane Cyanide Hexachlorobenzene Chlorophyll <i>a</i>	Manganese Iron	PCB PAH Dissolved oxygen pH Biological criteria	Dieldrin Dissolved oxygen Biological criteria	Biological criteria	Biological criteria

Pollution Reduction Exemptions

Rooftops

Projects that infiltrate stormwater runoff from rooftops using UICs (i.e., private soakage trenches or drywells) are not required to provide pollution reduction prior to infiltration. This exemption does not apply to projects that discharge stormwater offsite. All UICs must be registered with DEQ except for residential roofs (up to three units) and footing drains, which are excluded from UIC regulations. Refer to **Section 1.4** for specific requirements for UICs.

⁴ This TMDL does not have a specific load or wasteload allocations and is only currently a reduction goal.

Temporary Structures

Temporary structures (see [Definitions](#)) are exempt from **pollution reduction** requirements, subject to BES review. Exemptions will not be allowed in circumstances where permits or other municipal regulations may be violated if the requirement(s) are lifted.

Discharge to UICs

BES will allow new or redeveloped impervious areas in the right-of-way (public or private streets) to discharge to existing or new UICs without the installation of new or additional vegetated stormwater management facilities only if the UIC meets all of the following:

- New UICs must meet all current DEQ requirements and current standard design and capacity requirements as given in the current *Stormwater Management Manual* or the *Sewer and Drainage Facilities Design Manual*. New UICs do not need to be rule authorized prior to plan review.
- Existing public UICs must be compliant with all DEQ requirements as given in the City's WPCF Permit and must meet current design standards and capacity requirements as given in the current *Stormwater Management Manual* or the *Sewer and Drainage Facilities Design Manual*.
- The UIC must accept runoff only from areas draining from paved private streets or paved rights-of-way on residential streets (less than 1,000 trips per day).
- The UIC must meet current depth-to-groundwater requirements.
- Existing UICs must have available capacity to receive additional runoff. If existing facility records cannot determine capacity, BES may require the applicant to test the UIC to determine available capacity.
- The UIC must have a sedimentation manhole built to current standards. The applicant will be required to upgrade existing UICs to meet this condition.

The applicant must also follow the Special Circumstances process ([Section 1.7](#) and [Appendix D.7](#)) for payment of offsite management fees. If the UIC does not meet the characteristics above, a vegetated stormwater management facility will be required to provide pollution reduction. Additional restrictions may be applicable within designated Wellhead Protection Areas. See [Section 1.4](#) for requirements for new UICs.

Pollution Reduction Standards

In Portland, flow rate-based pollution reduction facilities are designed to treat runoff generated by a rainfall intensity of 0.19 inches per hour (depending on time of concentration; see [Exhibit 1-6](#)).

Exhibit 1-6: Rainfall Intensity Needed to Treat 90 Percent of the Average Annual Runoff in Portland for Flow Rate-Based Facilities

Site's time of concentration (minutes)	Rainfall intensity (inches per hour)
5	0.19
10	0.16
20	0.13

The rainfall intensities must be used in the Rational Method ($Q=C \times I \times A$) equation to calculate pollution reduction runoff rates for rate-based pollution reduction facilities.

Facilities sized by routing a hydrograph through the facility (rate-based facilities with a storage volume component) may use a continuous simulation program (with a minimum of 20 years of Portland rainfall data) or a single-storm hydrograph-based analysis method, such as the Santa Barbara Urban Hydrograph (with 0.83 inches of rainfall over 24 hours and NRCS Type 1A rainfall distribution), to demonstrate treatment of 90 percent of the average annual runoff volume. (See [Appendix E](#) for more detailed information about the formulation of Portland's pollution reduction standards.)

Volume-based facilities are designed to treat runoff generated by 0.83 inches of rainfall over 24 hours (with NRCS Type 1A rainfall distribution) with a volume of basin/volume of runoff ratio of 2 and will treat roughly 90 percent of the average annual runoff.

Manufactured Stormwater Treatment Technologies

There will be sites that BES staff members and permit applicants agree is not technically feasible for vegetated facilities to meet all stormwater management requirements. Manufactured stormwater treatment technologies may be considered for sites in separated storm sewer areas where slope and infiltration limitations prevent the use of any reasonably located vegetated facilities (lined or unlined) or for sites unable to be sized for the water quality storm (0.83 inches in 24 hours). In those instances, approved manufactured stormwater treatment technologies may be proposed for pollution reduction.

BES maintains a list of approved manufactured stormwater treatment technologies (see [Chapter 2](#) and [Appendix B](#)). Applicants may select manufactured stormwater treatment technologies off the approved list under the Presumptive Approach for BES review and approval. Other facility types not on the list must be submitted to BES as a Performance Approach.

The approved vendor list is posted on the BES website at www.portlandoregon.gov/bes/swmm.

Additional Pollution Reduction Requirements for Vehicle and Equipment Traffic Areas

Vehicle and equipment traffic areas with the following characteristics must also incorporate a coalescing plate oil/water separator into the stormwater management design:

- commercial or industrial parking lots that store wrecked or impounded vehicles
- areas with a high likelihood of total oil and grease loadings – e.g., vehicle repair, vehicle sales, and vehicle fueling services

Requirements:

1. The coalescing plate oil/water separator must be installed upstream of the stormwater management facilities, and the sizing must meet [Section 4.3.3](#) requirements. Examples of oil/water separators are located in [Appendix G.5](#) (Typical Detail [SW-501](#)).
2. An O&M Plan, per [Chapter 3 and Appendix D.6](#) requirements, must be submitted for the oil/water separator.
3. Vehicle and equipment traffic areas that trigger these requirements must be paved with an impervious material; pervious/porous pavements are not allowed. Gasoline can react with asphalt pavement and compromise its integrity. Areas that have a high risk of gasoline spills or exposures must therefore be paved with concrete.
4. If discharging to a public or private UIC, the federal SDWA requires a state-issued UIC authorization by rule or a WPCF permit for facilities that have subsurface discharges of stormwater or wastewater. These authorizations and permits must be obtained from DEQ before any subsurface injection system is constructed. DEQ may classify the vehicle and equipment traffic areas described in this section as high risk and may not allow the use of UICs for stormwater disposal. Discharge of any stormwater mixed with runoff from motor vehicle waste from repair or maintenance activities or fluids from industrial or commercial areas where hazardous substances, toxic materials, or petroleum products are stored, used, or handled is prohibited. Contact DEQ and review [Section 1.4](#) for information about infiltration prohibitions in certain areas of the City and additional UIC requirements. Private discharges to a City UIC are prohibited.
5. Alternatives to these requirements can be requested by filling out the Source Control Special Circumstances form located in [Appendix D.7](#).

Pollution Reduction in Combined Sewer Areas

Pollution reduction is required in combined sewer areas for both public rights-of-way and private property, unless **all** of the following conditions are met:

1. The project has used vegetated stormwater management facility types to the maximum extent feasible, as approved by BES.
2. BES has assessed the impacted downstream area and confirmed that flow from the combined system will at no juncture be diverted to a surface water body, except as intended by the municipal system's design.
3. Future adopted plans for the CSO program do not include a separation of that conveyance system.
4. No activities are planned for the site that will require stormwater pollution prevention measures, as described in [Chapter 4](#) of this manual.
5. There is no significant risk of pollutant loading of a degree or nature that cannot be treated by the proposed stormwater facilities.
6. An offsite management fee is paid to BES. (See [Appendix D.7](#) for the appeal process to request an offsite management fee.)

1.3.4 Columbia South Shore

Columbia South Shore Well Field Wellhead Protection Area

The Water Bureau’s *Columbia South Shore Well Field Wellhead Protection Area Reference Manual* regulates the storage, handling, use, and transportation of hazardous materials in the Columbia South Shore Well Field Wellhead Protection Area (see [Exhibit 1-7](#)). Requirements apply to indoor and outdoor storage areas; loading and unloading areas; fuel dispensing facilities; storage, maintenance, and repair of vehicles and equipment; and transportation routes on private property and in public rights-of-way.

To protect groundwater from spills of hazardous materials, the requirements focus on spill control measures and prevention of infiltration into the ground. In portions of the wellhead protection area, drainage facilities in the public right-of-way must be lined with a polyethylene geomembrane liner and have appropriate spill control measures. Material and installation requirements for the polyethylene geomembrane liners are stated in Sections 00350 and 02320 of the *City of Portland Standard Construction Specifications*. Planting trees or deep-rooted shrubs over the top of required polyethylene geomembrane liners is prohibited in the wellhead protection area to protect the liners from root damage. Water Bureau review is required to determine which requirements apply. In some instances, infiltration may be allowed.

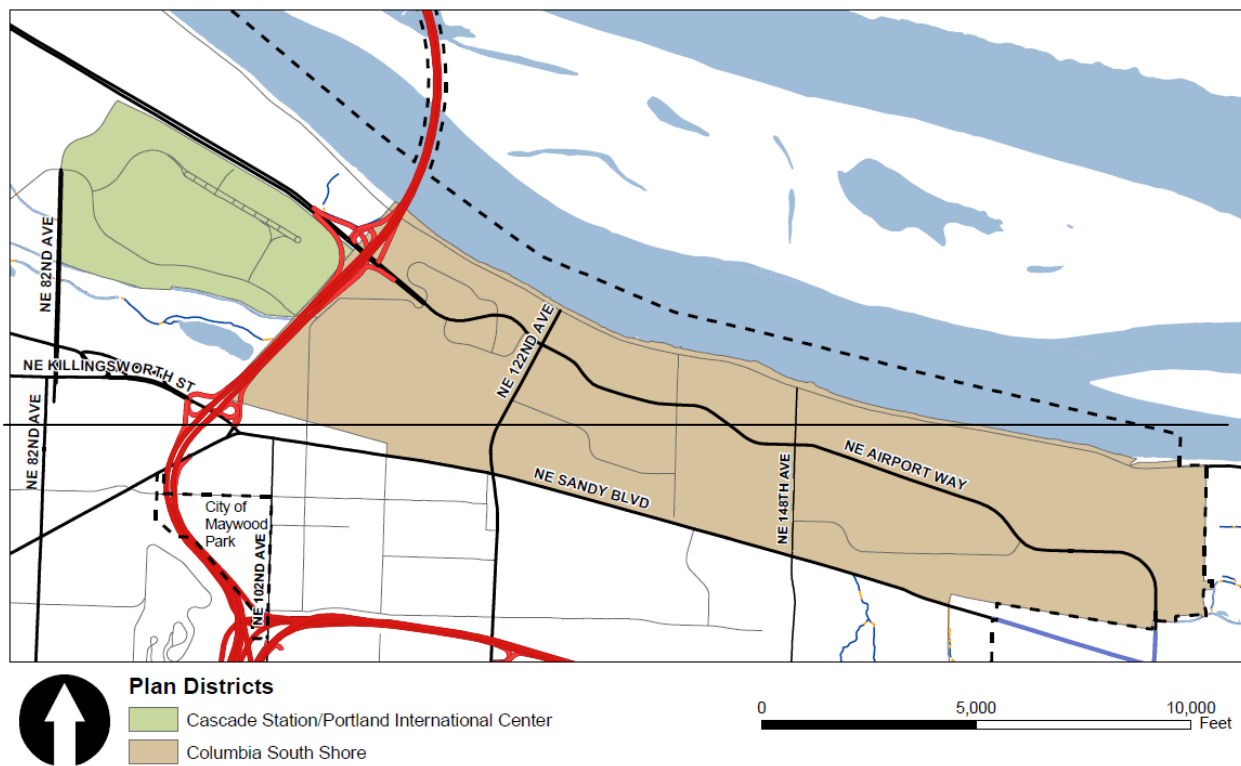
Exhibit 1-7: Columbia South Shore Well Field - Wellhead Protection Area



Columbia South Shore and Cascade Station/Portland International Center Plan Districts

The Columbia South Shore Plan District (Zoning Code Chapter 33.515.255) and Cascade Station/Portland International Center Plan District (Zoning Code Chapter 33.508.270) (see [Exhibit 1-8](#)) prohibit all new sumps, septic tanks, and other onsite disposal systems for sanitary disposal or disposal of industrial process water. All onsite stormwater and wastewater treatment and disposal systems must be discharged into a system approved by BES.

Exhibit 1-8: Cascade Station/Portland International Center and Columbia South Shore Plan Districts



1.3.5 Summary of Stormwater Management Requirements

Properties that propose new offsite discharges or new connections to the public system must comply with stormwater **infiltration and discharge** requirements for the impervious area draining to the discharge point, as specified in the stormwater hierarchy described in [Section 1.3.1. Exhibit 1-9](#) summarizes these requirements.

Exhibit 1-9: Summary of Infiltration and Discharge Requirements

Infiltration and Discharge	Stormwater Hierarchy
<p>Applies citywide. See Section 1.3.1.</p> <p><i>Exemptions: Sites with soils that do not infiltrate (less than 2.0 in/hr design infiltration rate as confirmed by infiltration testing), unstable soils, contamination or high risk of contamination, and wellhead protection areas are exempt from the total infiltration requirement. Flow control and pollution reduction requirements still apply.</i></p>	<ul style="list-style-type: none"> • Category 1: Vegetated infiltration facility or pervious pavement with no overflow or use of an ecoroof. • Category 2: Vegetated facility or pervious pavement with overflow to sump, drywell, or soakage trench or use of an ecoroof. • Category 3: Vegetated detention facility with overflow to drainageway, stream, river, or storm-only pipe. • Category 4: Vegetated detention facility with overflow to a combined sewer.

Projects that develop or redevelop over 500 square feet of impervious surface are required to comply with the **flow control** and **pollution reduction** requirements described in [Section 1.3.2](#) and [Section 1.3.3](#), respectively. Properties with existing development that propose new offsite discharges or new connections to the public system must also meet the pollution reduction and flow control requirements. [Exhibit 1-10](#) summarizes these requirements.

All projects must comply with [Chapter 3](#) O&M requirements and [Chapter 4](#) source control requirements.

Exhibit 1-10: Summary of Flow Control and Pollution Reduction Requirements

Flow Control (Detention and Retention)	
<p>Applies citywide to all projects that develop or redevelop over 500 square feet of impervious area.</p> <p><i>Detention exemptions: Sites that drain directly to the Columbia or Willamette Rivers or Columbia Slough (see site evaluation maps listed in References and Resources) and via storm-only systems with adequate capacity.</i></p> <p><i>Retention exemptions: Sites with unstable soils, contamination, or high risk of contamination.</i></p>	<ul style="list-style-type: none"> • Must use vegetated retention facilities to infiltrate onsite to the maximum extent feasible. • For discharge to a surface water body or storm-only system that discharges to surface water (other than those exempt), must detain: <ul style="list-style-type: none"> – 2-year postdevelopment peak runoff rate to one-half of the 2-year predevelopment peak rate – 5-year postdevelopment peak runoff rate to 5-year predevelopment peak rate – 10-year postdevelopment peak runoff rate to 10-year predevelopment peak rate – 25-year postdevelopment peak runoff rate to 25-year predevelopment peak rate • For discharge to a combined sewer, must detain the 25-year postdevelopment peak runoff rate to the 10-year predevelopment peak rate. • For all other discharge points, the base requirement is to maintain peak flow rates at their predevelopment levels for the 2-year, 5-year, and 10-year, 24-hour runoff events.
Pollution Reduction (Water Quality)	
<p>Applies citywide to all projects that develop or redevelop over 500 square feet of impervious area.</p> <p><i>Exemptions: Runoff from residential roofs (three units or less) that goes to UIC facilities.</i></p>	<ul style="list-style-type: none"> • Must achieve 70 percent TSS removal from 90 percent of the average annual runoff. • In watersheds with a TMDL or on DEQ’s 303(d) list of impaired waters, must use a pollution reduction facility that will reduce pollutants of concern. • Must use vegetated facilities to the maximum extent feasible.

1.4 UNDERGROUND INJECTION CONTROL (UIC) STRUCTURE REQUIREMENTS

This section provides general UIC information only. Complete UIC regulations and requirements are available on the DEQ website:
<http://www.deq.state.or.us/wq/uic/uic.htm>

DEQ defines a UIC as any system, structure, or activity that is intended to discharge fluids below the ground surface. UICs can pollute soil and groundwater if not properly designed, sited, and operated. Stormwater systems such as, but not limited to, sumps, drywells, and soakage trenches are examples of UICs subject to DEQ regulation.

DEQ can also classify other systems as UICs, depending on the design. Additional information about UIC determination is available on the DEQ website noted above. Examples of systems that DEQ can classify as UICs are provided below, along with criteria to help determine when the system is or is not a UIC.

UICs are regulated under the federal Safe Drinking Water Act (administered by DEQ) and the State Plumbing Code. DEQ regulates UICs under Oregon Administrative Rules 340-40 and 340-44. Applicants must obtain authorization from the DEQ Water Quality Division UIC Program before constructing, operating, modifying, or decommissioning any UIC.

Additional restrictions on the construction and operation of UICs may be applicable within designated Wellhead Protection Areas (WPAs). Complete WPA requirements can be found at <http://www.portlandoregon.gov/water/29890>.

Surface Infiltration Facilities

DEQ generally does not classify surface infiltration facilities such as pervious pavements, swales, planters, and basins as UICs.

Perforated Pipe Systems

An assemblage of perforated pipes, drain tiles, or other similar mechanisms, including French drains, designed and intended to collect and convey infiltrated stormwater to another disposal or discharge point, is not classified as a UIC. However, the final discharge point receiving stormwater from the collection or conveyance system may be classified as a UIC. If the final discharge point is below the ground surface, the system is generally classified as a UIC.

Pervious Pavements

When pervious pavement is designed with perforated pipe(s) to convey the stormwater to another point of discharge, DEQ does not classify the system itself as a UIC; however,

the point of discharge may be classified as a UIC. When pervious pavement is designed with a trench that is deeper than it is wide or with perforated pipe(s) under the pervious pavement, DEQ may classify the pervious pavement as a UIC. Utility trenches such as water, sewer, and gas lines are exempt from this classification.

If it is difficult to determine whether the proposed stormwater system design is or is not a UIC, it is best to consult with DEQ prior to submitting a City permit application.

DEQ UIC Registration, Rule Authorization, and Permitting

Owners or operators of new and existing public or private UICs, with the exception of single-family residential roof and footing drains, are required to register and provide site inventory data to DEQ. Residential roofs (up to three units) are excluded from UIC authorization.

Rule authorization allows the owner to operate a UIC without a water pollution control facility (WPCF) permit from DEQ. For rule authorization approval, UICs must meet the requirements of Oregon Administrative Rules Chapter 340, Division 340-44. These requirements are summarized below under “Criteria for DEQ UIC Rule Authorization.”

In some instances, DEQ may issue a permit for UICs instead of rule authorization; this is determined on a site-specific basis.

This section of the manual focuses on **proposed** public or private UICs for new construction and redevelopment, including UIC closures. Therefore, registration and rule authorization for proposed public and private UICs only (not existing UICs) will be discussed further.

The difference between a public and private UICs is as follows:

Public UIC: A public UIC collects stormwater from publicly owned facilities, parking lots, and public rights-of-way and is managed by the City of Portland.

Private UIC: A private UIC collects stormwater from private property, including roofs, parking lots, and other impervious surfaces, and discharges it to an onsite UIC. The onsite UIC is managed by the private property owner.

Development that proposes the use of either public or private UICs must follow the infiltration and discharge requirements in [Section 1.3.1](#) and meet all other requirements within this manual for managing stormwater.

Criteria for DEQ UIC Rule Authorization

DEQ has set minimum criteria for rule authorization, listed below and also found on the DEQ website at <http://www.deq.state.or.us/wq/uic/authorization.htm>.

- Only stormwater will be entering a UIC.
- Site development, design, construction, and management practices have minimized stormwater runoff entering the UIC.
- No other stormwater disposal destination is appropriate. Note: Discharge to the combined sewer system is not considered an appropriate discharge point if onsite infiltration is approved.
- UICs must not be located within 500 feet of water supply wells (domestic, irrigation, or industrial).
- UICs must not be located within 500 feet or a 2-year time of travel of public drinking water supply wells (whichever is more protective).
- No soil or groundwater contamination is present.
- The UIC is not deeper than 100 feet and does not discharge within a minimum separation distance of 5 feet of the highest seasonal groundwater level.
- A confinement barrier or filtration medium is present, or BMPs are used to prevent or treat stormwater contamination prior to entering a UIC.
- Design and operation of the UIC prevents accidental or illicit spills and allows for temporary blocking.

Compliance with these criteria must be demonstrated during the registration process to obtain rule authorization. If the criteria cannot be met, the applicant will have to apply for a permit or use another method of stormwater disposal. The provision of all required information in the application form will ensure a more timely review and approval process.

DEQ UIC Rule Authorization Process

DEQ has issued a WPCF permit to the City to construct and operate public UICs as specified within the permit. The permit requires the City to develop and implement a comprehensive management plan that details how the City will construct, operate, and

evaluate UICs to ensure compliance with permit requirements. Because of the City's permit, the rule authorization process for proposed public UICs is different than for private UICs. The public and private rule authorization processes are outlined below.

Constructing New UICs

Public UICs

The City of Portland manages the registration and rule authorization submittal process for public UICs proposed for construction, redevelopment, or decommissioning. To ensure a timely rule authorization process, it is critical for applicants to notify the City immediately once they have determined that UICs may be used for stormwater discharge from the public right-of-way. The City will complete the rule authorization process in accordance with the requirements of the City's WPCF permit. Notice to proceed will be given when the City determines that the proposed UIC meets permit requirements.

Private UICs

For private development or redevelopment using UICs for stormwater discharge, applicants must apply directly to DEQ for rule authorization before constructing the UIC. To ensure a timely review by DEQ, all required information should be provided in the application. For general requirements, see the previous "Criteria for DEQ UIC Rule Authorization." A City building permit does not authorize the construction of a UIC on private property; only DEQ can authorize a UIC.

DEQ recommends that registration and rule authorization applications for UICs serving private property should be submitted to DEQ according to the following timelines:

- Summer: At least 90 days prior to construction
- Winter: At least 60 days prior to construction

These timelines could be exceeded if all the required information is not provided by the applicant at the time of submittal. The applicant should allow for an appropriate amount of time to obtain all required information prior to submittal. For time-sensitive projects, DEQ recommends that applicants contact DEQ directly for an estimated application turn-around time.

DEQ requires a copy of the rule authorization approval letter to be kept onsite for local, state, and federal inspections.

Depth to Groundwater Investigation Requirements

Part of the rule authorization and permitting process requires both public and private UICs to have a minimum separation distance of 5 feet between the bottom of the UIC and the seasonal high groundwater level. Several areas within the City are known to

have shallow groundwater. Within areas of known or suspected shallow groundwater, additional information about depth to groundwater (DTW) must be collected to ensure the bottom of the proposed UIC meets separation distance requirements.

To determine if a DTW investigation is required for a proposed public or private UIC, refer to [Appendix F.1](#), Depth to Groundwater Investigation.

For public or private UICs proposed within the **50-foot** groundwater contour of the estimated depth to seasonal high groundwater, the applicant must provide the site-specific DTW investigation. One of the following methods must be used to obtain the DTW measurement:

- Install a temporary piezometer
- Use existing onsite or nearby high-quality shallow groundwater level data

For DTW investigation installation, DTW measurement, and reporting requirements and criteria for using existing data, see [Appendix F.1](#).

DEQ UIC Decommissioning Process

The decommissioning, or closure, of a UIC system requires submittal of a completed preclosure notification application to DEQ prior to closure. The preclosure application requires information about the UIC, development of a sampling plan, and collection and laboratory analyses of any sediment and standing water from within the UIC in accordance with the sampling plan to ensure that site remediation or cleanup is not necessary prior to closure. Include sufficient time in the construction schedule to accommodate the time necessary to collect, analyze, and summarize any sediment and water samples collected for decommissioning. DEQ recommends that applications be submitted 60 days prior to closure.

If flow is redirected from a private UIC to a City stormwater or drainage system, all new discharge connections must meet the requirements of this manual.

Public UICs

The City of Portland manages the preclosure application submittal process for public UICs proposed to be decommissioned. The City will complete the decommissioning process in accordance with the City's *UIC Management Plan, Appendix D: Decommissioning Procedure for UIC Systems*.

Private UICs

Preclosure applications for private UICs must be submitted directly to DEQ. A City building permit does not authorize the decommissioning of a UIC on private property. Only DEQ can authorize the decommissioning of a UIC.

For questions regarding rule authorization, permitting, and decommissioning of UICs, call 503-229-5886.

For copies of UIC registration applications, call 503-229-5189.

Rule authorization, permit, and preclosure applications, along with general information, can be found on the DEQ website at: <http://www.deq.state.or.us/wq/uic/uic.htm>.

Rule authorization and preclosure applications for private UICs should be sent, along with the associated application fee, to:

Oregon Department of Environmental Quality
Business Office
811 SW 6th Avenue
Portland, OR 97204

For technical questions, call the DEQ UIC Program at 503-229-5945.

DEQ Registration and Rule Authorization Resources

Resources are available to help applicants provide the required criteria for rule authorization. Below is a partial list of resources. Resources are also provided on the DEQ UIC registration forms.

- Well logs and drinking water well locations: Oregon Water Resources Department, <http://www.wrd.state.or.us>
- Site cleanup and releases: DEQ Profiler: <http://deq12.deq.state.or.us./fp20>
- DTW: USGS, 503-251-3200

1.5 NONCOMFORMING PARKING LOT AND LANDSCAPE REQUIREMENTS

In addition to the requirements of this manual, development and redevelopment projects must also meet the following requirements of the City Code (Title 33: Planning and Zoning). Chapters 33.266 (Parking and Loading) and 33.248 (Landscaping and Screening) identify parking requirements and development standards. Chapter 33.258 (Nonconforming Situations) requires nonconforming parking and maneuvering areas to be brought to compliance with current landscaping requirements under certain conditions (Section 33.258.070). Many of these parking lots lack stormwater facilities and must also upgrade their stormwater facilities if it is feasible to use the newly landscaped areas for stormwater treatment and discharge. Feasibility is determined by a number of factors, including but not limited to the following:

Grade: Existing grades must allow stormwater to flow toward the new vegetated facilities. This requirement does not apply when it is impractical for runoff to flow into landscaped areas.

Soil conditions: Soil conditions must be evaluated to determine if infiltration is feasible at the proposed location. Sites that have contaminated soils conditions must be evaluated by DEQ to determine if areas on the property are suitable for infiltration without the risk of mobilizing contaminants in the soil or groundwater.

Surrounding development: Because infiltration facilities must be set back 5 feet from any property line, sites where perimeter landscaping abuts the property line will be evaluated for stormwater infiltration. The review will consider, among other things, the location of existing development on abutting or downhill parcels.

If a stormwater facility is determined feasible, the appropriate sizing requirements, as specified in [Chapter 2](#) of this manual, must be used to calculate the size of the facility.

1.6 LEED CREDITS

In 2001, the City adopted a Green Building Policy that requires new construction and major renovations of all City facilities to meet the “Certified” level of LEED (Leadership in Energy and Environmental Design). The policy was updated in 2005 to require that new City facilities earn at least LEED Gold and go 30 percent beyond the City of Portland's *Stormwater Management Manual* baseline code requirements. In addition, the policy requires 70 percent ecoroof coverage on all new or replacement roofs.

In 2005, the Portland Development Commission (PDC) adopted a similar policy that requires LEED Silver certification for all publicly financed private-sector projects (that have PDC financing equal to or greater than 10 percent of total project costs and over \$300,000) larger than 10,000 square feet. To help offset the cost of LEED certification, the Oregon Department of Energy expanded the state Business Energy Tax Credit (BETC) to include buildings rated LEED Silver and higher, which has become a powerful incentive for developers and building owners to design and build to the LEED standard. These policies, in addition to a number of other green building initiatives throughout the City, are helping move environmental building practices and LEED certification forward in Portland.

The stormwater management requirements included in this manual support the achievement of LEED certification. The requirements can also assist with integrated credit strategies relating to water-efficient landscaping, water use reduction (using stormwater for non-potable uses such as landscape irrigation, toilet and urinal flushing, and custodial uses), and heat island effects from roofs. It is the responsibility of the applicant to verify that the project will fulfill any LEED requirements. The City of Portland assumes no responsibility for verifying or interpreting credit achievement.

For more information about LEED requirements, see the U.S. Green Building Council's website at <http://www.usgbc.org/>.

1.7 SPECIAL CIRCUMSTANCES AND APPEALS

Special Circumstances

Special circumstances on a proposed site may make it impractical to implement onsite **infiltration, pollution reduction or flow and volume control** to the standards specified in this chapter. In that case, applicants may fulfill all or a portion of their stormwater management obligations by compensating the City for the future development of offsite facilities.

Onsite stormwater management must be achieved to the maximum extent feasible, as approved by the City, in all cases before any offsite facilities or fees will be allowed. **Appendix D.7** describes the process and the submission requirements.

Special circumstances may make it impractical to meet the source control requirements of Chapter 4. In that case, applicants may propose alternatives or exceptions. **Appendix D.9** describes the process and the submission requirements.

Impervious Area Reduction Techniques
Applicants should thoroughly consider impervious area reduction techniques, such as ecoroofs and pervious pavement, before designing a stormwater management plan (see **Section 1.3** and **Section 2.3.1**). If site conditions are appropriate, the use of these techniques can reduce the required size of a stormwater management facility. In some cases, these techniques can eliminate the need for additional stormwater management facilities. Depending on the scope and impact of a project, BES may require an onsite ecoroof or pervious pavement before any special circumstance is allowed.

Appeals

The City has an appeals process that allows applicants to appeal staff interpretation of the City Code and of adopted policies and procedures that guide the review of development proposals. Applicants may appeal any issue related to interpretation of the stormwater management policy (e.g., staff assessment of a site’s stormwater management level or a permit denial).

Appendix D.7 describes the appeals process for the requirements of Chapters 1 through 3 (except Section 1.3.3). **Appendix D.9** describes a separate appeals process for Section 1.3.3 and for the source control requirements in Chapter 4.

Chapter 2 FACILITY DESIGN

This chapter provides the information needed to select and design stormwater management facilities that meet the City of Portland’s pollution reduction, flow and volume control, and infiltration and discharge requirements. It is divided into three main sections: site planning, sizing methodologies, and facility design.

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2.1 SITE PLANNING

As presented in Chapter 1, the City of Portland requires stormwater to be managed onsite to the maximum extent feasible before it is discharged to a pipe system with limited capacity or to a surface drainage channel. This is achieved by limiting effective impervious area and by directing stormwater to vegetated areas designed to manage stormwater.

This section introduces several overarching goals for integrating stormwater requirements into a comprehensive site plan and outlines the overall process for creating and permitting a stormwater management plan.

2.1.1 Design Goals

The following goals provide guidance for incorporating stormwater management facilities into an integrated site design.

Goal 1: Create an Informed Project Team

Early in the design process, it is critical to establish a clear understanding of the City of Portland's stormwater requirements with all members of the project team. With Portland's emphasis on vegetated facilities, stormwater management decisions have expanded beyond traditional civil engineering expertise. Members of the design team may include the developer, the developer's representatives, civil engineers, geotechnical engineers, landscape architects, architects, geologists and planners. It is recommended that licensed design professionals develop the stormwater management plan or oversee its development. On teams where there is more than one design professional making stormwater management decisions, clear roles and responsibilities should be established to ensure efficient communication and design development.

Stormwater management can greatly impact project permitting as well as the project schedule and budget; therefore, it is important to anticipate potential issues and encourage early collaboration across all disciplines. Project team members should be prepared to strategize and integrate solutions that reduce impervious area, limit stormwater discharge, and protect and improve water quality.

Goal 2: Maximize Permeability, Minimize Offsite Discharge

Creating a site design with less pavement and roof area reduces the stormwater volumes and flow rates, which can ultimately result in smaller stormwater management facilities and lessen downstream impacts. Options include clustering the development to limit the building footprint, as well as **impervious area reduction techniques** (see [Section 2.3.1](#) for guidelines and specifications). Maximizing permeability at every

opportunity requires the integration of many decisions at all levels of the project, from site planning to materials selection; these decisions should be made with stormwater management in mind.

Goal 3: Use Stormwater as a Design Element

Unlike conveyance systems that hide water beneath the surface and work independently of site topography, infiltration systems can work with natural land forms and land uses to become a major site design element. When stormwater management is considered during the conceptual design phase, the infiltration and drainage system can suggest building footprints and circulation routes. In this way, the drainage pattern helps generate the urban form, creating a more aesthetically pleasing relationship to the natural features of the site.

In addition to serving as the organizing element for the site, the drainage system can be integrated into development plans to:

- ✓ improve site aesthetics
- ✓ provide recreational opportunities
- ✓ maximize land values
- ✓ improve project marketability
- ✓ help meet landscape and screening requirements
- ✓ provide wildlife habitat
- ✓ provide environmental education for employees, visitors, and the public

Fencing or hiding stormwater facilities out of view not only loses the opportunity to create an aesthetically pleasing site design, but also sends the message that stormwater is an attractive nuisance. While there are legitimate concerns for safety and liability, these concerns can usually be resolved with careful design consideration, such as specifying shallow facility depths with gentle side slopes.

Plans that integrate stormwater facilities with the other development objectives can yield a series of small landscaped areas that meet other project objectives, rather than creating one large, fenced pond at the end of the conveyance system. Furthermore, facilities such as ecoroofs, swales, planters, and basins can all be landscaped with plants that are attractive and easy to maintain.

2.1.2 Steps in the Design and Permit Process

Once the project goals and objectives are established and the concept development is complete, the following steps are recommended for designing and permitting a stormwater management plan. See [Appendix D](#) for all submittal requirements and forms. A detailed explanation of each step is provided on the following pages.

- 1. Evaluate the Site**
- 2. Confirm Current Requirements**
- 3. Characterize Site Drainage Area and Runoff**
- 4. Determine Source Control Requirements**
- 5. Develop Conceptual Design**
- 6. Develop Landscape Plan**
- 7. Complete Stormwater Management Plan**
- 8. Prepare Operation and Maintenance Plan**
- 9. Submit Final Plans and Obtain Permits**
- 10. Construct and Inspect**

Steps 1 through 6 must be completed to ensure that Bureau of Environmental Services (BES) approval criteria and land use review requirements can be met through the Bureau of Development Services (BDS) processes for land use cases and building permits, including any required inspections. If an underground injection control (UIC) facility is proposed, Steps 1 through 5 also allow the applicant to prepare for Oregon Department of Environmental Quality (DEQ) rule authorization or Water Pollution Control Facility permit application. Once a land use or DEQ decision is rendered, the applicant can proceed with Steps 6 through 10. Steps 1 through 5 can also be referenced for early assistance and other preliminary reviews.

If land use review or DEQ authorization is not required for the development proposal, the applicant will generally complete Steps 1 through 10 in the course of acquiring the required zoning, site development, building, and public works permits.

Note: Every project is different, and it is not within the scope of this manual to specify what permits or reviews are required. Every applicant is encouraged to visit the Development Services Center to identify comprehensive project review and permit requirements. (See [References and Resources](#) for contact information.)

Step 1: Evaluate the Site

The first step in designing a stormwater management plan is to document and evaluate existing site conditions. (See [References and Resources](#) for a list of available site evaluation maps.)

- Identify existing site features that could be protected or incorporated into the site. Identify existing natural or manmade drainage features, including open channels, drainageways, ditches, ponds, depressions, wetlands, streams, lakes, and rivers. Include riparian areas and other significant vegetation, including mature trees. Identify limits of development and access, as related to disturbance of soils, vegetation, and water quality sensitive areas.
- Delineate tree canopy on and around the site. Where and when desirable or required by tree preservation and mitigation standards, conserve or plan to supplement existing tree canopy, especially conifers.
- Identify surface and groundwater features that will affect the facility design, including size of drainage area/basin, topography and slopes, geologic formations, and seasonal groundwater levels. Document the distance to drinking water wells, wellhead protection areas, and other groundwater areas of concern.
- Identify existing utilities, including all public and private storm, sanitary, and combined sewers, as well as water lines. (Refer to site evaluation maps in the [References and Resources](#) section.) Identify drainage flows across the property from upland areas to downstream receiving waters.
- Private systems may need to be decommissioned and public service provided. Locate existing sumps, drywells, cesspools, and septic systems. Contact BDS Records & Resources at 503-823-7660 for plumbing as-builts and access to building plans on private property. Contact BES System Development Assistance at 503-823-7761 for as-builts of public property or the right-of-way.
- Consider land use, traffic area and circulation, and other water quality concerns with respect to contributing drainage basins. Plan to keep stormwater management facilities a safe distance from operations that involve hazardous materials or solid waste.
- Research existing soil conditions, particularly infiltration potential and whether contamination exists onsite. Determine hydrologic soil group, soil drainage class, and potential for erosion. (Refer to site evaluation maps in the [References and Resources](#) section.) Examine boring and/or infiltration test results from nearby drywells or sumps to support the feasibility of infiltration.

Step 2: Confirm Current Requirements

The next step is to confirm current requirements for the site.

- This is the appropriate time to confirm all required City of Portland reviews and permits, as well as all other permit requirements – e.g., National Pollutant Discharge Elimination System construction site and discharge permits, DEQ UIC authorization, and other applicable requirements.
- In addition to confirming stormwater management requirements, identify setbacks (see [Exhibit 2-1](#)), easements, protected areas, and other site restrictions by consulting all applicable standards and requirements. These include, but are not limited to, environmental zones, wellhead protection areas, greenway overlays, plan districts, seep/spring or other environmental tracts, tree conservation and tree root protection areas, landscape and/or screening requirements, and all other zoning or density requirements.
- Collect and confirm existing reports, tests, or studies required for site development – e.g., Phase I and Phase II environmental site assessments and geotechnical reports.
- If the site conditions and/or the development proposal are complex, contact BDS to initiate an Early Assistance meeting with City staff to discuss conceptual site plan ideas. If the project is subject to a land use review, the pre-application process may also be initiated. Contact the Stormwater Early Assistance Team at 503-823-7761 for more information.

Exhibit 2-1: General Summary of City of Portland Setbacks

Setbacks are derived from the State or Oregon plumbing and building code and represent best practices for ensuring safety of nearby structures or features. BES will enforce these setbacks unless an alternative is approved through BDS plumbing code appeal¹. Setbacks are measured from the center of a drywell or from the outside edge of a surface stormwater facility to the adjacent boundary, structure, or facility. All setback distances provided are minimums that can be increased at the discretion of City of Portland staff. Under typical conditions, setbacks assume that the stormwater facility is either level to or at a lower elevation than the finished floor elevation of any nearby structures. If an applicant proposes to encroach in a setback, the applicant must provide a signed and stamped geotechnical report that demonstrates that the proposal will meet the intent of the building and/or plumbing code requirements as part of an approved plumbing code appeal. An alternative facility design may be required to meet conditions of appeal approval.

Distance in Feet	Setback from	Stormwater Facility
5	Property line ²	All infiltration facilities
10	Any foundation	All infiltration facilities
100	Upslope from any drainfield	All infiltration facilities
100	Slopes 10% or greater	Swales and basins
100	Slopes 20% or greater ³	Trenches and drywells
200	Slope greater than 10' high & steeper than 2h:1v	UIC
500 (or 2 yr time of travel)	Drinking water well	UIC

Notes:

- No setbacks are required for permeable pavers, pervious asphalt, or pervious concrete. A liner may be required where located within 5 feet of infrastructure.
- Stormwater facilities may have typical setbacks. See facility-specific setback information in [Section 2.3.3](#).

¹ Information about BDS plumbing code appeals can be found online at www.portlandoregon.gov/bds.

To submit a plumbing code appeal, please check the BDS website for instructions (<http://www.portlandoregon.gov/bds/34196>) or contact the appeals secretary at 503-823-7335.

² Waterproof flow-through facilities may be located up to the property line as long as the facility is less than 30 inches above the lowest adjacent grade.

³ Where grade is 20 percent or greater and slope setbacks cannot be met, geotechnical reports or engineering will be required. This applies to all infiltration facilities.

Step 3: Characterize Site Drainage Area and Runoff

The third step involves evaluating the characteristics of the stormwater created by the proposed development or redevelopment.

- Determine if the project will use the Simplified, Presumptive, or Performance Approach (see [Section 2.2](#) for a complete description of each) to size the stormwater management facilities. This is important because it establishes the type and number of infiltration tests that will be required. Begin to gather the information needed for the stormwater management submittals. (See [Appendix D](#) for submittal requirements.)
- Conduct soil infiltration testing, as specified in [Appendix F.2](#). Infiltration testing is also discussed in [Sections 2.2.1](#) and [2.2.2](#).
- Begin to formulate how the stormwater management plan will meet the pollution reduction, flow control, and infiltration and discharge requirements of this manual.
- Work with BES staff to determine what upstream and downstream cumulative activities will impact the proposed project.
- Work with BES staff to determine if the capacity of the downstream receiving system (natural or manmade) must be characterized.
- If necessary, plan to safely route upstream flows across the site both during and after construction. Determine if drainageway protection is necessary. Refer to [Appendix A.3](#), “Private Drainage Reserve Administrative Rules,” if necessary.
- Develop preliminary calculations that estimate how much stormwater will be created, how much can be infiltrated onsite, and how much, if any, will be discharged offsite.

Step 4: Determine Source Control Requirements

Source control measures prevent contaminants from entering stormwater. This step evaluates whether source control issues apply to the project and identifies the appropriate measures to limit exposure of contaminants to stormwater. Source control measures do not meet flow control or pollution reduction requirements.

- It is important to evaluate commercial and industrial sites. Depending on the activity, materials handled, and potential for spills at a site, the potential for high pollutant loads is typically greater than for other land uses. Cover of outdoor

storage and work areas and other measures may be required. (See [Chapter 4](#) for more detail.)

- Some vehicle and equipment traffic areas (e.g., areas used for storage, repair, fueling, and washing of vehicles) are subject to specific requirements. (See [Section 1.3.3](#) and [Chapter 4](#) for more detail.)
- Stormwater management options may be limited in some cases because of contamination onsite or on an adjacent site, as determined by BES.

Step 5: Develop a Conceptual Design

This step includes stormwater facility selection and preliminary sizing.

- Select the appropriate facility type, location, and size for each proposed facility (see [Section 2.2](#)). Consider detail specifications, especially minimum and maximum dimension and setback requirements.
- Develop a preliminary site grading plan. It is essential for impervious surfaces to be graded to drain toward the stormwater facilities. The facilities must also be depressed to allow sheet flow into the area. Since this design approach is still new to many construction contractors, it is advisable to clearly supplement the grading plan with appropriate cross-sections and detailed drawings.
- Some situations, such as steep slopes and high sediment loads, may limit facility options. Steep slopes will typically require more complex engineering. Plan to implement onsite erosion and sediment controls to reduce the amount of sediment getting into the stormwater. Excessive sedimentation can damage a facility and require costly repairs. Pretreatment may be necessary to protect vegetated facilities. If a facility will be used for erosion control during construction, it should be constructed before general grading occurs and rehabilitated after construction.
- Determine if hydrologic and hydraulic models specified in the City's *Sewer and Drainage Facilities Design Manual* are necessary to size the conveyance facility. Correlate calculations between the conveyance infrastructure and the stormwater facility sizing.
- Complete a conceptual site plan and necessary submittals required for land use review. Submit them to the City for review. Include preliminary design calculations that demonstrate how the proposed plan will meet the pollution reduction, flow control, and infiltration and discharge requirements, including

which category of the stormwater hierarchy ([Section 1.3.1](#)) the project will achieve.

Step 6: Develop a Landscape Plan

Once the preliminary sizing is complete, attention to the proposed soils and vegetation is necessary. See [Section 2.3.2](#) for more detailed information about landscape requirements and planting plans, [Appendix D.1](#) for submittal guidelines, and [Appendix F](#) for soil and plant specifications.

- At this step, it is appropriate to consult with a qualified landscape professional. Proper soil and plant selection is critical to the success of a facility and must not be left unspecified.
- Stormwater management facilities should be integrated with the other project landscape areas. Select plant species and develop a planting plan. Consider the use of native plants where appropriate. Harsh urban conditions may require hardier species.
- Schedule plantings so they are well established before concentrated flows are routed to a facility. If possible, plan to wait 3 to 6 months before routing water into a facility. If this is not possible, establish approved erosion control measures before routing stormwater to a facility.

Step 7: Complete a Stormwater Management Plan

Once the conceptual plan is complete (or approved through the land use review process), complete final plans and permit items. See [Section 2.2](#) for a more complete description of requirements and [Appendix D](#) for submittal guidance.

- Plans and specifications must be prepared or closely supervised by a certified design professional licensed in the State of Oregon.
- Confirm that all design criteria are met. Confirm that volume storage within a facility is adequate. Complete grading plans, including inlet and outlet locations, elevations, and sizes. Ensure that landscape construction and erosion control techniques are well described. Ensure adequate maintenance access to all stormwater facilities.
- Finalize the project schedule.
- Complete the facility design, with applicable construction documents.

- Finalize required stormwater submittals (forms, plans, reports).

Step 8: Prepare an Operation and Maintenance Plan

See **Chapter 3** for operations and maintenance (O&M) submittal guidelines and a sample O&M Plan. Since site plans may change during review, a draft O&M Plan should be submitted with site plans. A final and recorded O&M Plan will be required prior to permit issuance.

- Outline the scope of activities, schedule, and responsible parties for inspecting and maintaining the facility, both during the warranty period (if applicable) and over the long term. Vegetation management, structural repairs, and sediment removal are some of the primary maintenance activities to be addressed. Commercial and industrial sites generally require more frequent maintenance than residential sites.
- Vegetation may need temporary irrigation during times of drought, as well as mulch to retain topsoil, heat, and moisture and to suppress weed growth.
- Avoid the use of fertilizers, herbicides, or pesticides, especially in the main flow path of water (they are prohibited in public facilities). If they must be used, use sparingly and in a manner that minimizes the discharge of these pollutants into the stormwater.
- Temporary fencing may be needed to protect plants from foot traffic and construction activities that can compact soil and damage vegetation.
- Excessive sediment accumulation can block stormwater infiltration into a facility and damage vegetation and should therefore be monitored and removed promptly. Store and dispose of sediment in accordance with local regulations. (Refer to Metro at www.OregonMetro.gov or 503-797-1700 for proper disposal options.) This is particularly important on sites with high pollutant levels and on contaminated sites.
- Facilities that will come into the City's ownership and operation are subject to more specific policies and guidance. See **Section 3.2.3**.
- If UICs are proposed that will require registration with DEQ, DEQ also requires an O&M plan.

Step 9: Submit Final Plans and Obtain Permits

- Submit all final plans and drawings to the City of Portland for review, final approval, and permitting of the project.
- Provide additional information to City staff reviewing the application, as requested, to expedite the review process.
- Once permits are approved and issued, call for locates and begin construction.

Step 10: Construct and Inspect

- Once design plans for **public facilities** are approved and permitted, the applicant must schedule a preconstruction meeting with all relevant bureau construction inspection teams to coordinate and evaluate all stormwater components of the project before construction. Meetings with design engineers, contractors, and construction review teams are integral to ensuring that all stormwater facilities are constructed according to the development goals, project plans, and current design specifications.
- City staff performs construction inspections on **public facilities** as needed. Initial inspection coordination is established at the preconstruction meeting. Inspections throughout the project are coordinated by the City inspector and the contractor or general manager.
- BES performs construction inspections on **private property** within the development permitting process. The number, type, and sequencing of inspections required for proposed stormwater management systems will vary by a number of factors, including phasing of construction, type of development, and type and number of stormwater facilities. The inspection requirements will be determined during plan review. Vegetated stormwater facilities will usually require multiple inspections throughout the construction phase. Instructions on requesting inspections will be provided during plan review and permit issuance. The applicant is encouraged to contact BES prior to building the facility to schedule preconstruction meetings or to verify inspection requirements. For more information on inspections of onsite stormwater management facilities, contact the BES Development Review Hotline at 503-823-7761.
- BES also inspects private facilities post-construction to ensure long-term compliance with the recorded O&M Plans and provides technical assistance on facility O&M. See [Chapter 3](#) for O&M requirements. For questions, technical assistance with maintenance, or to revise recorded O&M Plans, contact the Maintenance Inspection Program at 503-823-5320.

2.2 SIZING METHODOLOGIES

This section presents three methodologies for sizing stormwater management facilities: the **Simplified Approach**, **Presumptive Approach**, and **Performance Approach**.

Facilities sized with the Simplified and Presumptive approaches comply with the City's infiltration and discharge, flow and volume control, and pollution reduction requirements (see [Section 1.3.5](#)). When the Performance Approach is used, it is up to the applicant to demonstrate that those requirements are met.

Applicability

Applicants must select **one** of the following approaches. Each approach has a unique plan review and approval process that establishes a permit track for the project. The final selection of a project design approach is subject to City approval.

For every application, the impervious area should include the **total** proposed impervious area, including all streets, tentative driveways plans, redeveloped areas, and tentative building footprints, based on the allowed building coverages and setbacks per the zoning code.

The **Simplified Approach** is available for projects with less than 10,000 square feet (0.23 acre) total new or redeveloped impervious area, including but not limited to roofs, patios, parking areas, and driveways. (See [Section 2.2.1](#) for more information.) This approach is most appropriate for private, small-scale residential development, typically with limited professional design services available. It is not allowed for use on large, complex projects or on projects that have multiple catchments that, when combined, exceed 10,000 square feet of new or redeveloped impervious area. It is not allowed on projects that require a public works permit or include private street improvements. BES may require applicants to use a different approach upon review of site conditions and technical constraints.

The **Presumptive Approach** is available for medium- to large-scale residential and commercial projects of any size on either private or public property. Slightly modified requirements apply to streets. (See [Section 2.2.2](#) for more information.) This approach is required for projects with new or redeveloped impervious area of 10,000 square feet (0.23 acre) or greater or projects with proposed street improvements. It can also be applied to size facilities on smaller projects where the more detailed hydrologic calculations will allow the applicant to size a facility more accurately by taking measured infiltration rates and other more specific design factors into account. This approach requires the assistance of a licensed engineer or qualified design professional.

The **Performance Approach** is available for projects with unique circumstances that require analysis that goes beyond the capabilities or specifications of the Simplified and Presumptive approaches. It may be used to address a range of circumstances, including but not limited to:

- size a performance-based facility (wetlands, ponds, grassy swales, etc.)
- propose an alternate design methodology or facility specification
- address unique site conditions
- apply a new or emerging design technology, such as manufactured stormwater treatment technologies not approved for general use in the City of Portland

The Performance Approach requires the assistance of a licensed engineer or qualified professional. Detailed engineering calculations must be provided as evidence of the proposed design's performance with respect to the stormwater requirements provided in [Section 2.2.3](#).

2.2.1 Simplified Approach

Projects that use the Simplified Approach use a simple surface area ratio calculation to size stormwater facilities. The applicant quantifies the amount of new or redeveloped impervious area that is proposed and multiplies that area by a sizing factor that varies by facility type. The sizing factors were developed with analysis based on the Santa Barbara Urban Hydrograph (SBUH) method. [Appendix C.1](#) provides information about the SBUH method, and [Appendix C.2](#) provides information about the Simplified Approach basis of sizing. BES may require applicants to use a different approach upon review of site conditions and technical constraints.

Vegetated surface facilities available with the Simplified Approach include swales, planters, basins, and filter strips, all of which are designed to receive and manage stormwater runoff from adjacent impervious surfaces. Ecoroofs and pervious pavement are also allowed under the Simplified Approach, but those surfaces receive direct rainfall and cannot receive stormwater runoff from adjacent impervious areas. All vegetated surface facilities and ecoroofs designed with the Simplified Approach require an overflow to an approved discharge point. Onsite infiltration is achieved when overflows are directed to a **subsurface infiltration facility**, including but not limited to drywells and soakage trenches.

Simplified Approach Infiltration Testing

The Simplified Approach requires at least one infiltration test to be conducted before selecting and sizing facilities. (See [Appendix F.2](#) for the **Simplified Approach Infiltration Test** instructions and requirements. The **Simplified Approach Submittal Guide** has instructions on how to submit the infiltration testing information on the **Simplified Approach Form** (both found in [Appendix D](#)).

The Simplified Approach Infiltration Test does not require correction factors be applied to the tested infiltration rate. A tested infiltration rate of 2 inches per hour or greater requires onsite infiltration. A tested infiltration rate of less than 2 inches per hour requires the use of a partial infiltration or flow-through facility with overflow to an approved discharge point. Exceptions apply depending on site conditions and the approved discharge point. See [Section 2.3](#) for a description of facility configurations. If the tested infiltration rate is greater than 2 inches per hour, the designer should consider the use of the Presumptive Approach where well-draining soils can be factored in to more accurately design the stormwater facility.

Simplified Approach Submittal Requirements

Applicants using the Simplified Approach must submit a completed **Simplified Approach Form** as part of their permit application, along with a complete site plan, construction drawings, and facility details. An **Operations and Maintenance Form** and a copy of the appropriate **Operations and Maintenance Specifications** must also be included. On sites with steep slopes or shallow groundwater, BES may require a geotechnical report in order to evaluate the suitability of the proposed facility and its location. BES staff may also require an encased falling head or a double-ring infiltrometer infiltration test under the Presumptive and Performance Infiltration Testing Requirements to verify that the Simplified Approach is appropriate.

See [Appendix D.3](#) for complete information about the submittal requirements and necessary forms for the Simplified Approach.

2.2.2 Presumptive Approach

The Presumptive Approach allows the designer to factor in site-specific data to determine the size and configuration of the stormwater facility for swales, basins, and planters. Like the Simplified Approach, the Presumptive Approach includes impervious area reduction techniques, vegetated surface facilities, subsurface facilities, and hybrid facilities. See [Section 2.3.1](#) for a complete overview of facility types.

Standard sizing tools and stormwater calculators allow designers to size basins, swales, and planters with consideration of native infiltration rates and other unique site conditions of the project. See below for a discussion of approved stormwater sizing calculators.

Vegetated surface facilities available with the Presumptive Approach include swales, planters, and basins, all of which are designed to receive and manage stormwater runoff from adjacent impervious surfaces. Ecoroofs and pervious pavement are also allowed under the Presumptive Approach, but those surfaces receive direct rainfall and do not receive stormwater runoff from adjacent impervious areas. Under the

Presumptive Approach, swales, planters, and basins can be designed as infiltration, partial infiltration, or flow-through facilities.

Subsurface facilities that can be used with the Presumptive Approach include drywells and sumps. Sizing assumptions and facility dimensions are required with every permit application.

Hybrid facilities can only be designed under the Presumptive Approach. They combine the benefits of vegetated surface facilities with those of subsurface infiltration facilities to provide pollution reduction, flow control, and full or partial infiltration. (See [Section 2.3.1](#) for a complete description of hybrid facilities.)

Presumptive Approach Infiltration Testing

The Presumptive Approach requires infiltration tests to be conducted before performing any design calculations for basins, swales, planters, and UICs. Three infiltration testing methods are available to determine the design infiltration rate:

- open pit falling head
- encased falling head
- double-ring infiltrometer

A qualified professional must exercise judgment in the selection of the infiltration test method. Refer to [Appendix F.2](#) for the number and location of tests required. Depending on site conditions and the proposed facility location, the City may adjust the required number of tests. If the location and/or orientation of the proposed facility are revised during the design process, retesting will be required, unless otherwise approved by the City.

The Presumptive Approach requires in all cases that **correction factors** be applied to the **tested infiltration rate** to determine the **design infiltration rate**. See [Exhibit F.2-1](#) for the corrections factors that apply.

For the Presumptive Approach, a design infiltration rate of 2 inches per hour or greater requires onsite infiltration. A design infiltration rate less than 2 inches per hour allows the use of a partial infiltration or flow-through facility depending on site conditions. Exceptions apply depending on site conditions and the approved discharge point. See [Section 2.3](#) for a description of facility configurations and [Appendix F.2](#) for infiltration testing information.

Approved Stormwater Sizing Calculators

The City maintains a list of approved stormwater sizing calculators allowed under the Presumptive Approach. BES will post the list of approved stormwater sizing

calculators to the BES website at www.portlandoregon.gov/bes/swmm with any required data entry or calculator parameters in order to meet local conditions and the design criteria of the *Stormwater Management Manual*.

If the project designer proposes to deviate from the allowable ranges or maximum catchment sizes specified in an approved stormwater sizing calculator, the proposal must be submitted under the Performance Approach.

Presumptive Approach Calculations

If an approved stormwater sizing calculator is not used, the following principles must apply. The inflow hydrograph generated by the catchment area is routed through the surface infiltration facility modeled as a reservoir, with an infiltration rate of 2 inches per hour assumed for the growing medium. The model should **not** adjust the infiltration rate as the hydraulic head is increased.

When designing swales and basins where some infiltration can be accounted for through the side slopes, the entire area of the facility cannot be assumed to infiltrate. Infiltration through the side slopes is limited to the horizontal area at 75 percent of the maximum depth. To find the design infiltration area of the facility, use the equations that follow.

When designing a stormwater facility (onsite surface and subsurface infiltration), calculations should confirm that the inflow hydrograph of the 10-year, 24-hour storm can be stored and infiltrated without exceeding the maximum depth or storage capacity of the facility. Where sites have a native soil design infiltration rate greater than the design infiltration rate of the growing medium, the analysis should assume a free outlet condition at the base of the growing medium. If the native soils have a lower design infiltration rate than the growing medium, it is necessary to route a second hydrograph through the drain rock below the growing medium, also modeled as a reservoir with infiltration. The inflow to the second hydrograph (gravel reservoir) is the outflow hydrograph generated through infiltration of the growing medium. Again, the analysis should confirm that this second hydrograph can be stored and infiltrated without exceeding the maximum depth or storage capacity of the gravel reservoir. If necessary, the size of the facility should be revised until capacity is not exceeded. There is the added complexity in cases where the gravel reservoir is filled while the surface facility is still draining. This full condition can influence the infiltration capacity of the growing medium and affect the results of the initial routing model.

Presumptive Approach Required for Streets

The Presumptive Approach is required for sizing vegetated stormwater facilities in the public right-of-way and private streets. In addition to the other requirements and specifications provided in [this section](#), the following apply:

- The open pit falling head infiltration test may be used for sizing street facilities, but depending on the development proposal and the existing site conditions, the City may require the double-ring infiltrometer test. Both the open pit falling head test and the double-ring infiltrometer test specifications are located in [Appendix F.2](#). Refer to [Exhibit F.2-1](#) for the location and minimum number of tests required.
- **Trees**, planted in accordance with the City of Portland Urban Forestry requirements, may be used as an impervious area reduction technique in the public right-of-way and on private streets. Refer to [Section 2.3.3](#) for more information.
- **Stormwater Management Typical Details** are available specifically for public streets (see [Appendix G.3](#)). Commonly referred to as “Green Street Details,” they are tailored to circumstances commonly found in the right-of-way. Vegetated stormwater facilities for streets are often affected by street design criteria and are subject to certain dimensional limitations.

Presumptive Approach Submittal Requirements

Applicants using the Presumptive Approach must submit a **Stormwater Management Report** as part of their permit application, along with a complete site plan, construction drawings, and details. An **Operations and Maintenance Form** and a copy of the site-specific **Operations and Maintenance Plan** must also be included. See [Appendix D.4](#) for complete information about the submittal requirements for the Presumptive Approach.

2.2.3 Performance Approach

Applicants who have developed stormwater management facilities or plans that do not meet the requirements of the Simplified Approach or Presumptive Approach as described previously must submit plans under the Performance Approach. Performance Approach submittals may include impervious area reduction techniques, vegetated surface facilities and subsurface facilities that vary from the specified design requirements. Performance Approach submittals will be reviewed by technical staff under the direction of the Chief Engineer or designee.

The Performance Approach may be used to:

- size a performance-based facility (ponds, grassy swales, etc.)
- propose an alternate design methodology or facility specification, such as conveying runoff from impervious area to ecoroofs or pervious pavement
- address unique site conditions
- apply a new or emerging design technology, such as manufactured stormwater treatment technologies not approved for general use in the City of Portland

Facilities must be designed using the hydrologic analysis methods described below. If these hydrologic analysis methods are not used, BES must pre-approve the alternative method before the plans and calculations are submitted. Regardless of how the hydrologic calculations are performed, all hydrologic submittals must include data necessary to facilitate BES's review.

An approved stormwater sizing calculator can be used under the Performance Approach, with justification included for sizing variables outside the allowable ranges of the Presumptive Approach.

Infiltration and Discharge

If surface infiltration facilities such as swales, planters, or basins are proposed to meet infiltration requirements, the sizing methodology must rely on retaining the 10-year storm through a facility that can be calculated using SBUH, NRCS TR-55, HEC-1, or SWMM. The Rational Method must be used to design the infiltration flow rate for public infiltration sumps.

Flow Control

With the exception of facilities sized using the Simplified Approach, BES will use the SBUH to check design calculations for flow control facilities. The design professional may also use NRCS TR-55, HEC-1, or SWMM to demonstrate compliance with flow control standards.

Pollution Reduction

The City will accept a design proposed for pollution reduction requirements if the applicant demonstrates the following:

- Facilities will perform at the required efficiency: 70 percent total suspended solids (TSS) removal from 90 percent of the average annual runoff (see [Section 1.3.3](#)) and is capable of reducing Total Maximum Daily Load (TMDL) pollutants of concern (if applicable). Documented performance is required and must include published data, with supporting cited research, demonstrating removal of target pollutants at required levels.

- For sites regulated under discharge permits, pollution reduction facilities that target a specific pollutant of concern will be considered as long as pollution reduction requirements for the entire site are also being met.
- Facilities can be efficiently maintained to perform at the required level. Public facilities should not require more costly maintenance than facilities designed using the Simplified or Presumptive approach.

Flow Rate-Based Facilities

With the exception of facilities sized using the Simplified and Presumptive approaches, BES will use the Rational Method, with rainfall intensities presented in [Section 1.3.3](#), to verify flow rates used to size rate-based pollution reduction facilities. Through a continuous simulation model using Portland rainfall data, BES has verified that these intensities treat 90 percent of the average annual runoff volume. The design professional may also use SBUH, NRCS TR-55, HEC-1, or SWMM to demonstrate treatment of 90 percent of the average annual runoff volume.

Flow Volume-Based Facilities

Volume-based pollution reduction facilities included in this manual (wet ponds and extended wet detention ponds) must use the predetermined volume of 0.83 inch over 24 hours with a volume of basin/volume of runoff ratio of 2 to be in compliance. Through a continuous simulation model using Portland rainfall data, BES has determined that this volume provides adequate detention time to treat 90 percent of the average annual runoff volume.

Combination Rate/Volume-Based Facilities

With the exception of facilities sized using the Simplified Approach, BES will use a software program based on the SBUH method, or a continuous simulation model with Portland rainfall data, to verify the sizing of flow rate-based pollution reduction facilities that also rely on a storage volume component. The design professional may also use NRCS TR-55, HEC-1, or SWMM to demonstrate treatment of 90 percent of the average annual runoff volume.

Conveyance

Refer to BES's *Sewer and Drainage Facilities Design Manual* for acceptable hydrologic analysis methods for stormwater conveyance. The Rational Method will be used to verify design calculations for pipe or surface conveyance facility sizing. HEC-HMS or SWMM must be used for projects greater than 50 acres in size. (See Section 6-7 of the *Sewer and Drainage Facilities Design Manual*.)

Hydrologic Analysis Method Resources

The **SBUH method** may be applied to small, medium, and large projects. It is a recommended method for completing the analysis necessary for designing flow control facilities when not using the Simplified Approach.

The **SCS TR-55 method** may be applied to small, medium, and large projects. This is also one of the recommended methods for completing hydrologic analyses necessary for designing flow control facilities when not using the Simplified Approach. (Refer to SCS Publication 210-VI-TR-55, Second Edition, June 1986.)

The **HEC-HMS method** may be used on medium and large projects. (Refer to the HEC-HMS User's Manual.)

The **SWMM method** may be used on medium and large projects. (Refer to the SWMM User's Manual.)

Performance Approach Submittal Requirements

Under the Performance Approach, the applicant must demonstrate that the proposed management plan meets or exceeds all of the City of Portland's stormwater requirements. Applicants using the Performance Approach must submit a **Stormwater Management Report** as part of their permit application, along with a complete site plan, construction drawings, and details. An **Operations and Maintenance Form** and a copy of the **Operations and Maintenance Plan** must also be included.

See [Appendix D.5](#) for complete information about the submittal requirements for the Performance Approach.

2.3 FACILITY DESIGN

This section provides detailed guidelines and specifications for designing the stormwater facilities included in this manual. The three sizing methodologies described in [Section 2.2](#) (the Simplified, Presumptive, and Performance approaches) are available to appropriately design and size the stormwater facilities. (See [Exhibit 2-4](#) for a list of stormwater facilities and their applicable design methodologies.)

2.3.1 Facility Overview

Impervious Area Reduction Techniques

Ecoroofs, pervious pavement, and trees are impervious area reduction techniques that can affect which design approach is required and reduce the overall square footage of impervious area that requires stormwater management. (See [Section 2.3.3](#) for facility restrictions and specifications). For example, if an applicant has a project with 11,000 square feet of impervious area, and site conditions allow for 3,000 square feet of pervious pavement, the applicant can reduce the impervious area to 8,000 square feet and use the Simplified Approach, as long as all other requirements for the Simplified Approach are met. Ecoroofs, pervious pavement, and trees intercept rainfall directly and are not allowed to receive stormwater runoff from other areas. Ecoroofs, pervious pavement, and trees must also be included on an O&M Plan that meets the requirements of Chapter 3.

Stormwater Management Facility Configuration

Stormwater management facilities can be configured to achieve

- surface infiltration,
- subsurface infiltration, or
- both surface and subsurface infiltration.

Surface infiltration facilities achieve infiltration in the upper layer of the ground surface and can include facilities such as swales, planters, and basins.

Subsurface infiltration facilities achieve infiltration below the ground surface and include facilities such as sumps, drywells, and soakage trenches. Subsurface infiltration facilities are subject to DEQ's UIC regulations (see [Section 1.4](#)).

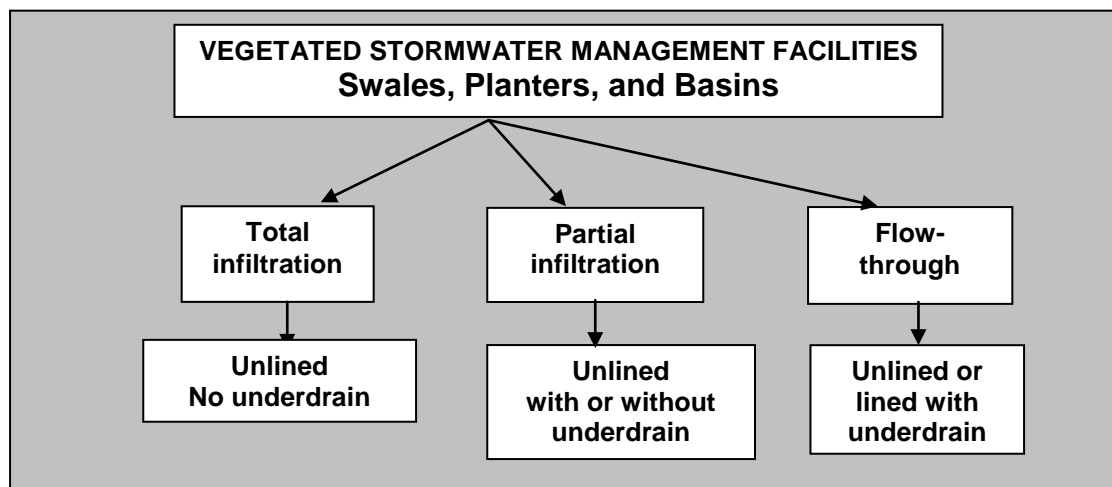
Hybrid facilities achieve both surface infiltration and subsurface infiltration by bypassing flows greater than the water quality storm directly to a gravel layer below the facility growing medium. By providing a direct connection to the gravel layer, the designer can take advantage of higher native infiltration rates, if they exist, or utilize the

belowgrade storage to reduce the size of the facility. Hybrid facilities are also subject to DEQ's UIC regulations.

Vegetated Surface Facilities

Swales, planters and basins can be configured to achieve total infiltration, partial infiltration, or flow-through. See [Appendix G.1](#), for typical configuration details.

Exhibit 2-2: Vegetated Stormwater Management Facilities Configurations



Total infiltration facilities need soils that drain well and infiltrate 2 inches per hour or greater allowing the stormwater to infiltrate into the surface or subsurface. Facilities that achieve total onsite infiltration do not require an offsite discharge point and therefore meet Category 1 or Category 2 requirements of the Stormwater Hierarchy (see [Section 1.3.1](#)).

Partial infiltration facilities are appropriate for sites with soils that drain fairly well and infiltrate greater than 0.5 inches per hour but less than 2 inches per hour. They achieve partial infiltration because they do not have a bottom or a liner but may include a surface overflow and an underdrain where flows in excess of the facility capacity are routed to an approved discharge point as specified in Category 3 or 4 of the Stormwater Hierarchy (see [Section 1.3.1](#)). Depending on site conditions, partial infiltration facilities may be used where complete infiltration is not achievable or allowed.

For the Simplified Approach, refer to the tested infiltration rate.

For the Presumptive Approach, refer to the design infiltration rate.

Flow-through facilities are appropriate for sites with soils that do not drain well and infiltrate less than 0.5 inches per hour or that have other restrictive site conditions. Flow-through facilities may include an impervious or lined bottom. They include a surface overflow and an underdrain in the gravel layer where treated flow is routed to

an approved discharge point as specified in Category 3 or 4 of the Stormwater Hierarchy (see [Section 1.3.1](#)). Flow-through facilities with impervious bottoms (poured concrete or lined facilities as appropriate) are required on sites with steep slopes, high groundwater, or contamination. Flow-through facilities with impervious bottoms (poured concrete or lined facilities, as appropriate) are also appropriate next to structures or property lines to protect foundations, basements, and adjacent properties.

Hybrid Facilities

The hybrid facility is a configuration type that combines a vegetated surface facility with a subsurface infiltration facility. It is appropriate for sites with well draining soil but with space limitations. See the typical details for configuration E and F in [Appendix G.1 – SW-151 and SW-152](#) respectively. Hybrid facilities are UICs and subject to all DEQ UIC regulations (see [Section 1.4](#) for UIC requirements). They are not allowed on projects using the Simplified Approach sizing.

Facility Overflows

It is important to note the distinction between an **underdrain**, a facility **overflow**, and an **escape route**.

While both the underdrain and the overflow typically require a connection to an approved discharge point, the **underdrain** is typically set at an elevation below the growing medium to drain flows that pass through the growing medium and are trapped in a lined facility or can not infiltrate. An **overflow** is typically set at an elevation above the growing medium and is included as a backup in case the vegetated facility becomes clogged or the flow exceeds the design capacity of the facility. Where **underdrains** are utilized, an approved discharge point is required. **Overflows** are required when infiltration requirements cannot be met. See [Appendix G.1, SW-150](#), for typical overflow configuration details.

An **escape route** is a submittal requirement for all projects that delineates where flows will be routed to maintain public safety and prevent property damage in the event the facility fails or flows exceed the facility design capacity. It does not typically require a hard connection to an approved discharge point.

Performance Approach Facilities

Filter strips, grassy swales, and ponds are vegetated facilities that meet limited stormwater management requirements. Filter strips are allowed under the Simplified Approach for impervious area under 500 square feet. If filter strips are proposed for use with over 500 square feet of impervious area, the Performance Approach is required. Ponds and grassy swales are allowed only under the Performance Approach. Non-vegetated and structural stormwater management facilities such as sand filters, rainwater harvesting, and detention tanks require review and approval under the Performance Approach (see [Section 2.2.3](#)).

Manufactured Stormwater Treatment Technologies

Manufactured stormwater treatment technologies from the approved list may be used with the Presumptive approaches. Other manufactured stormwater treatment technologies that are not on the list may be used in specific applications but must be submitted to BES as a Performance Approach.

Source Control Devices

Source control devices include, but are not limited to, spill control manholes and oil/water separators. They are used to meet the source control requirements specified in [Chapter 4](#).

2.3.2 Landscape Requirements

As presented in [Section 1.3](#), the City of Portland's stormwater management approach relies on the use of vegetated infiltration facilities to comprehensively meet multiple requirements. Vegetated facilities must be used to the maximum extent feasible. Thriving vegetation is required in order to achieve compliance with the pollution reduction and flow control standards. This section outlines the landscape requirements for both private and public vegetated stormwater management facilities. These requirements are based on the City's experience and on standard design and construction methods in the landscape industry.

Relationship to Other Landscape Requirements

When vegetated facilities are integrated into project landscape areas, they can meet many, if not all, of Title 33 landscape requirements, applicable plan district requirements, and Title 17 requirements. The benefits of integrated designs include construction cost savings, combined maintenance, aesthetic benefits, and the greater likelihood of maintaining long-term functionality. A well-designed and established landscape will also prevent post-construction soil erosion. These approaches can also help reduce urban heat island effects and contribute to other sustainable principles.

Where the plant material requirements of this manual and Title 33 differ, the designer must use the larger quantity and sizes. (In calculating quantities, fractions should be rounded to the higher whole number.) Landscaping required by Title 33 may be counted toward meeting the facility-specific landscape requirements in this chapter if the plantings are located within the facility area. Similarly, plantings that meet the requirements in this chapter may also meet Title 33 landscape requirements.

An integrated design may require changing the size of some site elements. For example, the Title 33.266 parking code allows parking layout and dimensions to be designed to allow more space for stormwater facilities.

Standard Landscape Requirements

This section addresses the landscape requirements that apply to the design and construction of all vegetated stormwater facilities, both private and public. (See the individual facility descriptions in [Section 2.3.3](#) for facility-specific requirements.) It includes the following steps:

1. Site Preparation and Grading
2. Piping
3. Gravel Drain Rock
4. Geotextiles
5. Growing Medium
6. Vegetation
7. Mulch
8. Irrigation
9. Pollution Prevention

1. Site Preparation and Grading

- ✓ Existing vegetation to be saved must be clearly marked and securely protected. If native plants are present, they should be salvaged and stored for replanting once construction is complete. Unwanted vegetation in the facility area should be removed during site preparation with equipment appropriate for the type of material and site conditions.
- ✓ The location of all areas of future stormwater facilities should be clearly marked before site work begins. All stormwater facilities should be fenced or covered to protect them from damage or misuse during construction. Fencing is required around all infiltration facilities to prevent soil compaction during construction. The subgrade in proposed infiltration areas must not be compacted. At least 6 inches of native material must be maintained above the proposed bottom of the facility until construction is scheduled for the facility. **No vehicular traffic, material storage, or heavy equipment is allowed within 10 feet of the**

infiltration facility area after site clearing and grading have been completed, except that needed to excavate, grade, and construct the facility. Flow-through facilities must be covered with plywood or other sheeting to prevent misuse. No stormwater facility area should be used for dumping concrete or other construction waste, mixing grout, cleaning tools, washing paint brushes, etc.

- ✓ The erosion and sediment control plan set should show the fencing layout for vegetation to be protected and the location of stormwater facilities.
- ✓ Location of all stockpiles must be indicated, including erosion protection measures per the City's *Erosion and Sediment Control Manual*.
- ✓ Once the facility area is graded, all native subsoil must be tilled before installing the specified stormwater facility growing medium. No tilling should occur within the drip line of existing trees. After tilling is completed, no other construction traffic should be allowed in the area, except for planting and related work. **All construction and other debris must be removed before the growing medium is placed.** Furthermore, the soil must not be exposed during wet weather conditions and must be covered with the growing medium within 1 day of being exposed.
- ✓ Surface drainage must be prevented from entering the facility during construction until the facility is fully installed and the contributing catchment area is constructed. Proposed facility areas must be protected from sedimentation during construction. The contractor is responsible for protecting the facility from erosion before water is allowed to enter the facility. Appropriate erosion control measures, as required by the City's *Erosion and Sediment Control Manual*, must be used.

2. Piping

- ✓ For private property, piping must be cast iron, ABS SCH40, or PVC SCH40 material. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise 4-inch pipe minimum is required. Piping installation and sizing must follow current Uniform Plumbing Code requirements.
- ✓ For public facilities, 6-inch or 8-inch ASTM 3034 SDR 35 PVC pipe and perforated pipe are required. Refer to the City's *Sewer and Drainage Facilities Design Manual* for more information.

3. Gravel Drain Rock

- ✓ Drain rock may be required below the growing medium of a vegetated facility. For infiltration facilities, where drain rock is specified to retain stormwater prior to infiltration, the specification is 1½- to ¾-inch washed drain rock. Where drain

rock is specified primarily for detention and conveyance, the specification is $\frac{3}{4}$ -inch washed drain rock. For all flow-through facilities, $\frac{3}{4}$ -inch wash drain rock must be used.

- ✓ For private soakage trenches, the specification is $2\frac{1}{2}$ - to $\frac{3}{4}$ -inch washed drain rock.
 - ✓ The required depth of the drain rock for facilities designed with the Simplified Approach is 12 inches. The depth of the drain rock varies with the Presumptive Approach. Depending on native infiltration rates and the amount of stormwater being routed to the facility, zero to a maximum of 48 inches of drain rock may be specified.
 - ✓ If geotextiles are not used, a separation lens is needed between the growing medium and drain rock to keep the layers distinct and allow for good conveyance. The gravel lens should be $\frac{3}{4}$ - to $\frac{1}{4}$ -inch washed, crushed rock or pea gravel 2 to 3 inches in depth, depending on the facility design. Green streets require $\frac{3}{4}$ inch No. 4 open graded aggregate 3 inches in depth.
4. Geotextiles (if required or approved)
- ✓ Geotextiles are often used in the design and construction of stormwater facilities. Nonwoven fabrics make the best filters but are also good at separation. Woven fabrics have greater strength and are less likely to clog. Anywhere a geotextile is used in a critical application, a geotechnical professional should specify it for that application. Specifications provided in [Exhibit 2-3](#) are taken directly from the *City of Portland Standard Construction Specifications*, Table 02320-1.

Exhibit 2-3: Standard Geotextile Specifications

Drainage Geotextile for Filtration				
Permittivity	Grab Strength	Puncture Strength	Mullen Burst	Apparent Opening Size
ASTM D4491	ASTM D4632	ASTM D4833	ASTM D3786	ASTM D4751
0.5 s ⁻¹	80 (180) lb	35 lb	130 (290) Psi	70 US Sieve
Minimum	Minimum	Minimum	Minimum	Maximum

Nonwoven fabrics: LINQ 125EX; TNS E040; TNS R035; TNS R040; TNS R042; AMOCO 4535; Marafi 140NL. (ODOT Type II variation).

Subgrade Geotextile for Separation				
Permittivity	Grab Strength	Puncture Strength	Mullen Burst	Apparent Opening Size
ASTM D4491	ASTM D4632	ASTM D4833	ASTM D3786	ASTM D4751
0.01 s ⁻¹	180 Lb	80 Lb	290 psi	30 US Sieve
Minimum	Minimum	Minimum	Minimum	Maximum

Woven fabrics: Geotex 111F; AMOCO 1198 (GEOTEX 106F). Also refer to the Federal Highway Administration Manual *Geosynthetic Design and Construction Guidelines*, Publication No. FHWA HI-95-038, May 1995, for design guidance on geotextiles in drainage applications.

5. Growing Medium

- ✓ The City of Portland specifies the stormwater facility growing medium. The depth of the growing medium must be a minimum of 18 inches.
- ✓ For facilities designed with the Simplified Approach or for facilities on private property, the imported soil must be a sandy loam mixed with compost or a sand/soil/compost blend. It must be roughly one-third compost by volume, free-draining, and support plant growth. The compost must be derived from plant material; animal waste is not allowed. See [Appendix F.3](#) for recommended blended topsoil specifications.
- ✓ For streets, a blended topsoil is required as specified in [Appendix F.3](#).
- ✓ Soil analysis for all growing media is required for all public facilities and may be required for private facilities. Soil analysis is not required for single-family residential sites. The source of stormwater facility growing medium must be provided.

- ✓ Soil placement and planting should occur in conditions that do not result in over-compaction or erosion. Temperature, moisture levels, and handling can have a huge influence on the infiltration rate of a facility and on plant survivability.

6. Vegetation

- ✓ Plants are critical to the performance of vegetated stormwater facilities and therefore must be selected for the appropriate soil, hydrologic, and site-specific conditions. The planting design must minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis. Plantings should also be designed to minimize the need for mowing, pruning, and irrigation.
- ✓ For facilities located in environmental zones or for BES-maintained facilities located outside of the public right-of-way, all plants within the facility area must be appropriate native species from the BES recommended plant lists in [Appendix F.4](#) or the latest edition of the *Portland Plant List*. No plant species on the Nuisance Plants List or Required Eradication List contained in the *Portland Plant List* are allowed. The designer may also refer to the Planning Bureau's *Environmental Handbook* for more information.
- ✓ Structural components such as chain link fence, concrete bulkheads, outfalls, rip-rap, gabions, large steel grates, pipe, blank retaining walls, vault lids, and access roads should be screened from view by vegetation. The quantities and spacing of plant material required for each facility should provide sufficient screening. Attention should be paid to site conditions that may require adjustments to the planting plan, including the need for additional trees and shrubs. The intent of this requirement is not to dictate a specific solution such as a linear hedge. Designers are encouraged to integrate the facility landscaping with the screening objective. As a guide, landscape standards for screens are provided in L2, L3, or L4 standards as specified in City Code Chapter 33.248.
- ✓ The planting plan must indicate the location of all landscape elements, including size, spacing, and species of all proposed plantings and existing plants and trees to be preserved. A planting plan is a required submittal for all vegetated stormwater management facilities. The plant list must include the botanical and common name, size at time of planting, quantity, type of container, evergreen or deciduous, and other information in accordance with the facility-specific planting section and landscape industry standards. See facility specifications in [Section 2.3.3](#) for density and size requirements. Refer to [Appendix G.3](#) for planting templates appropriate for public and private streets, which require the use of containerized plants.

- ✓ Because portions of vegetated facilities areas are designed to accommodate inundation through the wet periods of the year, it is imperative for the designer to delineate the wet zone and develop a planting plan in accordance with the level of inundation/saturation. Many stormwater facilities are expected to have a wet zone (Zone A) that is saturated through most of the year in the center and lowest areas of the facility. The moderate to dry Zone B surrounds Zone A and is likely to be inundated much less frequently than the lower portions of the facility. For the purposes of this manual in determining landscaping requirements, **the delineation between Zone A and Zone B must be the elevation of either the outlet elevation or the top of the check dam, whichever is lower.** Planting plans must be specific to the designated zones.
- ✓ Depending on when stormwater will be routed to the facility, planting should preferably occur in the dormant season. For best results, planting should occur in the spring (March) or early fall (September through October).
- ✓ Plants must be healthy and vigorous. Within 2 years, a survival rate of 90 percent (no replacements) must be achieved. If the survival rate falls below this threshold, additional plants sufficient to meet the 90 percent survival rate must be installed. The number of additional plants required should be based on the mortality rate of the initial planting.

7. Mulch

- ✓ Fine to medium hemlock bark or well-aged organic yard debris compost is recommended for most stormwater facilities. Washed pea gravel or river rock may be used in stormwater planters. Mulch should be weed-free and applied 2 to 3 inches thick to cover all soil between plants. It should not be overapplied.
- ✓ **Mulch should be placed in the facility only in Zone B areas. Care should be given to keeping mulch material out of a stormwater flow path to avoid any material from clogging inlets or outlets or otherwise escaping the facility. Manure mulching and high-fertilizer hydroseeding are prohibited in a facility area during and after construction.** At the time of final inspection, all surface area soils should be covered with plants and/or mulch sufficient to prevent erosion.

8. Irrigation

- ✓ Permanent irrigation systems are not allowed for stormwater facilities in public or private streets, unless approved by BES. Temporary irrigation systems or alternative methods of irrigation for landscape establishment should be specified. Permanent irrigation systems are allowed for private facilities, but designers are encouraged to minimize the need for permanent irrigation. Innovative methods for watering vegetation are encouraged, such as the use of cisterns.

9. Pollution Prevention

- ✓ Projects must be designed to minimize the need for toxic or potentially polluting materials such as herbicides, pesticides, fertilizers, or petroleum-based fuels within the facility area before, during, and after construction. Use of these materials creates the risk of spills, misuse, and future draining or leaching of pollutants into facilities or the surrounding area. (For information about alternatives, contact Metro's Alternatives to Pesticides Program at 503-797-1811.)
- ✓ Materials that could leach pollutants or pose a hazard to people and wildlife must not be used as components of a stormwater facility. Some examples of these materials are chemically treated railroad ties and lumber and galvanized metals. Many alternatives to these materials are available.

Standard Landscape Requirements for Streets

Vegetation in stormwater facilities located in the public right-of-way must be covered by a 2-year warranty period, beginning from the time of signing the certificate of completion of the public works project. This is necessary to ensure proper establishment before the City assumes ownership. During the warranty period, regular maintenance tasks must be performed. These may include hand removal of undesirable or "weedy" vegetation, mowing, pruning, mulching, and regular summer irrigation. These tasks are essential to plant establishment and should not be deferred. City inspectors will monitor the establishment of the vegetation during the warranty period.

See <http://www.portlandoregon.gov/bds/article/311179> for the landscape requirements for private streets.

See [Appendix G.3](#) for Greenstreet planting templates and [Appendix F.4](#) for plant lists. Typically, plants are specified in 1-gallon pots and planted 12 inches on center. No medium to large shrubs are allowed in a stormwater facility next to a street.

Watershed Revegetation Program

Public works permit applicants may choose to enter into an agreement for vegetation services with BES's Watershed Revegetation Program (WRP). This agreement is optional and is offered so permit applicants can benefit from BES's professional expertise in establishing and maintaining stormwater management facility landscapes that treat public stormwater. This ensures plant establishment and proper performance of facilities that will eventually be maintained by the City following the warranty period.

Projects that use the WRP agreement for vegetation services will be exempt from the 10-month and 20-month inspections of vegetation establishment (as described in [Section 3.2.3](#)). The City becomes the responsible party for establishing vegetation to treat

stormwater within the facility. No other permitted elements (structural, inlets, etc.) are exempt from the warranty.

The WRP can deliver the following services:

- Prepare a planting plan and plant establishment treatment schedule to meet the requirements of the *Stormwater Management Manual*.
- Inspect topsoil prior to placement to meet the requirements on the permitted plans.
- Provide post-construction erosion control within the facility to stabilize soil, as shown on the plans.
- Source and acquire all plant material, and plant according to the plans. The City will interchange bare-root, containerized, and balled and burlapped plant material to meet the design intent.
- Irrigate the site as needed to establish plant material to meet performance criteria.
- Mulch the site as needed.
- Remove excessive sediment buildup.
- Interplant (replace dead vegetation) as needed to adapt to site conditions and performance.
- Clean garbage and other undesirable debris.
- Monitor for vegetation establishment through the end of the warranty period, at which time the City assumes responsibility for the project.
- Work with the permit holder to ensure that project implementation follows the permit, construction documents, design intent, and field conditions.
- Ensure prompt delivery of services with adequate coordination with other contractors.
- Provide all necessary labor and other miscellaneous work incidental to completion of the project, unless otherwise specified in the agreement.
- Install project signage, if appropriate.
- Perform treatments specific to the agreement for maintenance and monitoring of the project site(s).

Applicants can obtain more information directly from the WRP by calling 503-823-2365. The WRP is also available to provide some consultation regarding plant selection and proper placement within a facility that will eventually become City property.

2.3.3 Facility Design Criteria

This section provides a description and the specific design requirements for each stormwater facility listed below in [Exhibit 2-4](#). It also includes facility-specific information regarding submittal requirements, construction considerations, inspections, and maintenance, as well as additional resources as available. Variations that exist between the Simplified Approach and Presumptive Approach and variations between streets and private property are identified.

Exhibit 2-4: Stormwater Facilities

Page	Impervious Area Reduction Technique	Simplified Approach for Private	Presumptive Approach for Private	Presumptive Approach for Streets	Performance Approach for Streets
2-26	Ecoroof	•	•		
2-40	Pervious Pavement	•	•		•
2-45	Tree Credit	•		•	

Page	Vegetated Facility	Simplified Approach for Private	Presumptive Approach for Private	Presumptive Approach for Streets	Performance Approach
2-49	Downspout Extension	•			
2-52	Swale	•	•	•	
2-57	Curb Extension			•	
2-64	Planter	•	•	•	
2-68	Basin	•	•	•	
2-72	Filter Strip	•			•
2-74	Grassy Swale				•
2-79	Pond				•

Page	Facility	Simplified Approach for Private	Presumptive Approach for Private	Presumptive Approach for Streets	Performance Approach
2-89	Sand Filter				•
2-93	Soakage Trench	•	•		
2-98	Drywell	•	•		
2-102	Sump		•	•	
2-107	Manufactured Stormwater Treatment Technology		•	•	•
2-109	Rainwater Harvesting				•
2-112	Structural Detention				•

Page	Facility	As Required	Source Control
2-117	Oil/Water Separator	•	•
2-120	Spill Control Manhole	•	•



Exhibit 2-5: Hamilton Building Ecoroof. See [Appendix G.1](#) for typical ecoroof details.

Facility Description

An ecoroof, also called a green roof, is a lightweight vegetated roof system consisting of waterproofing material, a growing medium, and specially selected plants. An ecoroof can be used in place of a traditional roof as a way to limit impervious site area and manage stormwater runoff. Ecoroofs reduce post-developed peak runoff rates to near-pre-developed rates and reduce annual runoff volume by at least 50 percent. Ecoroofs also help mitigate runoff temperatures by keeping roofs cool and retaining most of the runoff in dry seasons. Although ecoroofs consist of lightweight growing medium and low-growing succulent vegetation, other more heavily planted systems are possible; in either case, the design must be self-sustaining.

The structural roof support must be sufficient to hold the additional weight of the ecoroof. Greater flexibility and options are available for new buildings than for re-roofing existing buildings, but retrofits are possible. For retrofit projects, an architect, structural engineer, or roof consultant can determine the condition of the existing building structure and what might be needed to support an ecoroof. Alterations might include additional decking, roof trusses, joists, columns, and/or foundations. Generally, the building structure must be adequate to hold an additional 15 to 30 pounds per square-foot (psf) saturated weight, including the vegetation and growing medium that will be used (in addition to snow load requirements). An existing rock ballast roof may be structurally sufficient to hold a 10-20 psf ecoroof (if the ballast is removed).

Design Requirements

- **Sizing:** Ecoroofs replace impervious area at a 1:1 ratio. They are not allowed to receive water from other impervious areas.
- **Slope:** Maximum roof slope shall be 25 percent, unless the applicant provides documentation of runoff control on steeper slopes.
- **Waterproofing:** A good-quality waterproofing material, such as modified asphalt, synthetic rubber, or reinforced thermal plastics, shall be used on the roof surface. Some waterproofing materials also act as a root barrier.
- **Protection boards or materials (optional):** These materials protect the waterproof membrane from damage during construction and over the life of the system and are usually made of soft fibrous materials. They often are not needed, depending on the membrane selected.
- **Ballast (optional):** Gravel ballast is sometimes placed along the perimeter of the roof and at air vents or other vertical elements. The need for ballast depends on operational and structural design issues. It is sometimes used to provide maintenance access, especially to vertical elements that require regular, periodic maintenance. In many cases, very little, if any, ballast is needed.
- **Header/separation board (optional):** In some situations, a header or separation board may be placed between gravel ballast and adjacent elements (such as soil or drains), but pressure-treated lumber is prohibited. In many cases, a header is not needed, and designers are encouraged to use one only when necessary.
- **Root barrier:** A root barrier is sometimes required in addition to waterproofing material, depending on the type used and the types of vegetation proposed. Root barriers impregnated with pesticides, metals, or other chemicals that may leach into stormwater are not allowed, unless the applicant can provide documentation that leaching does not occur. If a root barrier is used, it must extend under any gravel ballast and the growing medium and up the side of any vertical elements.
- **Drainage:** A method of drainage must be provided, although a manufactured product is not required. The drainage layer may include filter fabric, gravel, or be the growing medium itself.
- **Overflow:** Ecoroofs are not a full stormwater disposal system and need to have a conventional drainage system to manage excess runoff during periods of sustained or heavy rainfall. An approved discharge location must be identified for every ecoroof and a drain(s) provided. Downspouts or rain drains must be connected to an approved disposal location.
- **Growing medium:** A minimum of 4 inches of growing medium is required, composed of roughly 70 percent porous material/20 percent organic material (i.e., aged compost)/10 percent digested fiber or other mix approved by BES.

Ecoroofs with more than 6 inches of growing medium are acceptable, but must meet all other requirements.

- **Vegetation and coverage:** Drought-tolerant plants (per *Green Roof Plants* by Snodgrass & Snodgrass, the 2008 BES *Ecoroof Plant Report*, and/or equivalent) must achieve 90 percent coverage within 2 years. At least 50 percent of the ecoroof must be composed of evergreen species. A maximum of 10 percent of the ecoroof may be composed of non-vegetated components such as gravel ballast, pavers for maintenance access, etc. Mechanical units may protrude through the ecoroof, but are not considered elements of the ecoroof. Ecoroof vegetation should be:
 - drought-tolerant, requiring little or no irrigation after establishment
 - self-sustaining, without the need for fertilizers, pesticides, or herbicides
 - able to withstand heat, cold, and high winds
 - very low-maintenance, needing little or no mowing or trimming
 - perennial or self-sowing
 - fire-resistant

A mix of sedum/succulent plant communities is recommended because these plants possess many of these attributes. Herbs, forbs, grasses, and other low groundcovers can also be used to provide additional benefits and aesthetics; however, these plants may need more watering and maintenance to survive and keep their appearance.

- **Mulch:** A method to protect exposed soil from erosion must be provided, such as gravel mulch.
- **Access:** The design must consider safe access for maintenance of the ecoroof and other maintenance needs that require roof access.
- **Permits:** Residential (RS) or commercial (CO) building permits are required. Ecoroofs proposed to meet stormwater mitigation or stormwater management requirements must be included in an O&M Plan that meets the standards of Chapter 3.

Maintenance Requirements

- **Fertilizers:** Only nonchemical fertilizers may be used.
- **Pesticides/herbicides:** Pesticides and herbicides of any kind are prohibited on ecoroofs.
- **Irrigation:** During the establishment period (up to 3 years), irrigation shall not exceed ½ inch of water every 10 days, regardless of water source. Post-establishment irrigation shall not exceed ¼ inch of water every 14 days (May

through October), regardless of water source. Ecoroofs greater than 5,000 square feet should consider installing an irrigation flow meter.

Resources

For information about the floor area ratio bonus for ecoroofs in the Central City, refer to City Code Chapter 33.510.210, Option #10.

City of Portland ecoroof website: <http://www.portlandoregon.gov/bes/ecorooft>



Exhibit 2-6: Multnomah Art Center Permeable Pavers. See [Appendix G.1](#), SW-110, for typical details.

Facility Description

There are two main categories of pervious pavements: pervious concrete and pervious asphalt, which are poured in place, and permeable pavers, which are discrete units set in place. These methods of infiltrating stormwater provide a stable load-bearing surface without increasing the project impervious area. These impervious area reduction techniques decrease the obligation of stormwater management on the project site.

Pervious asphalt, pervious concrete, and permeable pavers can be used in practically all pedestrian areas as well as residential driveways and commercial parking lots. Pervious asphalt and concrete will be approved on private streets and public roadways on a case-by-case basis. See Exhibit 2-7 for a summary of the design requirements.

Pervious Asphalt and Concrete

Pervious asphalt and pervious concrete are similar to conventional asphalt and concrete in structure and form, except that the fines (sand and finer material) have been removed. The top lifts are thicker than traditional pavements to provide the required stability.

Pervious asphalt consists of an open-graded coarse aggregate cemented together by asphalt cement. The Oregon Department of Transportation (ODOT) has approved a

pervious asphalt mix for its uses on numerous public highways and freeways, referred to as its open-graded 1/2-inch or 3/4-inch asphalt mix design. Another common asphalt mix is the 3/8-inch mix. This mix cannot be used on roadways because the long-term perviousness is not clear. Refer to the ODOT 2008 Standard Specifications 00745 for more about open-graded mixes.

Pervious concrete is a structural, open-textured pervious concrete paving surface consisting of standard Portland cement, fly ash, locally available open-graded coarse aggregate, admixtures, fibers, and potable water. When properly handled and installed, porous concrete has a high percentage of void space (approximately 17 to 22 percent).

Permeable Pavers

There are many types of permeable pavers on the market today. Many manufacturers make specific pavers for pervious applications, while others make pavers that are not designed to accommodate infiltration. Brand names and specifications shall be supplied with permit applications.

Edge restraints for pavers are required to be permanent (cast-in-place or precast concrete curbs) and a minimum of 6 inches wide and 12 inches deep for private streets, public roadways, and commercial pavements. Residential restraints may be plastic, set with spikes.

Design Requirements

Additional stormwater from other impervious areas, such as roof tops, may not be directed to a pervious pavement system. Pervious pavements shall not be located over cisterns, utility vaults, underground parking, or other impervious surfaces.

- **Infiltration:** Where the tested infiltration rate is less than 2 inches/hour, the pavement section must sheet-flow to an adequately sized filter strip (500 square foot limit for pavement), or the pervious pavement subsurface rock may be sized for necessary detention. If an underdrain is proposed for collection, the conveyance must lead to a vegetated facility sized to treat the entire pervious paved area.
- **Setbacks:** There are no required setbacks, but impermeable liners between base rock and adjacent foundations are highly recommended. A liner may be required for areas located within 5 feet of structures or infrastructure. See [Exhibit 2-1](#) for more information on setbacks.
- **Sizing:** Pervious pavement and permeable pavers replace impervious area at a 1:1 ratio. The pavement section must be designed to directly infiltrate all stormwater from the pavement surface into a crushed rock storage layer, which must contain enough void space to store the 10-year, 24-hour storm and infiltrate it into the subgrade in less than 30 hours.

- **Slope:** Where slopes are greater than 5percent, the design must be engineered to specifically address under-pavement water retention. If the slope of the area is 10 percent or greater, pervious pavement is not allowed.
- **Subgrade:** Pervious pavement shall not be constructed over fill soils. The area to be paved should be leveled and lightly compacted with a plate compactor to include a slight grade away from foundations. Compaction of the subgrade soil is required for public roadways, private streets, parking lots, and fire lanes to ensure adequate structural stability and minimize rutting. Compaction should be to 95 percent for public roadways. Compaction will reduce the permeability of the soils and should therefore be done with caution and scarified prior to setting the aggregate base. Subgrade shall not be subject to truck traffic. The subgrade should not be constructed or compacted during wet conditions.
- For private streets a **California Bearing Ratio** or **resilient modulus** of the saturated subgrade must be determined. For all streets, the pavement design must be prepared by a registered professional engineer.
- **Geotextile fabric:** Subgrade geotextile for separation may be required between subgrade (native soil) and aggregate base (gravel layer). See [Exhibit 2-3](#) for geotextile specifications.
- **Aggregate base:** 6-inch minimum of washed, crushed 2- to ¾-inch or No. 57 rock.
- **Sand:** 1 inch of clean washed, coarse-filter-grade sand (ASTM No. 8 or 9). “Landscapers” or “playground” sand should not be used because it includes too many fines.
- **Top lift:** See [Exhibit 2-7](#) for the top lift depth requirements, which depend on the application. Asphalt and concrete must have at least 15 percent air voids in the completed top lift. Concrete must be 2400 to 2500 psi in 28 days.

Exhibit 2-7: Pervious Pavement Requirements for Top Lift Depth, Engineering, and Compaction

	Concrete (inches)	Asphalt (inches)	Pavers (inches)	Engineering Required?	Compaction Required?
Residential Driveway or Pedestrian Only	4	2.5	2 ¾	No	No
Private Street, Parking Lot, or Fire Lane	4	3	3 ⅛	Yes	Yes
Public Street	7	6	3 ⅛	Yes	95%

Submittal Requirements

Depending on the scope and scale of the proposed project, the following design approaches apply to pervious pavement:

- Simplified Approach for pedestrian walkways and residential driveways.
- Presumptive Approach for parking lots, shared courts, and fire lanes.
- When considering permeable pavement for the public right-of-way, the applicant must submit the project under the Performance Approach. Permeable pavement in the public right-of-way is approved on a case-by-case basis at the discretion of the City of Portland's chief engineers.
- When considering pervious pavement for private streets, the applicant must meet the specifications of the BDS's private street administrative rule, and the street section must be designed by (or under the direction of) a registered professional engineer. A site development permit is required for private street construction.
- Pervious pavement proposed to meet stormwater mitigation or stormwater management requirements must be included in an O&M Plan that meets the standards of Chapter 3.

Since achieving structural integrity and infiltration ability can be difficult, the pervious concrete supplier may be required to submit a testimonial with the permit application that the pervious mix will accomplish both tasks. Test panels may be required.

Construction Considerations

It is imperative during design to establish protection for the pervious pavement subgrade from over-compaction. The subgrade should not be constructed or compacted during wet conditions. The design professional must show how the construction manager will avoid traffic on the proposed paved area.

Maintenance

It is imperative during design to establish protection for the pervious pavement subgrade from over-compaction. The design professional must show how the pervious pavement requires specialized vacuuming at least once a year to remove fine particulates from the infiltration spaces. This maintenance must be performed with high-power vacuums (vac trucks). Without this maintenance, the facility will become

impervious over time. Additionally, some settling may occur over time, requiring additional aggregate base, washed sand, and/or paver replacement and repair.

Resources

Pervious Asphalt

ODOT 2008 Standard Specifications 00745.00

PDOT 2007 Standard Specifications 00744.00

National Asphalt Pavement Association Design, Construction, and Maintenance Guide

Pervious Concrete

AASHTO Guide for Design of Pavement Structures

Pervious Pavers

PDOT 2007 Standard Specifications 00760.00

Interlocking Concrete Pavement Institute Specifications

AASHTO Guide for Design of Pavement Structures

BDS's administrative rules on private streets:

<http://www.portlandoregon.gov/bds/article/311179>.



Exhibit 2-8: Portland street trees. See [Appendix G.3](#), SW-300, for typical street tree details.

Facility Description

Trees intercept precipitation and provide several stormwater management benefits: they hold water on their leaves and branches and allow it to evaporate, retaining flow and dissipating the energy of runoff. These functions are most measurable for storms of less than 0.5 inch over 24 hours, typical of Portland storm events. Although deciduous trees are not as effective during winter months, evergreen trees are effective year-round for these smaller storms and portions of larger storms. Generally, large trees with small leaves are the most efficient rainfall interceptors. Trees also facilitate stormwater infiltration and groundwater recharge.

Trees can also shade impervious area. This provides two direct benefits. First, the hard surface is protected from direct solar exposure, which reduces heat gain. The less heat gain there is in pavement, the less heat is absorbed by stormwater as it flows over the surface. Second, by shading pavement, the trees help reduce or minimize air temperature increases caused by the hot pavement.

Existing trees can have significant benefits in addition to stormwater management. Trees provide habitat for urban wildlife, energy conservation, aesthetics, visual screens, heritage value, windbreaks and recreation.

Trees are allowed as an impervious area reduction technique on both private property and in the public right-of-way under specific criteria and with provisions. The specifications that follow were developed to maximize the use of trees to mitigate stormwater impacts. The City Forester maintains authority over trees in the public right-of-way. BES will inspect trees on private property during installation and post-construction, and the property owner is responsible for maintenance.

Design Requirements

- **Site applicability:** For residential development on private property, new tree credit can only be used at sites larger than 5,000 square feet. For all sites including right-of-way with over 1,000 square feet of impervious surface to manage, no more than 10 percent of the impervious area can be mitigated through the use of trees. Exceeding this allowance in the right-of-way will be considered on a site by site basis under staff discretion.
- **New tree sizing:** New trees on private property must be at least 1.5 caliper inches at the time of planting, and new coniferous trees must be at least 5 feet tall to receive credit.
- **New tree setbacks:** New trees shall be planted within 25 feet of impervious surfaces. One hundred square feet of credit is given for new broadleaf trees, and 200 square feet of credit is given for new coniferous trees. (See minimum tree sizes below.)
- **Existing tree sizing and setbacks:** Credit also applies to existing trees kept on a site if the trunk is within 25 feet of impervious surfaces and are at least 1.5-inch caliper or larger. Caliper is the diameter of the tree measured 6 inches above the ground surface or root ball. The tree credit for existing trees is tiered based on caliper (see Exhibit 2-9).

Exhibit 2-9. Stormwater Credit for Existing Trees

Caliper of Existing Tree	Stormwater Credit
1.5 up to 6 inches	200 square feet
6 inches and larger	400 square feet per each 6 caliper inches

- **Tree selection:** The trees selected shall be suitable species for the site conditions and the design intent. Nuisance trees cannot receive stormwater tree credit. BES may require a certified arborists report to verify suitable tree selection and preservation.
- **Planting area:** Minimum planting space necessary for a new tree is determined by City Code and the City Forester. This area should be marked on plans and protected during construction per the City Code.
- **Street and public trees:** By City ordinance, the City Forester is authorized to set standards for tree sizes planted on publicly owned lands and public rights-of-way. A permit is required from Urban Forestry to plant, prune, or remove trees in the public right-of-way. New street trees must be at least 1.5 caliper inches for the one- and two-family residential development type, 2 caliper inches for multidwelling residential development type, and 2.5 caliper inches for all other development types. Caliper is the diameter of the tree measured 6 inches above the ground surface or root ball.
- **Other considerations:** Trees planted to meet stormwater facility planting requirements cannot also receive impervious area reduction credit. New or existing trees counting towards environmental zone mitigation cannot receive tree credit.
- **Limitations:** Tree credits may not be allowed if site circumstances or system limitations exist.

See [Appendix F.4](#) for plant species information.

Submittal Requirements

Trees to be given credit as an impervious area reduction technique shall be clearly labeled as such, with the size and species included. Approximate setbacks from property lines and structures shall be shown. Street trees planted less than 10 feet from a water line (or facility) require the installation of a tree root guard, per **Standard Plan 5-109**. Temporary irrigation measures shall be shown, if applicable. A note shall be included on the permit drawings that call for City inspection after the tree has been planted, or in the case of existing canopy, after the site grading has been completed. Trees proposed for stormwater credit will need to be included in the required O&M Plan. BES may require a survey and certified arborist report to verify suitable tree selection or tree preservation for any trees designated for stormwater tree credit.

Construction Considerations

Protection of existing trees during construction shall meet City Code requirements unless the City Forester approves exemptions to this requirement. The applicant will have to provide documentation required by the Forester to ensure the tree will remain healthy after construction and for the life of the tree.

Maintenance

- Trees shall be maintained and protected on the site after construction and for the life of the development (50 to 100 years or until any approved redevelopment occurs in the future). During the life of the development, trees approved for stormwater credit shall not be removed without approval from the BES. Trees that are removed or die shall be replaced within 6 months with like species or alternatives approved by BES.
- Trees may be pruned for safety and arboricultural health purposes only; however, if a tree is planted near a building, pruning to protect the structure is recommended.
- Long-term irrigation is not required.

Resources

Urban Forestry website: <http://www.portlandonline.com/parks/index.cfm?c=38294>

City of Portland Standard Plans and Specifications:
<http://www.portlandonline.com/transportation/index.cfm?c=40032> .

Citywide Tree Regulatory Improvement Project:
<http://www.portlandoregon.gov/bps/46921>



Exhibit 2-10. Disconnected downspout.

Facility Description

Directing downspouts to splash blocks is a method of stormwater management that directs roof runoff to vegetated or mulched landscape areas for onsite infiltration. This method can be utilized for small-scale projects on private property that have appropriate site conditions. Roof runoff is directed to existing landscaping where it can spread out and safely soak into the soils and remain on the property. Existing site conditions will determine if this is a suitable method for managing stormwater onsite. Property line and building setbacks as well as surface grade and available landscaped areas for infiltration must be considered. Proposed downspout locations and roof/gutter alignments will impact the feasibility of this option. As such, a preliminary site visit by BES staff is recommended to determine if downspout extensions are a viable option.

Design Requirements

- **Site Suitability:** Downspout extensions are suitable for sites that have well draining soils (≥ 2 inches/hour) and have an overall slope of 10 percent or less. A maximum of 500 square feet of roof area is allowed to drain to each downspout. For new development or redevelopment, only small-scale projects on private property with less than 1,000 square feet of new impervious area, including garages, additions, and accessory dwelling units, are eligible to use this method. For stormwater retrofits or alterations to existing structures, the structure must be smaller than 5,000 square feet.

- **Setbacks:** Downspouts typically discharge 2 feet from slab on grade and structures with crawl spaces and 6 feet from all foundations with basements. The point of discharge typically are set back 5 feet from property lines and 10 feet from all neighboring structures or buildings and retaining walls over 36 inches in height. Splash blocks are **not** considered part of the downspout extension and are included for erosion control and flow dispersal only. See [Exhibit 2-1](#) for more information on setbacks.
- **Sizing and grade:** The landscape area utilized for disposal of stormwater must be at least 10 percent of the roof area that drains to each downspout. The grade of the landscape area must gently slope away from the foundation and neighboring properties and allow stormwater to spread out over the required 10 percent infiltration area. Setback requirements must be retained over the entire infiltration area.
- **Materials:** Durable, gutter-grade materials such as aluminum, steel, copper, vinyl, and plastic downspouts can be utilized for extensions. Downspouts need to be secured to the structure and connections securely fastened together with appropriate materials (i.e., sheet metal or similar screws). Flexible downspout extensions are not approvable materials. Rain chains must be securely fastened to the structure and the ground in a vertical alignment and must meet setback standards in order to be approved. Splash blocks, rock, or flagstone must be utilized for erosion control and flow dispersal at the point of discharge. Downspouts can be directed to drain onto grass without additional erosion control measures.
- **Other Considerations:** Downspouts must not be directed to drain onto or over impervious areas, including walkways, driveways, and patios or onto neighboring properties, including public sidewalks and streets. Downspouts and gutters may be regraded, piped, redirected in order to convey water to a safe infiltration area. Downspouts need to drain directly to landscape areas intended for infiltration. Landscaped areas above buried oil tanks or adjacent to retaining walls over 36 inches high cannot be utilized as infiltration areas.

Submittal Requirements

An applicant for downspout extension approval must submit a site plan that notes downspout locations and roof drainage areas and that clearly illustrates roof area limitations, setbacks, and infiltration area requirements can be met. All other permit requirements apply, including an O&M Plan that meets the standards of Chapter 3.

Alternate onsite disposal methods such as soakage trenches will be required upon inspection for sites that cannot meet applicable downspout extension setback and landscape requirements.

Construction Consideration

Downspouts need to be located in areas that can accommodate stormwater flows and do not cross walkways or drain onto driveways, patios, or other impervious surfaces. Downspout locations and quantity can be field-fit based on site conditions to meet required standards. The design should consider landscape grade during construction to ensure the finished landscape grade will allow stormwater to drain safely away from building foundations and property lines. Hinged downspout extensions or “flipper” extensions can be utilized for ease of landscape maintenance.

Maintenance

Downspout extension must be included in an O&M Plan that meets the standards of Chapter 3. The property owner should:

- check and clear elbows and bends in downspouts to prevent clogging
- regularly clean gutters and ensure that parts are securely fastened together
- check the grade of landscape and look for erosion at the point of discharge
- maintain landscaping as needed



Exhibit 2-11: Henry V Swale. See [Appendix G.1](#), SW-120, for typical private property swale detail and [Appendix G.3](#), SW-300-302, for typical Green Street swale details.

Facility Description

Swales are typically long, narrow, gently sloping landscaped depressions that collect and convey stormwater runoff. They are planted with dense vegetation that treats stormwater from rooftops, parking lots, and streets. As the stormwater flows along the length of the swale, the vegetation and check dams slow the stormwater down, filter it, and allow it to infiltrate into the ground. Where soils do not drain well, swales can overflow to an approved discharge point such as a drywell or sump. Swales should be integrated into the overall site design and can be used to help fulfill landscape requirements. Grassy swales are described as a separate facility and require the Performance Approach.

Design Requirements

- **Soil suitability:** Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to flow through the facility. See Appendix F.2 for infiltration testing procedures. For the Simplified Approach (Section 2.2.1), if the tested infiltration rate is greater than or equal to 2 inches per hour, the swale must overflow to a subsurface infiltration facility. If the tested infiltration rate is less than 2 inches per hour, the swale should be designed as a partial infiltration or flow-through facility, with an overflow to an approved discharge point. For the Presumptive Approach

(Section 2.2.2), the existing infiltration rate also determines the type of swale, but additional variables are factored in to determine the configuration of the facility.

- **Setbacks:** Infiltration swales are typically set back 5 feet from property lines and 10 feet from building foundations. There are no setback requirements for lined flow-through swales. See [Exhibit 2-1](#) for more information on setbacks.
- **Access:** The design must consider safe access for maintenance of the swale.
- **Sizing:** For the Simplified Approach, a sizing factor of 0.09 is required. For the Performance Approach, surface area and depth of facility vary. An approved stormwater sizing calculator allows the designer to size stormwater facilities with respect to native infiltration rates and other unique site conditions of the project.
- **Dimensions and slopes:** The minimum swale width is 5 feet on private property and 8 feet on streets. A 2-foot-wide flat bottom width is required where feasible. Swales designed with the Simplified Approach are 9 inches deep measured from the top of the growing medium to the overflow inlet elevation. Swales designed with the Presumptive Approach vary in depth from 6 to 12 inches. In all cases, maximum side slopes are 3 horizontal to 1 vertical and 4 horizontal to 1 vertical is required immediately adjacent to pedestrian areas. Maximum longitudinal slope is 6 percent. Freeboard for swales must be noted on the plans. Freeboard can be defined as the vertical distance between the design water surface elevation and overtopping elevation or the vertical distance between the top of the check dam and the outside berm or curb elevation (whichever is lower).
- **Check dams:** Check dams are required in swales to allow water to pool and infiltrate into the ground. They also slow flow to remove coarse sediment and prevent erosion. They shall be constructed of durable, nontoxic materials such as rock, brick, concrete, or soil by integrating these materials into the grading of the swale. Check dams are as long as the width of the swale and perpendicular to flow path of stormwater. They generally form a 12-inch-wide bench on top and measure 4 to 10 inches high, depending on the depth of the facility. See Appendix G.3, SW-340, for typical check dam details.
- **Gravel drain rock:** Drain rock may be required below the growing medium of a swale. For infiltration facilities, where drain rock is specified to retain stormwater prior to infiltration, the specification is 1½- to ¾-inch washed drain rock. Where drain rock is specified primarily for detention and conveyance, the specification is ¾-inch washed drain rock. For all flow-through facilities, ¾-inch wash drain rock shall be used. Drain rock and the growing medium must be separated by filter fabric (if required; see [Exhibit 2-3](#) for geotextile specifications), or a 2- to 3-inch layer of ¾ to ¼-inch washed, crushed rock must be used.

- **Piping:** For private property, piping shall be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities that drain up to 1,500 square feet of impervious area; otherwise, a 4-inch pipe minimum is required. Piping installation must follow current Uniform Plumbing Code. For streets, 6-inch or 8-inch ASTM 3034 SDR 35 PVC pipe and perforated pipe are required. Refer to the *City's Sewer and Drainage Facilities Design Manual* for more information.
- **Growing medium:** For swales designed with the Simplified Approach or swales on private property, the imported soil shall be a sandy loam mixed with compost or a sand/soil/compost blend. It shall be roughly one-third compost by volume, free-draining, and support plant growth. The compost shall be derived from plant material; animal waste is not allowed. For streets, the blended topsoil is specified in Appendix F.3. In all cases, the blended topsoil shall be 18 inches deep.
- **Vegetation:** The entire facility area must be planted with vegetation. The facility area is equivalent to the total area of the swale, including bottom and side slopes, as developed in the sizing calculations.

Swales should be designed so they do not require mowing.

See [Appendix F.4](#) for suggested plant material appropriate for private property and the public right-of-way. See [Appendix G.3](#) for typical details and planting templates. Minimum container size is 1 gallon. Minimum quantities are shown on [Exhibits 2-12 through 2-15](#).

Private Property

Exhibit 2-12: Private Swale Vegetation - ZONE A

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
115	Herbaceous plants	100	1 gallon	1'
OR				
100	Herbaceous plants	100	1 gallon	1'
4	Small shrubs	100	1 gallon	3'

Exhibit 2-13: Private Swale Vegetation - ZONE B

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
1	Evergreen tree	200	Min height 6'	-
OR				
1	Deciduous tree	200	Min caliper 1½" at 6" above base	-
AND				
3	Large shrubs	100	3 gallon or equivalent	4'
4	Medium to small shrubs	100	1 gallon or equivalent	2'
70	Groundcover	100	1 gallon or equivalent	1'

Streets

Plantings adjacent to streets require special attention to line-of-sight and maintenance issues.

Exhibit 2-14: Street Swales - ZONE A

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
115	Herbaceous plants	100	1 gallon	1'
OR				
100	Herbaceous plants	100	1 gallon	1'
4	Small shrubs	100	1 gallon	2'

Exhibit 2-15: Street Swales - ZONE B

Number of plants	Vegetation type	Per square feet	Spacing density (on center)	Size
12	Small shrubs	100	2'	1 gallon or equivalent
70	Groundcover	100	1'	1 gallon or equivalent

Mulch: Fine to medium hemlock bark or well-aged organic yard debris compost is recommended for swales. It should be placed in the facility only in areas above the high-water line. Care should be given to keeping mulch material out of a stormwater flow path to avoid any material from clogging inlets or outlets or otherwise escaping the facility. It must be weed-free and applied 2 to 3 inches thick to cover all soil between plants. It should not be over-applied.

Construction Considerations

Infiltration swales areas should be clearly marked before site work begins to avoid soil compaction or sedimentation to preserve infiltration capacity during construction. No vehicular traffic, except that specifically used to construct the facility, should be allowed within 10 feet of infiltration swale areas.



Exhibit 2-16: North East Siskiyou Street curb extension.

Facility Description

Stormwater curb extensions comprise retrofitting a section of paved roadway with a vegetated swale behind a secondary curb that “extends” into the roadway. This new vegetated area manages stormwater runoff and often utilizes existing street inlets for routing water into and out of the facility. Curb extensions have been typically used in retrofit situations to manage runoff from developed rights-of-way. A change in curb alignment into the roadway allows for stormwater to efficiently flow into the facility. Curb extensions can also provide a location for a stormwater facility since available space behind an existing curb line is more likely to be constrained or inadequate in size. The presence of utilities, potential loss of on street parking spaces, and the narrowing of the road width are all considerations in curb extension placement and design.

Curb extensions can also improve auto, pedestrian, and bicycle safety. Extensions narrow the crossing distance for pedestrians, improve sight-lines, and provide a visual presence in the roadway to slow cars approaching intersections.

Stormwater curb extensions effectively intercept stormwater from the street gutter and send it into gently sloping or flat bottomed facilities. Within the facilities, vegetation and check dams slow the stormwater down, filter it, and in many cases allow it to infiltrate into the ground. In locations where soils do not drain well, curb extensions can overflow to an approved discharge point such as a storm sewer, sump, or open channel drainage way, such as a creek or stream.

General Guidelines

Local Service Streets (as defined by the Portland Bureau of Transportation) typically accommodate curb extensions and the design considerations outlined below are directed primarily for this application. Curb extensions can also be accommodated on higher classification streets using similar design considerations. However, significantly more scrutiny and review are required to ensure vehicle and pedestrian safety, safety for maintenance crews, and adequate sizing of the facility for those situations.

Additional considerations for higher classification streets may include analysis for future transportation system demands. These demands may call for future travel lanes, bike lanes, or turn lanes that would potentially conflict with a curb extension. Other facilities such as planter boxes within the planting strip behind the curb may be more appropriate for high traffic areas.

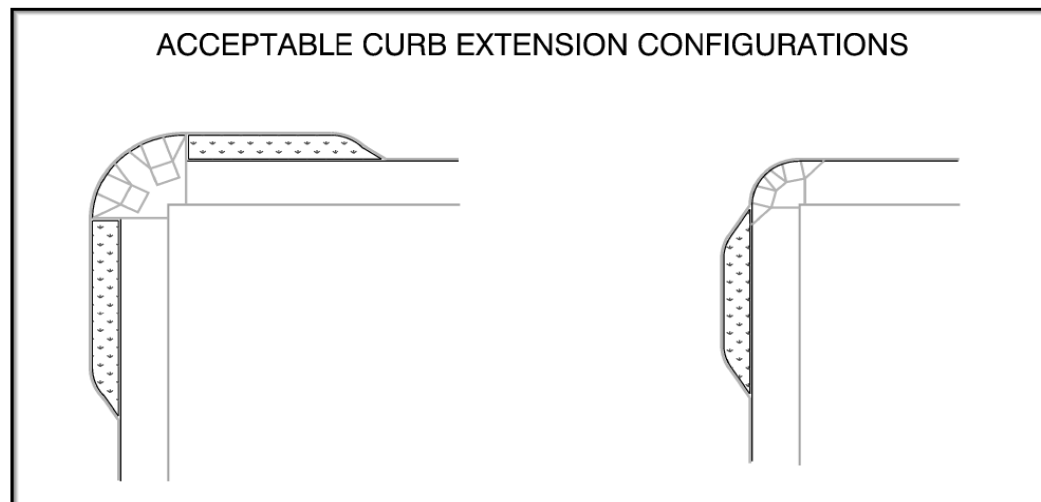
Curb extensions should be designed for optimal collection of stormwater to fit into the existing streetscape to the maximum extent practicable. Designers should take into consideration the impact to adjacent property owners and preserving existing desirable amenities within the right-of-way such as on street parking, walkways, landscaping, street trees, and utilities.

- Since curb extensions occupy space typically used for on-street parking, a technique for mitigating impacts to adjacent property owners is centering surface stormwater facilities between property owners. Even though this may not be the most efficient location for collection of stormwater, it reduces the impact to one property by spreading it over two. This technique can allow for at least one on-street parking space to be retained on each property frontage. In general, projects should avoid removing parking entirely along frontages without driveways or off-street parking areas.
- For mid-block curb extension applications, it is acceptable for stormwater to flow into a facility and then back out (such facilities are referred to as a “flow-through” facilities). When a stormwater curb extension is combined with pedestrian ramps at corners, stormwater should be collected within the facility to the maximum extent practicable. This may include the installation of underdrains and/or overflow inlets within the stormwater facilities. Stormwater must not flow across the base of the pedestrian ramps when exiting the facility.
- The development potential of adjacent property should be considered to the maximum extent practical when placing facilities. For example, an undeveloped or underdeveloped lot might require a driveway at a future time, which could conflict with a surface stormwater facility. The BDS should be contacted to determine if a development inquiry or building permit exists for adjacent properties.

Street Design Requirements and Considerations

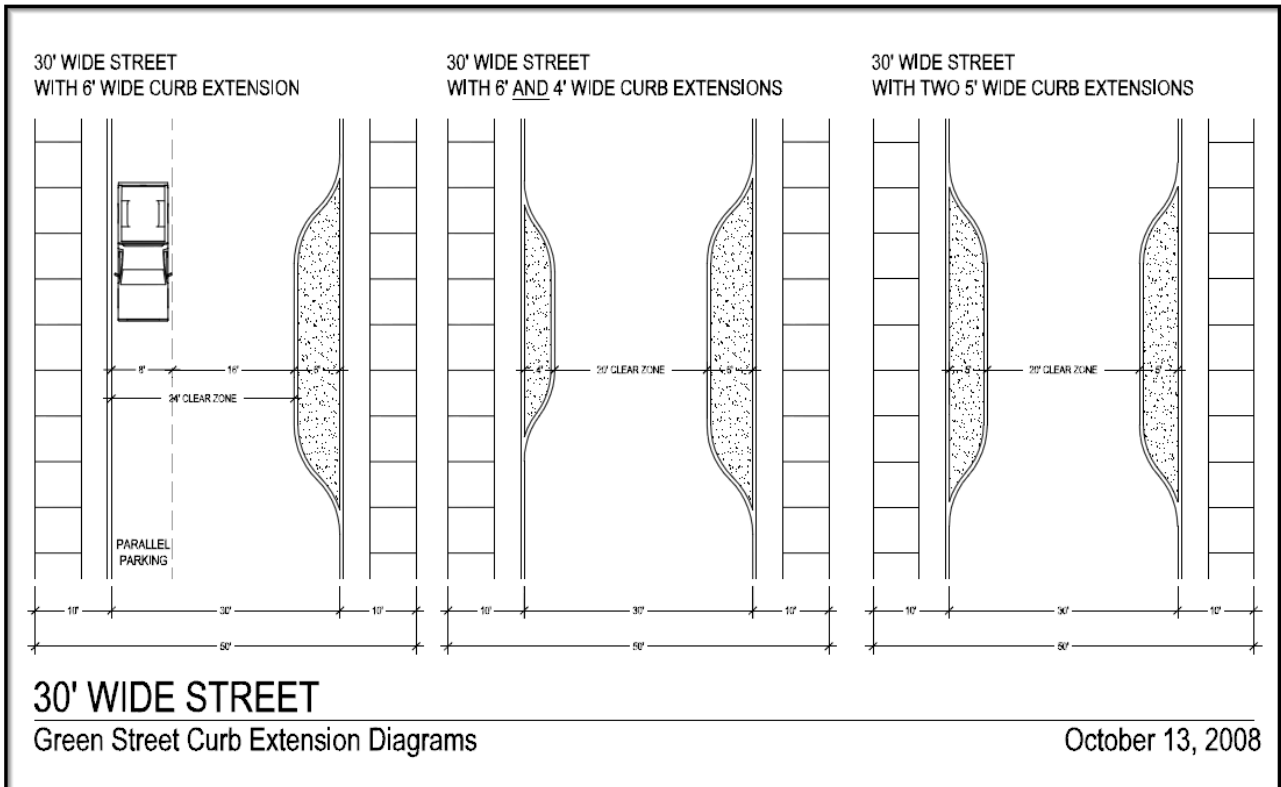
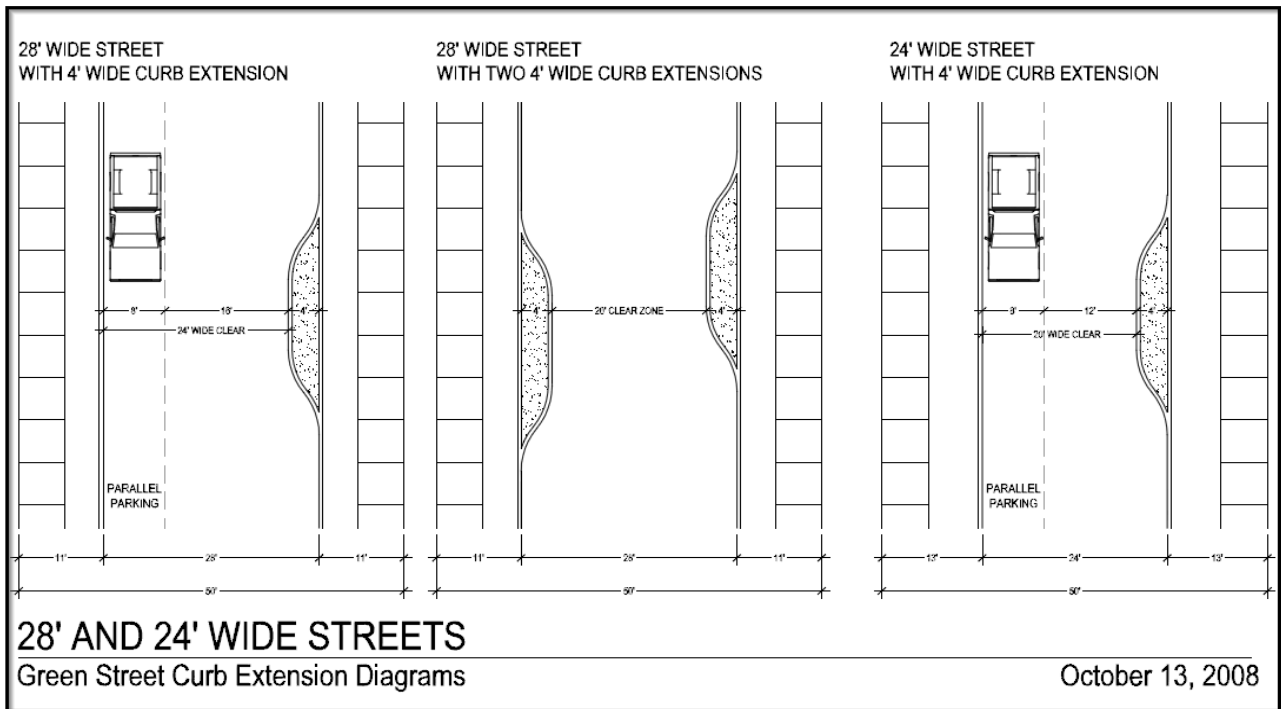
- A curb extension in an existing right-of-way is considered to be an alteration. As a result, the federal law requires that such a curb extension project improve adjacent corners that do not have pedestrian ramps. See City Standard Drawing P-548 in the *City of Portland Standard Construction Specifications*.
- For corner applications, stormwater curb extensions must be placed at the Point of Curvature (PC) or the Point of Tangency of a corner radius or as close to the corner ramp as possible without blocking the pedestrian ramp. Where a curb extension cannot be placed at or very close to the PC of a corner radius, stormwater curb extensions must be moved back approximately 18 feet to allow for a legal parking space.
- Stormwater curb extensions proposed on both sides of a street corner must be incorporated into a full curb extension including the corner ramps (See Exhibit 2-17). Subject to BES approval, a single stormwater curb extension can be placed on one side of a corner without requiring that the corner ramp be incorporated into the extension. The specific geometry requirements for a full corner curb extension are determined by Portland Bureau of Transportation (PBOT) traffic engineers according to site conditions.
- Corners with pedestrian ramps must be constructed (see Exhibit 2-17) in a Pedestrian District or City Walkway per the City's Transportation System Plan. If there is a safety benefit to shortening the crossing distance for pedestrians, and/or if the street is a designated Safe Route to School and on higher classification streets, these requirements will be conveyed by transportation staff.
- For midblock applications, locate stormwater curb extensions at the wing of a driveway or at least 18 feet from a driveway wing to either remove or allow for parking.

Exhibit 2-17. Acceptable Curb Extension Configurations.



- The presence of existing fire hydrants and mature street trees will impact placement of curb extensions. Consequently, coordination with the Portland Water Bureau and Portland Parks and Recreation is necessary.
- A thickened curb and gutter per *City of Portland Standard Construction Specification Drawing P-540* must be used along the street side of all surface stormwater facilities in the public right-of-way.
- Typical curb extensions vary in width from 4 to 6 feet as measured from the face of the existing curb to the street-facing face of a new curb. The actual width of the curb extension varies depending on many factors, including but not limited to existing street width, on-street parking, bike lanes, traffic engineering considerations, and conflicts with utilities, such as water lines. A distance of 20 feet between curbs on opposite sides of the street must be maintained on all local, two-way residential streets per Portland Fire Bureau requirements, unless specific exceptions are approved (See Exhibit 2-18).

Exhibit 2-18. Street Widths for Curb Extensions.



Note: 32 feet and wider streets may have up to 6 feet curb extensions on one or both sides of the street.

- In addition to PBOT and Fire Bureau requirements, existing utility locations may also impact allowable curb extension width. It may be necessary to reduce the width of a curb extension to avoid a utility conflict.
- Curb extensions must be designed with a wheel stop at the inlet/outlet of a facility when adjacent to on-street parking. Significant damage to both the facility and a vehicle can occur if a vehicle enters the curb opening of a curb extension. See [Appendix G.3](#).
- To prevent odor issues in combined sewer areas, beehive inlets located within a curb extension stormwater facility should be piped to manholes or daisy-chained with street inlets and not piped directly to a main-line combined sewer. If a connection to the sewer cannot be avoided, an approved method must be used to prevent the escape of sewer gas. Refer to the *BES Sewer and Drainage Facilities Design Manual*.
- The “Green Street Site Assessment Checklist” ([Appendix G.4](#)) should be used for field checks and applicable details.
- Generally, a minimum length of 30 feet is required to accommodate a mid-block curb extension ranging from 4 to 6 feet in width. Any linear length shorter than this should not be considered for a curb extension.
- Existing sidewalks with a vertical or horizontal displacement greater than or equal to ½ inch must be repaired at locations where new construction meets old as shown on the *City of Portland Standard Construction Specifications* Drawing P-554. Many existing sidewalks are old and not able to withstand even minimal adjacent disturbance or construction loads. Since the adjacent property owner is responsible under City Code for sidewalk maintenance and repair, the sidewalk must be restored to a condition as good as the condition that existed before construction. Replacement of fragile sidewalks beyond the minimal requirements allowed by P-554 should be evaluated during the design process by PBOT staff.

Stormwater Requirements

- **Soil suitability:** Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to flow through the facility. See Appendix F.2 for infiltration testing procedures and requirements.
- **Setbacks:** Infiltration curb extensions are typically set back 10 feet from building foundations. There are no setback requirements for lined flow-through curb extensions. See [Exhibit 2-1](#) for more information on setbacks.

- **Sizing:** Surface area and depth of facility vary. An approved stormwater sizing calculator allows the designer to size stormwater facilities with respect to native infiltration rates and other unique site conditions of the project. See [Appendix G.3](#) for stormwater curb extension geometry and typical sections.
- **Dimensions and slopes:** The minimum curb extension width is 4 feet, and the length will vary. They may vary in depth from 6 to 9 inches measured from the top of the street curb. Maximum longitudinal slope is 6 percent.
- **Check dams:** Check dams may be required perpendicular to the flow line to encourage water to pool and infiltrate into the ground.
- **Gravel drain rock:** Drain rock may be required below the growing medium of a curb extension. Refer to [Appendix G.3](#) for specific details.
- **Piping:** 8-inch ASTM 3034 SDR 35 PVC pipe and 4-inch perforated pipe are required. Refer to the *BES Sewer and Drainage Facilities Design Manual*.
- **Growing medium:** For curb extensions, the blended topsoil is specified in [Appendix F.3](#). The blended topsoil must be 18 inches deep unless otherwise specified.
- **Vegetation:** The entire facility area must be planted with vegetation. The facility area is equivalent to the total area of the facility, including bottom and side slopes, as developed in the sizing calculations. Curb extensions should be planted so they do not block traffic sight lines or require mowing. See [Appendix F.4](#) for suggested plant material appropriate for private property and the public right-of-way. See [Appendix G.3](#) for typical details and planting templates.
- **Liners:** Full or partial liners may be required for protecting adjacent water facilities/utilities. In addition, they may be required on higher classification streets, in locations with hazardous materials or topography considerations, and in wellhead protection areas. Other methods may be considered where impervious or waterproof facilities are required, such as single-pour concrete forms.



Exhibit 2-19: Epler Hall Planter. See [Appendix G.1](#), SW-130, for typical private property planter detail and [Appendix G.3](#), SW-310 through SW-313, for typical Green Street planter details.

Facility Description

Planters are structural landscaped reservoirs used to collect, filter, and infiltrate stormwater, allowing pollutants to settle and filter out as the water percolates through the vegetation, growing medium, and gravel. Depending on site conditions, planters can be designed to completely or partially infiltrate the stormwater they receive. They can also be designed as lined, flow-through facilities where stormwater is temporarily stored. Excess stormwater collects in a perforated pipe at the bottom of the flow-through planter and drains to an approved discharge point. Planters can be used to help fulfill a site's required landscaping area requirement and should be integrated into the overall site design. Numerous design variations of shape, wall treatment, and planting scheme can be used to fit the character of a site. Because flow-through planters can be constructed immediately next to buildings, they are ideal for sites with setback requirements, poorly draining soils, steep slopes, or other constraints.

Design Requirements

- **Soil suitability:** Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to flow through the facility. See [Appendix F.2](#) for infiltration testing procedures. For the Simplified Approach ([Section 2.2.1](#)), if the tested infiltration rate is greater than or equal to 2 inches per hour, the planter must overflow to a subsurface infiltration facility. If the tested infiltration rate is less than 2 inches

per hour, the planter should be designed as a partial infiltration or flow-through facility, with an overflow to an approved discharge point. For the Presumptive Approach ([Section 2.2.2](#)), the existing infiltration rate also determines the type of planter, but additional variables are factored in to determine the configuration of the facility.

- **Setbacks:** Infiltration planters are typically set back 5 feet from property lines and 10 feet from building foundations. No setbacks are required for lined, flow-through planters where the height above finished grade is 30 inches or less. Lined flow-through planters can be used next to foundation walls, adjacent to property lines, or on slopes when they include a waterproof lining. See [Exhibit 2-1](#) for more information on setbacks.
- **Access:** Design must consider safe access for maintenance of the planter.
- **Sizing:** For the Simplified Approach, a sizing factor of 0.06 is required. For the Performance Approach, surface area and depth of facility vary. An approved stormwater sizing calculator allows the designer to size the planter with respect to native infiltration rates and other unique site conditions of the project.
- **Dimensions and slopes:** The minimum infiltration planter width is 30 inches, and the minimum flow-through planter width is 18 inches (measured from inside the planter walls). Facility storage depth must be at least 12 inches (from inlet elevation of overflow to top of growing medium), unless a larger-than-required planter area is specified. Planters are flat facilities that shall not slope more than 0.5 percent in any direction. A minimum of 2 inches of freeboard (vertical distance between the design water surface elevation and overtopping elevation) shall be provided.
- **Planter walls:** Planter walls shall be made of stone, concrete, brick, or other durable material. For planters that require an impervious bottom, a single-pour concrete solution is preferred. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater shall not be used.
- **Waterproofing (if required):** Flow-through facilities that require an impervious bottom can be achieved through either a waterproof liner (geomembrane) or a single-pour concrete box. If lined, there are many liner options, and installation varies. Liners should be installed to the high water mark. Liner shall be 30 to 40-mil PVC or HDPE as appropriate or approved equivalent.
- **Gravel drain rock:** Drain rock may be required below the growing medium of a planter. For infiltration facilities, where drain rock is specified to retain stormwater prior to infiltration, the specification is 1½- to ¾-inch washed drain

rock. Where drain rock is specified primarily for detention and conveyance, the specification is ¾-inch washed drain rock. For all flow-through facilities, ¾-inch wash drain rock shall be used. Drain rock and growing medium must be separated a 2- to 3-inch layer of ¾- to ¼-inch washed, crushed rock or by filter fabric (see [Exhibit 2-3](#) for geotextile specifications). Green streets require ¾ inch No. 4 open graded aggregate 3 inches in depth.

- **Piping:** For private property, piping shall be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise, a 4-inch pipe minimum is required. Piping installation must follow current Uniform Plumbing Code. For streets, 6-inch or 8-inch ASTM 3034 SDR 35 PVC pipe and perforated pipe are required. Refer to the *City’s Sewer and Drainage Facilities Design Manual* for more information.
- **Growing medium:** For planters designed with the Simplified Approach or planters on private property, the imported soil shall be a sandy loam mixed with compost or a sand/soil/compost blend. It shall be roughly one-third compost by volume, free-draining, and support plant growth. The compost shall be derived from plant material; animal waste is not allowed. For streets, the blended topsoil is specified in [Appendix F.3](#). In all cases, the blended topsoil shall be 18 inches deep.
- **Vegetation:** The entire facility area must be planted with vegetation. The facility area is equivalent to the total area of the planter, as developed in the sizing calculations. The entire surface area of a planter is inundated with water and therefore requires only Zone A plants. See [Appendix F.4](#) for suggested plant material appropriate for private property and the public right-of-way. See [Appendix G.3](#) for typical details and planting templates. Minimum container size is 1 gallon. Minimum quantities are shown on [Exhibit 2-20](#).

**Exhibit 2-20: Planter Vegetation - ZONE A
Private and Public Property**

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
115	Herbaceous plants	100	1 gallon	1'
OR				
100	Herbaceous plants	100	1 gallon	1'
4	Small shrubs	100	1 gallon	2'

Note: Tree planting is not required in planters but is encouraged where practical. Tree planting is also encouraged near planters.

- **Mulch:** Washed pea gravel or river rock is recommended for planters. It should be applied 2 to 3 inches thick to cover all soil between plants. It should not be overapplied.

Construction Considerations

Special attention should be paid to the structural waterproofing if the planter is constructed adjacent to building structures. Infiltration planter areas should be clearly marked before site work begins to avoid soil compaction and sedimentation to preserve infiltration capacity during construction. No vehicular or foot traffic, except that specifically used to construct the facility, should be allowed within 10 feet of infiltration planter areas.

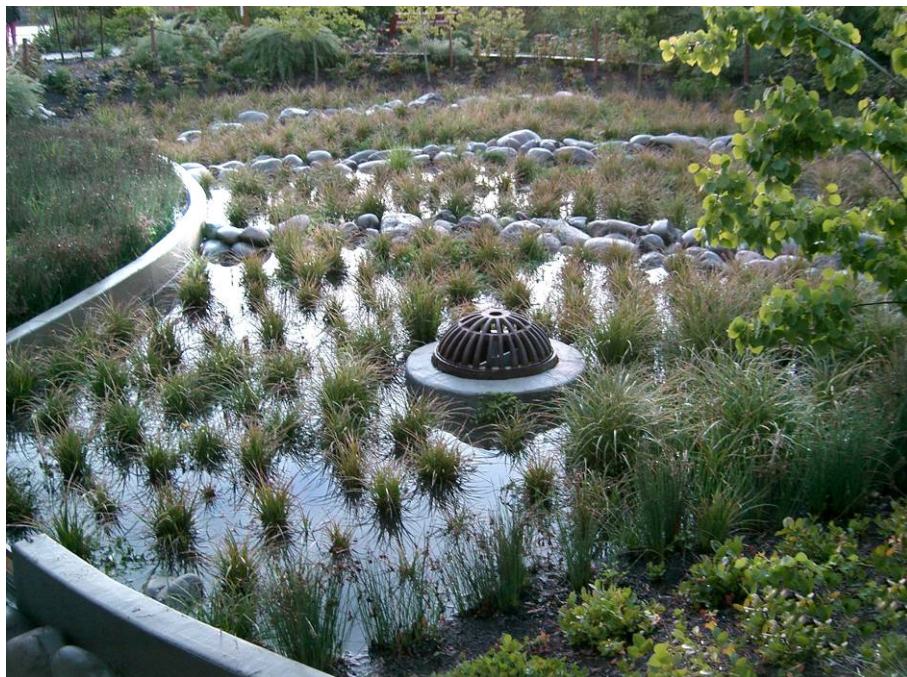


Exhibit 2-21: Glencoe School Infiltration Basin. See [Appendix G.1](#), SW-140, for typical basin details.

Facility Description

Vegetated infiltration basins are shallow landscaped depressions used to collect and hold stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground. Basins are also referred to as rain gardens. They are either excavated or created with bermed side slopes. An inlet pipe or sheet flow over impervious area conveys the stormwater into the basin, where it is temporarily stored until it infiltrates into the ground. Basins often provide complete onsite infiltration for small storm events. They can be sized to infiltrate large storms in areas where soils drain well or overflow to an approved discharge point. Basins can have a formal or informal design that can be used to help fulfill a site's landscape requirements.

Design Requirements

- **Site suitability:** Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to flow through the facility. See [Appendix F.2](#) for infiltration testing procedures. For the Simplified Approach ([Section 2.2.1](#)), if the tested infiltration rate is greater than or equal to 2 inches per hour, the basin must overflow to a subsurface infiltration facility. If the tested infiltration rate is less than 2 inches per hour, the basin should be designed as a partial infiltration or flow-through facility, with an overflow to an approved discharge point. For the Presumptive

Approach ([Section 2.2.2](#)), the existing infiltration rate also determines the type of basin, but additional variables are factored in to determine the configuration of the facility.

- **Setbacks:** Basins are typically set back 5 feet from property lines and 10 feet from building foundations. Infiltration basins are typically set back from downstream slopes: a minimum of 100 feet from slopes of 10 percent; add 5 feet of setback for each additional percent of slope up to 30 percent; infiltration basins shall not be used where slopes exceed 30 percent. There are no setback requirements for lined, flow-through basins. See [Exhibit 2-1](#) for more information on setbacks.
- **Access:** Design must consider safe access for maintenance of the basin.
- **Sizing:** For the Simplified Approach, a sizing factor of 0.09 is required. The maximum designed ponding time shall be a function of the facility storage depth. For the Presumptive Approach, surface area and depth of facility vary. An approved stormwater sizing calculator allows the designer to size stormwater facilities with respect to native infiltration rates and other unique site conditions of the project.
- **Dimensions and slopes:** For basins designed with the Simplified Approach, the facility storage depth is 12 inches from the top of the growing medium to the overflow inlet elevation. For basins designed with the Presumptive Approach, the facility storage depth may vary from 9 to 18 inches. Maximum side slopes are 3 horizontal to 1 vertical. Minimum bottom width is 2 feet. A minimum of 2 inches of freeboard (vertical distance between the design water surface elevation and overtopping elevation) shall be provided.
- **Gravel drain rock:** Drain rock may be required below the growing medium of a basin. For infiltration facilities, where drain rock is specified to retain stormwater prior to infiltration, the specification is 1½-to ¾-inch washed drain rock. Where drain rock is specified primarily for detention and conveyance, the specification is ¾-inch washed drain rock. For all flow-through facilities, ¾-inch wash drain rock shall be used. Drain rock and growing medium must be separated by a 2-to 3-inch layer of ¾ - to ¼-inch washed, crushed rock or filter fabric (see [Exhibit 2-3](#) for geotextile specifications). Green streets require ¾ No. 4 open graded aggregate 3 inches in depth.
- **Piping:** For private property, piping shall be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise, a 4-inch pipe minimum is required. Piping installation must follow current Uniform Plumbing Code. For streets, 6-inch or 8-inch ASTM 3034 SDR 35 PVC pipe and perforated pipe are required. Refer to the City's *Sewer and Drainage Facilities Design Manual* for more information.

- **Growing medium:** For basins designed with the Simplified Approach or planters on private property, the imported soil shall be a sandy loam mixed with compost or a sand/soil/compost blend. It shall be roughly one-third compost by volume, free-draining, and support plant growth. The compost shall be derived from plant material; animal waste is not allowed. For streets, the blended topsoil is specified in [Appendix F.3](#). In all cases, blended topsoil shall be 18 inches deep.
- **Vegetation:** The entire facility area must be planted with vegetation. The facility area is equivalent to the total area of the basin, including bottom and side slopes, as developed in the sizing calculations, plus a 10-foot buffer around the basin. See [Appendix F.4](#) for suggested plant material appropriate for private property and the public right-of-way. See [Appendix G.3](#) for typical details and planting templates. Minimum container size is 1 gallon. Minimum quantities are shown on [Exhibits 2-22 and 2-23](#).

Exhibit 2-22: Basin Vegetation - ZONE A

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
115	Herbaceous plants	100	1 gallon	1'
OR				
100	Herbaceous plants	100	1 gallon	1'
4	Small shrubs	100	1 gallon	3'
OR				
100%	Seed coverage			

Exhibit 2-23: Basin Vegetation - ZONE B

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
1	Evergreen tree	300	Min height 6'	-
OR				
1	Deciduous tree	300	Min caliper 1 ½" at 6" above base	-
AND				
4	Large shrubs	100	3 gallon or equivalent	4'
6	Medium to small shrubs	100	1 gallon or equivalent	2'
70	Groundcover	100	1 gallon or equivalent	1'

Wildflowers, native grasses, and ground covers shall be selected and designed to not require mowing. Turf and lawn areas are not allowed for BES-maintained facilities; any exceptions will require BES approval.

- **Mulch:** Fine to medium hemlock bark or well-aged organic yard debris compost is recommended for basins. It should be placed in the facility only in areas above the high-water line. Care should be given to keeping mulch material out of a stormwater flow path to avoid any material from clogging inlets or outlets or otherwise escaping the facility. It must be weed-free and applied 2 to 3 inches thick to cover all soil between plants. It should not be overapplied.

Construction Considerations

Infiltration basin areas should be clearly marked before site work begins to avoid soil compaction or sedimentation during construction. No vehicular or foot traffic, except that specifically used to construct the facility, should be allowed within 10 feet of infiltration basin areas.

See **Appendix G.1**, SW-160, for typical filter strip details.

Facility Description

Vegetated filter strips are gently sloped areas that are designed to receive sheet flows. They are typically linear facilities that run parallel to the impervious surface and are commonly used to receive the runoff from walkways and driveways. Filter strips are covered with vegetation, including grasses and groundcovers, which filter and reduce the velocity of the stormwater. As the stormwater travels downhill, it infiltrates into the soils below.

Driveway center filter strips are used between the drive aisles of residential driveways. They are typically 3 feet wide and placed between two 3-foot-wide paved sections. (The minimum width of a residential driveway is 9 feet, of which the inner 3-foot section could be pervious and used for infiltration as long as all other code requirements are met.) The strip is used exclusively to treat and infiltrate the stormwater from the impervious area of the drive aisles. The drive aisles must be sloped toward the driveway center filter strip. The driveway center filter strip must be maintained to the required design requirements (including 100 percent landscaping coverage) stated below.

Design Requirements

- **Soil Suitability:** Filter strips are appropriate for all soil types. Unless existing vegetated areas are approved as a filter, stormwater facility growing medium shall be used for the top 12 inches of the facility.
- **Setbacks:** Filter strips are typically 5 feet from the property line; 10 feet from buildings; and 50 feet from wetlands, rivers, streams, and creeks. See [Exhibit 2-1](#) for more information on setbacks.
- **Access:** Design must consider safe access for maintenance of the facility.
- **Sizing:** Where the Simplified Approach is applicable, the filter strip is sized at 20 percent of impervious area treated for a maximum of 500 square feet of impervious area to be managed by the filter strip. If the Simplified Approach cannot be used, the Performance Approach will be required for sizing the filter strip, with demonstration of infiltration feasibility.

- **Dimensions and slopes:** Filter strips shall slope between 0.5 and 6 percent. Slope of pavement area draining to the strip shall be less than 6 percent. Filter strips shall have a minimum width of 5 feet, measured in the direction of the flow.
- **Level spreaders:** A grade board or sand/gravel trench may be required to disperse the runoff evenly across the filter strip. The top of the level spreader must be horizontal and at an appropriate height to provide sheet flow directly to the soil without scour. Level spreaders shall not hold a permanent volume of runoff. Grade boards can be made of any material that will withstand weather and solar degradation. Trenches used as level spreaders can be filled with washed crushed rock, pea gravel, or sand. (See [Appendix G.5](#), SW-524).
- **Growing medium:** For filters designed with the Simplified Approach or filters on private property, the imported soil shall be a sandy loam mixed with compost or a sand/soil/compost blend. It shall be roughly one-third compost by volume, free-draining, and support plant growth. The compost shall be derived from plant material; animal waste is not allowed. The growing medium shall be 12 inches deep for filter strips.
- **Vegetation:** The entire filter strip must have 100 percent coverage by native grasses, native wildflower blends, native ground covers, or any combination thereof. See Appendix F.4 for more information.
- **Check dams:** If necessary, check dams shall be constructed of durable, nontoxic materials such as rock or brick or graded into the native soils. Check dams shall be 12 inches wide, 3 to 5 inches high, and run the length of the filter..

Facility Description

Grassy swales are long, narrow grassy depressions used to collect and convey stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground or flows through the facility. In addition to providing pollution reduction, they can also manage flow rates and volumes. Grassy swales should be integrated into the overall site design and can be used to help fulfill a site's required landscaping area requirement.

Grassy swales must be designed and submitted under the Performance Approach. (See [Section 2.2.3](#) for submittal requirements.) The facility must be able to provide 70 percent TSS removal from 90 percent of the average annual runoff (as described in [Section 1.3.3](#)) and provide detention of the post-development peak runoff rates to less than predevelopment peak runoff rates (as described [Section 1.3.2](#)).

Design Requirements

- **Soil suitability:** Grassy swales are appropriate for all soil types.
- **Setbacks:** Grassy swales are typically set back 5 feet from centerline of the swale to property lines and 10 feet to building foundations, unless the swale is lined with impermeable fabric. See [Exhibit 2-1](#) for more information on setbacks.
- **Access:** Design must consider safe access for maintenance of the facility.
- **Sizing:** The Simplified Approach and Presumptive Approach are not available to size grassy swales. The Performance Approach must be used, and the following criteria apply:

The swale width and profile shall be designed to convey runoff from the pollution reduction design storm intensity at:

- maximum design velocity of 0.9 feet per second
- minimum hydraulic residence time (time for Q_{design} to pass through the swale) of 9 minutes
- a Manning n value of 0.25

A minimum of 1 foot of freeboard above the water surface shall be provided for facilities not protected by high-flow storm diversion devices. Swales without high-flow diversion devices shall be sized to safely convey the 25-year storm event, analyzed using the Rational Method (peak 25-year, 5 minute intensity = 3.32 inches per hour).

Velocity through the facility shall not exceed 3 feet per second during the high-flow events (i.e., when flows greater than those resulting from the pollution reduction design intensity are not passed around the facility).

- **Flow spreader:** The grassy swale shall incorporate a flow-spreading device at the inlet. The flow spreader shall provide a uniform flow distribution across the swale bottom. In swales with a bottom width greater than 6 feet, a flow spreader shall be installed at least every 50 feet.
- **Check dams:** For slopes greater than 5 percent, check dams shall be used (a minimum of one 6-inch-high dam every 10 feet).

[Exhibits 2-24, 2-25, and 2-26](#) are based on the City standards and may be used to easily determine swale length, given the peak flow rate, and the desired swale bottom width.

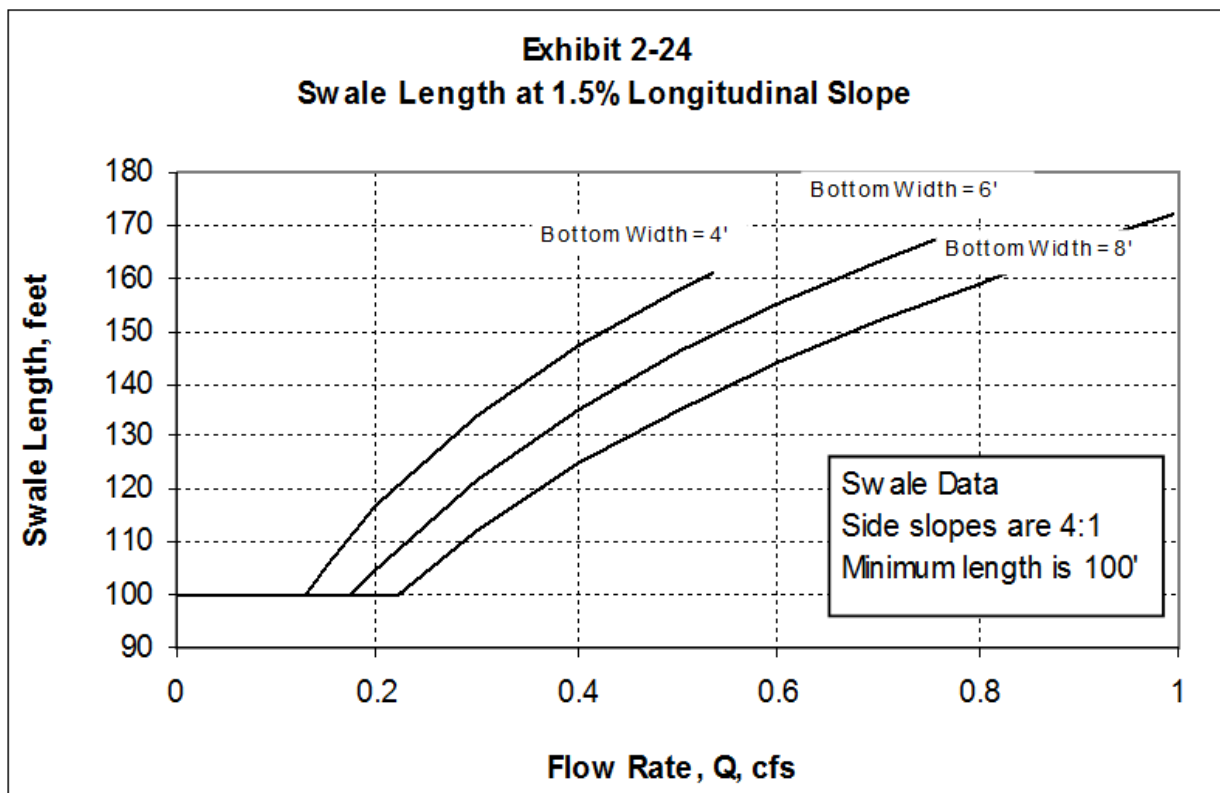


Exhibit 2-25
Swale Length at 3.0% Longitudinal Slope

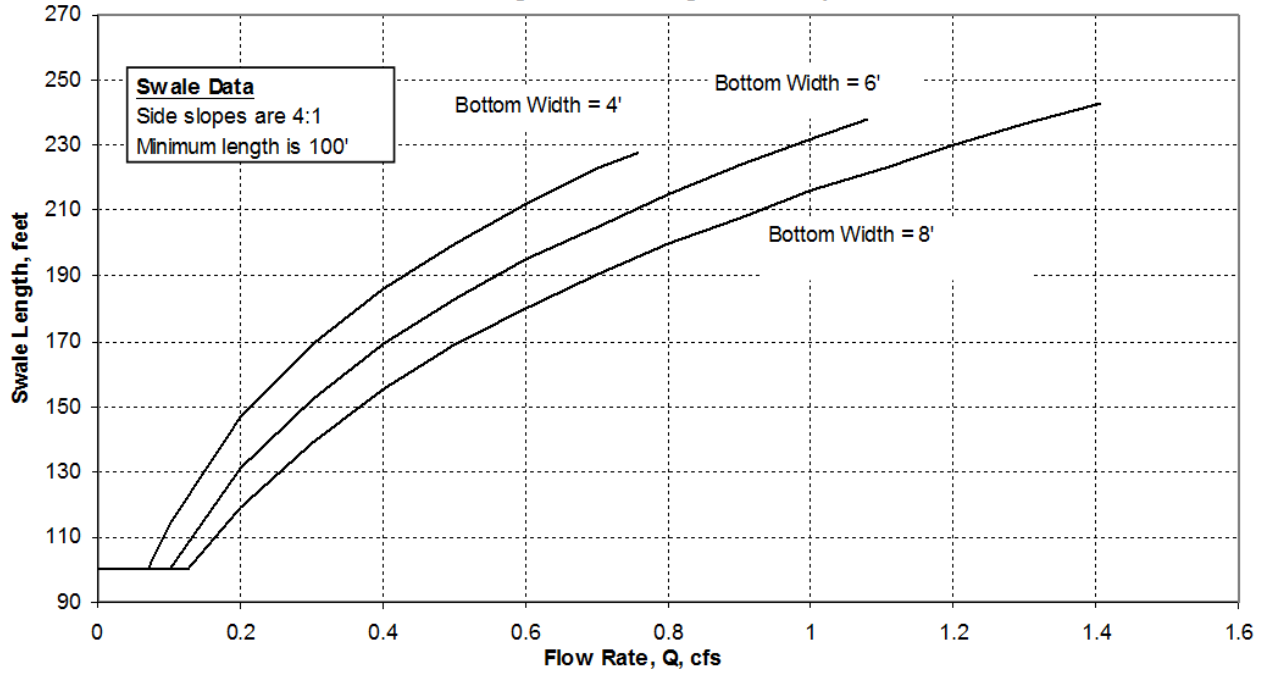
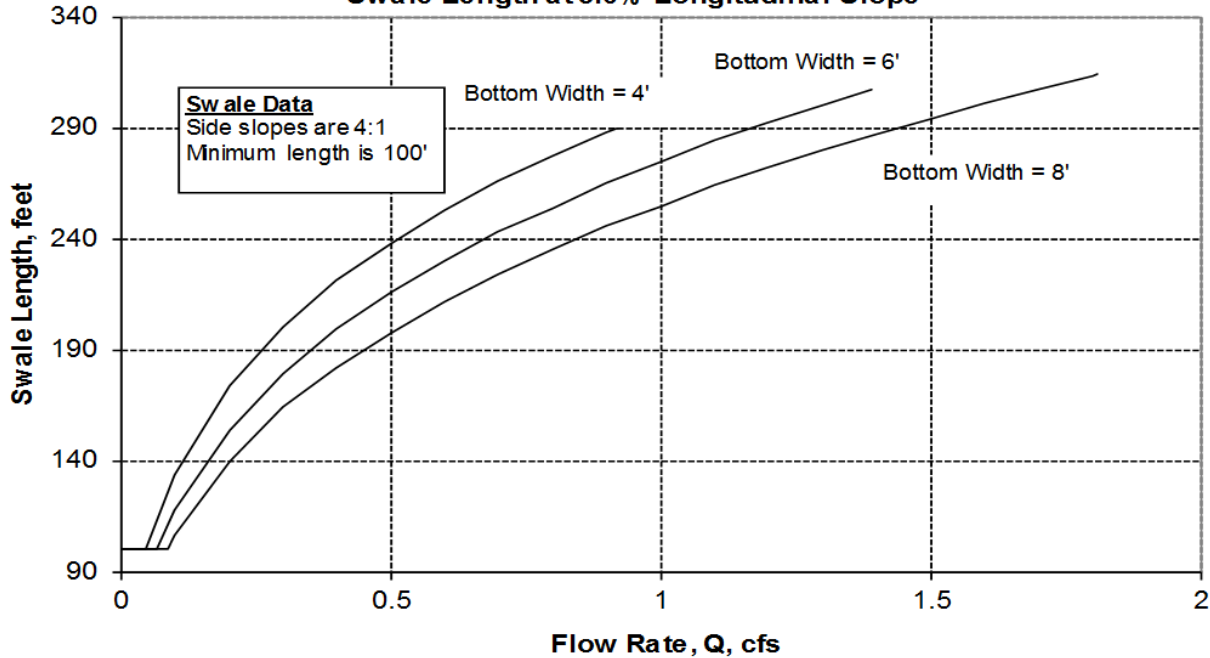


Exhibit 2-26
Swale Length at 5.0% Longitudinal Slope



- Dimensions and slopes:** The minimum grassy swale width on private property is 10 feet, with a minimum 2-foot flat bottom. The minimum grassy swale width on public property is 12 feet, with a minimum 4-foot flat bottom. Maximum side

slopes for both are 4 horizontal to 1 vertical. The minimum length for both is 100 feet.

When designing grassy swales, slopes and depth should be kept as mild as possible to avoid safety risks and prevent erosion within the facility. To minimize flow channelization, the grassy swale bottom shall be smooth, with uniform longitudinal slope. Maximum surrounding ground slopes shall not exceed 10 percent.

- **Growing medium:** Blended topsoil shall be used within the top 18 inches of the facility to support plant growth, per specifications in [Appendix F.3](#).
- **Vegetation:** Grasses shall be established as soon as possible after the swale is completed and before water is allowed to enter the facility. Unless vegetation is established, biodegradable erosion control matting appropriate for low-velocity flows (approximately 1 foot per second) shall be installed in the flow area of the swale before water is allowed to flow through the swale. [Exhibit 2-27](#) shows vegetation requirements for grassy swales.

Exhibit 2-27: Vegetation for Grassy Swales

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
1	Evergreen tree	200	Min height 6'	-
OR				
1	Deciduous tree	200	Min caliper 1 ½" at 6" above base	-
AND				
100%	Native or swale seed mix coverage (completely cover bottom and side slopes)			

For the swale flow path, approved native grass mixes are preferable and may be substituted for standard swale seed mix. Seed shall be applied at the rates specified by the supplier. The applicant shall have plants established at the time of facility completion (at least 3 months after seeding). No runoff shall be

allowed to flow in the swale until grass is established. Trees and shrubs may be allowed in the flow path within swales if the swale exceeds the minimum length and widths specified. See [Appendix F.4](#) for more information on trees and shrubs that are appropriate for their zone.

Native wildflowers and grasses used for BES-maintained facilities shall be designed to not require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once or twice annually. Lawn-type areas are not allowed for BES-maintained facilities; any exceptions require BES approval. Grassy swales in environmental zones shall meet requirements established by Title 33 for grass species in E-zones.

Submittal Requirements

Grassy swales require the applicant to submit a stormwater management plan under the Performance Approach.

Construction Considerations

No concentrated flows are allowed into the facility until the vegetation is fully established.

Maintenance

Access routes to grassy swales for maintenance purposes must be shown on the plans. Public swales need to provide a minimum 8-foot-wide access route, not to exceed a 10 percent slope.

See **Appendix G.2**, SW-230 through SW- 234, for typical pond details.

Facility Description

Three types of ponds are described in this section: wet ponds, extended wet ponds, and dry ponds, all of which must be designed and submitted under the Performance Approach. (See **Section 2.2.3** for submittal requirements.) The facility must be able to provide 70 percent TSS removal from 90 percent of the average annual runoff (as described in **Section 1.3.3**) and provide detention of the postdevelopment peak runoff rates to less than predevelopment peak runoff rates (as described **Section 1.3.2**).

The City encourages applicants to design ponds to function as multipurpose facilities (e.g., parks, open space, or recreation facilities), provided that any alternative uses are compatible with the primary stormwater functions and maintenance standards.

Wet ponds are constructed with a permanent pool of water (commonly referred to as pool storage or dead storage). Stormwater enters the pond at one end and displaces water from the permanent pool. Pollutants are removed from stormwater through gravitational settling and biological processes. When the sizing criteria presented in this section are used, pollution reduction requirements are presumed to be met. Additional facilities may be required in order to meet flow control requirements, as applicable. An overflow mechanism to an approved discharge point (see **Section 1.3.1**) is required.

Extended wet ponds are also constructed with a permanent pool of water, but have additional storage above that fills during storm events and releases water slowly over a number of hours. The permanent pool is sized to provide pollution reduction, and the additional storage above (extended detention area) is sized to meet flow control requirements. Pollutants are removed from stormwater through gravitational settling and biological processes. When the sizing criteria presented in this section are used, pollution reduction requirements are presumed to be met. The extended detention must be designed using acceptable hydrologic modeling techniques (see **Section 2.2**) to meet applicable flow control requirements (see **Section 1.3.2**). An overflow mechanism to an approved discharge point (see **Section 1.3.1**) is required.

Dry detention ponds are designed to fill during storm events and slowly release the water over a number of hours. Dry detention ponds must be designed using acceptable hydrologic modeling techniques (see **Section 2.2**) to meet applicable flow control requirements (see **Section 1.3.2**). Additional facilities are required in order to meet pollution reduction requirements, unless the bottom flow path of the pond is designed

as a swale according to the swale sizing and design criteria. An overflow mechanism to an approved discharge point (see [Section 1.3.1](#)) is required.

Design Requirements

- **Location and Ownership:**
 - All open ponds to be maintained by the City of Portland shall be located in a separate open space tract with public sewer easements dedicated to the City.
 - Open ponds serving more than one tax lot or designed to function as multi-use/recreational facilities shall be located in a separate tract (e.g., Tract A), defined easement, or designated open space.
 - Instream ponds are not allowed.
- **Soil Suitability:** Wet and extended wet detention ponds are applicable in NRCS hydrologic soil group C and D soils (A and B soils with impermeable liner). Dry detention ponds are applicable in NRCS hydrologic soil group B, C, and D soils. Sites with Type A soils should consider the use of an infiltration basin.
- **Setbacks:** Ponds are typically constructed to maintain the following setback distances from structures and other facilities. (All distances are measured from the edge of the maximum water surface elevation.) See [Exhibit 2-1](#) for more information on Setbacks.
 - Minimum distance from the edge of the pond water surface to property lines and structures: 20 feet, unless an easement with adjacent property owner is provided.
 - Distance from the toe of the pond berm embankment to the nearest property line: one-half of the berm height (minimum distance of 5 feet).
 - Minimum distance from the edge of the pond water surface to septic tank, distribution box, or septic tank drain field: 100 feet.
 - Surrounding slopes shall not exceed 10 percent. Minimum distance from the edge of the pond water surface to the top of a slope greater than 15 percent: 200 feet, unless a geotechnical report is submitted and approved by BES (see [Appendix G.2](#), SW-230).
 - Minimum distance from the edge of the pond water surface to a well: 100 feet (see [Appendix G.2](#), SW-230).
- **Access:** Design must consider safe access for maintenance of the facility.
- **Dimensions and slopes:**
 - Slopes and depth should be kept as mild as possible to avoid safety risks. Slopes within the pond shall not exceed 3 horizontal to 1 vertical.

- The maximum depth of the pond shall not exceed 4 feet. The 0- to 2-foot depth shall be distributed evenly around the perimeter of the pond.
 - The distance between all inlets and the outlet shall be maximized to facilitate sedimentation. The minimum length-to-width ratio is 3:1, at the maximum water surface elevation. This ratio is critical to prevent “short-circuiting,” where water passes directly through the facility without being detained for any length of time. If area constraints make this ratio unworkable, baffles, islands, or peninsulas may be installed, with City approval, to increase the flow path and prevent short-circuiting.
 - Minimum freeboard shall be 1 foot above the highest potential water surface elevation (1 foot above the emergency overflow structure or spillway elevation).
 - Dry detention ponds shall be divided into a minimum of two cells. The first cell (forebay) shall contain approximately 10 percent of the design surface area and shall provide at least 0.5 foot of dead storage for sediment accumulation.
 - Wet and extended wet detention ponds shall be divided into a minimum of two cells. The first cell (forebay) shall contain approximately 10 percent of the design surface area.
- **Sizing:**
 - Wet and extended wet detention ponds should be designed for large drainage areas (5 to 150 acres) to help avoid problems associated with long periods of stagnant water.
 - For wet and extended wet detention ponds, a water budget shall be submitted for review. The water budget must demonstrate that the base flow to the pond is sufficient such that water stagnation/alga matting will not become a problem.

Wet and Extended Wet Detention Permanent Pool Sizing: The permanent pool (or dead) storage volume, V_{pond} , is equivalent to twice the runoff volume generated by a storm of 0.83 inch over 24 hours (NRCS Type 1A rainfall distribution). This volume can be approximated using the following formula:

$$\text{Volume} = 2 \times (2,276 \times \text{Impervious Acreage})$$

Volume = permanent pool volume, cubic feet

Impervious Acreage = area of impervious surfaces to manage, acres

EXAMPLE

A 20-acre site is to be developed. After development, the site will be 60 percent impervious. What is the required volume for a wet pond to meet pollution reduction requirements?

For the postdevelopment condition, the total area is 20 acres and the impervious area has increased to 60 percent, or 12 acres:

$$\text{Permanent Pool Volume} = 2 \times (2,276 \times 12) = \underline{54,624 \text{ cubic feet}}$$

- **Flow control for extended wet detention and dry detention ponds:** To restrict flow rates exiting the pond to those required by [Section 1.3](#), a control structure must be used. For extended wet detention ponds, this control structure must be located above the permanent pool elevation. The outlet orifice shall be designed to minimize clogging.

Note: Because of minimum orifice size requirements (2 inches for public facilities, 1 inch for private facilities), detention facilities that rely on orifice structures to control flows for small projects (under 15,000 square feet of impervious development footprint area) are not allowed. In these cases, rather than constructing a detention facility onsite, the applicant may apply to pay an offsite management fee through the special circumstances appeal process (see [Appendix D.7](#)). The appeal must clearly demonstrate that vegetated facilities (including ecoroofs) have been considered before the offsite management fee will be considered.

Design Requirements

The following criteria apply to control structure design:

- Weir and orifice structures must be enclosed in a catch basin, manhole, or vault and must be accessible for maintenance.
- The control structure shall be designed to pass the 100-year storm event as overflow, without causing flooding of the contributing drainage area.

The methods and equations for the design of flow-restricting control structures, for use with extended wet detention ponds, and dry detention ponds are described below.

Orifices

- Orifices may be constructed on a “tee” riser section (see [Appendix G.2 SW-263](#)) or on a baffle (see [Appendix G.2 SW-264](#)).
- The minimum allowable diameter for an orifice used to control flows in a public improvement is 2 inches. Private facilities may use a 1-inch-diameter orifice if additional clogging prevention measures are implemented. The orifice diameter shall always be greater than the thickness of the orifice plate.

- Multiple orifices may be necessary to meet the 2- through 25-year design storm performance requirements for a detention system. However, extremely low flow rates may result in the need for small orifices (< 1 inch for private facilities, < 2 inches for public) that are prone to clogging. In these cases, retention facilities that do not rely on orifice structures shall be used to the maximum extent practicable to meet flow control requirements (see [Section 1.3.2](#)). Where this is not practicable, the applicant must pay the offsite management fee rather than constructing a flow control facility. Large projects may also result in high flow rates that necessitate excessively large orifice sizes that are impractical to construct. In such cases, several orifices may be located at the same elevation to reduce the size of each individual orifice.
- Orifices shall be protected within a manhole structure or by a minimum 18-inch-thick layer of 1½- to 3-inch evenly graded, washed rock. Orifice holes shall be externally protected by stainless steel or galvanized wire screen (hardware cloth) with a mesh of ¾ inch or less. Chicken wire shall not be used for this application.
- Orifice diameter shall be greater than or equal to the thickness of the orifice plate.
- Orifices less than 3 inches shall not be made of concrete. A thin material (e.g., stainless steel, HDPE, or PVC) shall be used to make the orifice plate; the plate shall be attached to the concrete or structure.

Orifice Sizing Equation:

$$Q = C A \sqrt{2gh}$$

where:

Q = Orifice discharge rate, cubic feet per second (cfs)

C = Coefficient of discharge, feet (suggested value = 0.60 for plate orifices)

A = Area of orifice, square feet

h = hydraulic head, feet

g = 32.2 ft/sec²

The diameter of plate orifices is typically calculated from the given flow. The orifice equation is often useful when expressed as an equivalent orifice diameter in inches.

$$d = \sqrt{\frac{36.88 Q}{\sqrt{h}}}$$

where:

Q = flow, cfs
d = orifice diameter, inches
h = hydraulic head, feet

Rectangular Notched Sharp Crested Weir:

$$Q = C(L - 0.2H) * H^{1.5}$$

where:

Q = Weir discharge, cfs
C = $3.27 + 0.40 \times H/P$, feet
P = Height of weir bottom above downstream water surface, feet
H = Height from weir bottom to crest, feet
L = Length of weir, feet*

* For weirs notched out of circular risers, length is the portion of the riser circumference not to exceed 50 percent of the circumference.

V-Notched Sharp Crested Weir:

$$Q = C_d \left(\tan \frac{\theta}{2} \right) H^{\frac{5}{2}}$$

where:

Q = Weir discharge, cfs
C_d = Contraction coefficient, feet (suggested value = 2.5 for 90 degree weir)
θ = Internal angle of notch, degrees
H = Height from weir bottom to crest, feet

- **Outlet/overflow:**

- If a riser pipe outlet is used, it shall be protected by a trash rack and anti-vortex plate. If an orifice plate is used, it shall be protected with a trash rack with at least 10 square feet of open surface area. In both cases, the rack must be hinged or easily removable to allow for cleaning. The rack shall be adequately secured to prevent it from being removed or opened when maintenance is not occurring.
- All ponds shall have an emergency overflow spillway or structure designed to convey the 100-year, 24-hour design storm for postdevelopment site conditions, assuming the pond is full to the overflow spillway or structure

crest. The overflow shall be designed to convey these extreme event peak flows around the berm structure for discharge into the downstream conveyance system. The overflow shall be designed and sited to protect the structural integrity of the berm. This will ensure that catastrophic failure of the berm is avoided, property damage is avoided, and water quality of downstream receiving water bodies is protected (see [Appendix G.2](#), SW-232).

- The subgrade of the spillway shall be set at or above the 100-year overflow elevation of the control structure. The spillway shall be located to direct overflows safely toward the downstream conveyance system and shall be located in existing soil wherever feasible. The emergency overflow spillway shall be armored with riprap or other flow-resistant material that will protect the embankment and minimize erosion. Riprap shall be designed in conformance with [Section 2.3](#) and shall extend to the toe of each face of the berm embankment. The emergency overflow spillway weir section shall be designed for the maximum design storm event for postdevelopment conditions, using the following formula:

$$L = \frac{Q_{100}}{3.21H^{1.5}} - 2.4 H$$

where: L = Length of bottom of weir, feet
 Q₁₀₀ = 100-year postdevelopment flow rate, cfs
 H = Height of emergency overflow water surface, feet

- **Berm embankment/soil stabilization:**

- Pond berm embankments shall be designed by a civil engineer licensed in the State of Oregon.
- Pond berm embankments shall be constructed on native consolidated soil (or compacted and stable fill soil) that is free of loose surface soil materials, roots, and other organic debris. Topsoil is required over the consolidated soil to support required plantings.
- Pond berm embankments shall be constructed by excavating a key equal to 50 percent of the berm embankment cross-sectional height and width, measured through the center of the berm. The berm must be keyed into the native soil by excavating a trench below the berm. This keys the berm into the native soil and prevents it from sliding.
- The berm embankment shall be constructed of compacted soil (95 percent maximum dry density, Modified Proctor Method per ASTM D1557) placed in

- 6- to 8-inch lifts with hand-held equipment, or 10- to 12-inch lifts with heavy equipment.
- Anti-seepage collars shall be placed on outflow pipes in berm embankments that impound water greater than 8 feet in depth (see [Appendix G.2](#), SW-233). During construction, exposed earth on the pond side slopes shall be sodded or seeded with appropriate seed mixture. Establishment of protective vegetative cover shall be ensured with appropriate surface-protection best management practices (BMPs) and reseeded as necessary. See the City of Portland’s *Erosion Control Manual*.
 - Pond embankments shall be constructed with a maximum slope of 3H: 1V on the upstream and downstream face. Side slopes within the pond shall be sloped no steeper than 3H: 1V. The use of retaining walls in ponds requires preapproval from BES. Retaining walls shall not exceed one-third of the circumference of the pond. Detailed structural design calculations must be submitted with every retaining wall proposal.
 - Pond berm embankments 6 feet or less in height (including freeboard), measured through the center of the berm, shall have a minimum top width of 6 feet, or as recommended by a geotechnical engineer.
 - Where maintenance access is provided along the top of berm, the minimum width of the top of berm shall be 15 feet.
 - **Growing medium:** Because pond grading generally requires the topsoil to be removed to form the basin shape of the pond, the resulting top layers of soil must be amended, or topsoil must be brought back in to ready the soil for planting. Topsoil shall be used within the top 12 inches of the facility, or the soil shall be amended per [Appendix F.3](#) to support plant growth.
 - **Vegetation:** The planting design shall minimize solar exposure of open water areas. Trees or other appropriate vegetation shall be located around the east, south, and west sides of the facility to maximize shading. Reducing solar exposure has two benefits: it helps reduce heat gain in water before discharging to a receiving water, helping it maintain a healthy and aesthetic pond condition, reducing algae blooms and the potential for anaerobic conditions to develop.

The facility area is equivalent to the area of the pond, including bottom and side slopes, plus the 10-foot buffer around the pond. The emergent plant zone shall be at least 25 percent of the total pond water surface area. Minimum plant material quantities are shown in [Exhibits 2-28 and 2-29](#).

Exhibit 2-28: Pond Vegetation - Emergent Plants

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
115	Wetland plants	100	6" plugs	1'
OR				
100	Wetland plants	100		1'
4	Small shrubs	100	1 gallon	3'
OR				
100%	Seed coverage			

Exhibit 2-29: Pond Vegetation – Side Slopes and Buffer

Number of plants	Vegetation type	Per square feet	Size	Spacing density (on center)
1	Evergreen tree	300	Min height 6'	-
OR				
1	Deciduous tree	300	Min caliper 1 ½" at 6" above base	-
AND				
4	Large shrubs	100	3 gallon or equivalent	4'
6	Medium to small shrubs	100	1 gallon or equivalent	2'
70	Groundcover	100	1 gallon or equivalent	1'

See [Appendix F.4](#) for more information.

Wildflowers, native grasses, and groundcovers used for BES-maintained facilities shall not require mowing. Where mowing cannot be avoided, facilities shall be designed to require mowing no more than once or twice annually. Turf and lawn areas are not allowed for BES-maintained facilities; any exceptions require BES approval.

- **Fencing and signage:** Fences are required for all City-maintained ponds with a permanent or temporary pool greater than 18 inches deep, interior side slopes steeper than 3H: 1V, or any walls/bulkheads greater than 24 inches high. The design shall address screening requirements for fencing. Fencing for privately owned facilities is at the discretion of the owner. The owner may, however, want to use the criteria for City-maintained facilities.

For both private and City-maintained facilities, Title 33 may prohibit fencing or require screening in some locations. The designer is responsible for determining which sections of Title 33 apply to the project. If fencing is prohibited by Title 33, the designer may have to modify the facility or site design to provide an alternate means of securing the site (for example, reducing the depth of water or side slopes of the facility to minimize safety concerns).

For both private and City-maintained facilities where fencing is used, fences shall be at least 6 feet high. The 6-foot height may not be required in situations where fences are not needed to prevent climbing (e.g., on steep slopes where they are needed to prevent slipping). For City-maintained facilities, a minimum of one vehicular locking access gate shall be provided. It shall be 10 feet wide, consisting of two swinging sections each 5 feet wide. At least one pedestrian gate shall be provided, with a minimum 4-foot width.

Fencing materials shall be complementary to the site design. If chain link fencing is proposed for a City-maintained facility, it shall be specified in accordance with the City of Portland *2007 Standard Construction Specifications*.

Submittal Requirements

Ponds require the applicant to submit the stormwater management plan under the Performance Approach. In addition to the submittal requirements included in the Stormwater Management report, all plans must show:

- facility dimensions and setbacks from property lines and structures
- profile view of facility, including typical cross-sections with dimensions
- all stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection

Additional information may be required on the drawings during permit review, depending on individual site conditions.

Maintenance

Access routes to the pond for maintenance purposes must be shown on the plans. Public ponds must provide a minimum 8-foot-wide access route, not to exceed 10 percent in slope.

See **Appendix G.2**, SW-220 through SW-222, for typical sand filter details.

Facility Description

Sand filters, like planters, are structural landscaped reservoirs used to collect, filter, and infiltrate stormwater, allowing pollutants to settle and filter out as the water percolates through the sand and gravel. They can be constructed above, at, or below grade. Depending on site conditions, sand filters can be designed to completely infiltrate all the stormwater they receive or designed as flow-through facilities where only a portion of the flow is infiltrated, and overflow is directed to an approved discharge point.

If plants are used, sand filters can be used to help fulfill a site's required landscaping area requirement and should be integrated into the overall site design. Numerous design variations of shape, wall treatment, and planting scheme can be used to fit the character of a site.

Sand filters must be designed and submitted under the Performance Approach. (See **Section 2.2.3** for submittal requirements.) The facility must be able to provide pollution reduction of 70 percent TSS removal from 90 percent of the average annual runoff (as described in **Section 1.3.3**) and provide detention of the postdevelopment peak runoff rates to less than predevelopment peak runoff rates (as described in **Section 1.3.2**).

Design Requirements

- **Soil suitability:** Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to flow through the facility. See **Appendix F.2** for infiltration testing procedures. If the tested infiltration rate is greater than or equal to 2 inches per hour, the sand filter must overflow to a subsurface infiltration facility. If the tested infiltration rate is less than 2 inches per hour, the sand filter should be designed as a partial infiltration or flow-through facility, with an overflow to an approved discharge point.
- **Setbacks:** Infiltration sand filters typically have 5-foot setbacks from property lines and 10-foot setbacks from building foundations. No setbacks are required for lined flow-through sand filters where the height above finished grade is 30 inches or less. Lined flow-through sand filters can be used next to foundation walls, adjacent to property lines, or on slopes. See **Exhibit 2-1** for more information on setbacks.
- **Access:** Design must consider safe access for maintenance of the facility.

- **Sizing:** Sand filters must be designed to meet the stormwater management requirements as specified in [Sections 1.3](#) and [2.2.3](#). Sand filters shall be designed to pond water for less than 4 hours after each storm event.
- **Dimensions and slopes:** The minimum flow-through sand filter width is 18 inches, and the minimum infiltration planter width is 30 inches. The minimum sand filter depth is 18 inches. Sand filters are relatively flat facilities that shall not slope more than 0.5 percent in any direction. Where the facility is at or above grade, the storage depth must be at least 12 inches between the top of the filter medium and the base of the overflow, unless a larger-than-required planter square-footage is used. For subgrade facilities, the filter medium must be 30 inches deep, with 8 inches of gravel above and below for conveyance. A minimum of 2 inches of freeboard (vertical distance between the overflow inlet elevation and overtopping elevation) shall be provided.
- **Planter walls:** Planter walls shall be made of stone, concrete, brick, or other durable material. For planters that require an impervious bottom, a single-pour concrete solution is preferred. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater shall not be used.
- **Waterproofing (if required):** Flow-through facilities require an impervious bottom, achieved through either a waterproof liner (geomembrane) or a single-pour concrete box. If lined, there are many liner options and installation varies. Liners should be installed to the high water mark. Liner shall be 30 to 40-mil PVC or HDPE as appropriate or approved equivalent.
- **Gravel drain rock:** Drain rock is required below the sand. For infiltration facilities where drain rock is specified to retain stormwater prior to infiltration, the specification is 1½-to ¾-inch washed drain rock. Where drain rock is specified primarily for detention and conveyance, the specification is ¾-inch washed drain rock. All flow-through facilities shall use ¾-inch wash drain rock. Drain rock and growing medium must be separated by filter fabric (see [Exhibit 2-4](#) for geotextile specifications) or use a 2- to 3-inch layer of ¾- to ¼-inch washed, crushed rock. Green streets require ¾ inch No 4 open aggregate 3 inches in depth.
- **Piping:** For private property, piping shall be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise, a 4-inch pipe minimum is required. Piping installation must follow current Uniform Plumbing Code. For streets, 6-inch or 8-inch ASTM 3034 SDR 35 PVC pipe and perforated pipe are required. Refer to the *City's Sewer and Drainage Facilities Design Manual* for more information.

Where a collector manifold with perforated lateral branch lines is used, lateral branch line spacing shall not exceed 10 feet. The underdrain laterals shall be placed with positive gravity drainage to the collector manifold. The collector manifold shall have a minimum 1 percent grade toward the discharge joint. All laterals and collector manifolds shall have cleanouts installed, accessible from the surface without removing or disturbing filter media.

- **Vegetation:** Plantings are recommended in sand filters. Plants enhance infiltration, prevent erosion, and compete with weeds.

For public sand filters, the following additional criteria apply:

The sand filter must consist of an inlet structure, sand bed, underdrain piping, and liner. Criteria for the inlet structure and sand bed are provided below.

- The **inlet structure** shall spread the flow of incoming water uniformly across the surface of the filter medium during all anticipated flow conditions. This flow shall be spread in a manner that prevents roiling or otherwise disturbing the filter medium.
- **Sand bed:**
 - The length-to-width ratio shall be 2:1 or greater.
 - The effects of consolidation and/or compaction must be taken into account when placing medium materials. The surface of the filter medium shall be level.
 - Sand used as filter bed medium shall be certified by a testing laboratory as meeting or exceeding the filter bed specifications presented below.
 - **Filter bed** medium shall consist of clean medium to fine sand with no organic material or other deleterious materials, and shall meet the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8"	100
#4	95-100
#8	80-100
#16	45-85
#30	15-60
#50	3-15
#100	< 4

Submittal Requirements

Sand filters require the applicant to submit the stormwater management plan under the Performance Approach.

Construction Considerations

Special attention should be paid to structural waterproofing if the facility is constructed adjacent to building structures. The location of the infiltration sand filter shall not be subject to compaction prior to, during, and after the construction of the facility.

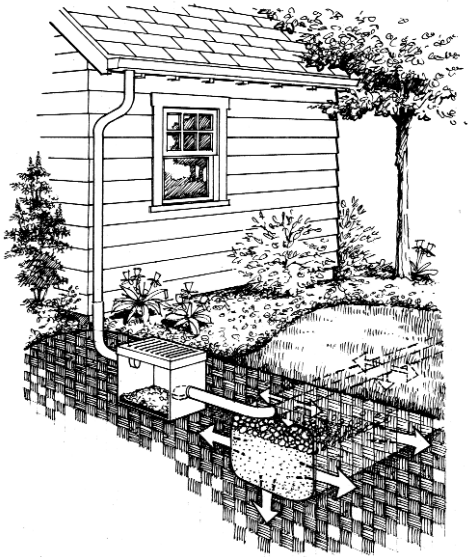


Exhibit 2-30: Soakage Trench illustration. See **Appendix G.1**, SW-180 and SW-181, for typical soakage trench details.

Facility Description

A soakage or infiltration trench is a shallow trench in permeable soil that is backfilled with washed drain rock. The trench surface may be covered with grass, stone, sand, or plantings. Private soakage trenches can be used to provide stormwater discharge by collecting and recharging stormwater runoff into the ground. The use of soakage trenches is highly dependent on the soil type and height of the groundwater table. Soakage trenches are not allowed in the right-of-way.

Note: Soakage trenches are “Class V Injection Wells” under the federal UIC Program. These facilities must be registered with DEQ and classified as exempt, authorized by rule, or authorized by permit. Since the UIC Program states that these types of trenches can have a direct impact on groundwater, pollution reduction is required before discharging stormwater into them (unless they are used exclusively for residential roof runoff from three units or less).

For more information about the UIC requirements, refer to **Section 1.4** or visit DEQ's website: <http://www.deq.state.or.us/wq/uic/uic.htm>. For technical questions call the DEQ-UIC Program at 503-229-5886. For copies of applications or forms, call 503-229-5189. Any modification to a trench that functions as a UIC must have prior approval from DEQ before modifications are made. Modifying any DEQ-approved soakage trench without DEQ approval voids the original approval.

There are two soakage trench configurations, one for the east side of the City and one for the west side. The distinction between east and west side soakage trenches is based on soil type and site characteristics rather than orientation to the Willamette River. The west side is often characterized with Cascade, Cornelius, and Powell silt loams where soils are “somewhat poorly drained” (*Soil Survey of Multnomah County, Oregon, 1983*) and frequently steeply sloped. The east side is dominated by the “well-drained” Multnomah and Latourell loams and silt loams. The use of east and west side design specifications is based on site conditions, not necessarily geographic location.

Soakage trenches are excluded from use within the Columbia South Shore and Cascade Station/Portland International Center Plan Districts (see [Exhibit 1-8](#)). See [Section 4.3](#) for areas affected by source control requirements. Additional requirements may be applicable within Wellhead Protection Areas. Complete Wellhead Protection Area requirements can be found online at <http://www.portlandoregon.gov/water/29890>.

Design Requirements

- The maximum impervious area to be served by a soakage trench is 10,000 square feet.
- Trenches shall not be constructed under current or future impervious surfaces.
- All trenches shall be constructed in native soil and shall not be subject to vehicular traffic or construction work that will compact the soil, thus reducing permeability.
- Minimum drawdown time for a soakage trench is 10 hours.
- **Soil suitability:** Soil conditions are critical to the success of soakage trenches. Submission of infiltration test results is required and must be approved by BES. Infiltration test results must be recorded on the Simplified Approach Form where the Simplified Approach is applicable and otherwise in the Stormwater Management Report (see [Appendix D.3 and D.4](#)). Supporting geotechnical analysis is required for slopes of 20 percent or greater, or when requested.
 - A 2-inch/hour infiltration rate is required at the facility base.
 - There must be a 5-foot separation distance from the bottom of the trench to any impervious layer or water table. Soakage trenches are not allowed in areas of shallow groundwater where the separation distance from the bottom of the trench to seasonally high groundwater is less than 5 feet.
- **Setbacks:** Soakage trenches typically have 5-foot setbacks from property lines and 10-foot setbacks from building foundations, unless an appeal is approved by

BDS. One hundred-foot setbacks are typical for slopes 20 percent or greater. See [Exhibit 2-1](#) for more information on setbacks.

- **Sizing:** Simplified trench sizing is based on treating 90 percent of the average annual runoff, which is a storm event of 1.8 inches of precipitation as described in a storm analysis of City of Portland precipitation (see [Appendix E](#)). The sizing of trench facilities varies, based on site conditions.

Soakage trench sizing is based on the SBUH method, with a 24-hour NRCS type 1A hyetographic distribution. East- and west-side trenches are designed with infiltration rates of 2.00 inches and 0.85 inch per hour, respectively. Pore space of the fill material was assumed to be 30 percent, with vertical infiltration area only. The trench shall infiltrate the entire design storm without overflow.

[Exhibit 2-31](#) shows soakage trench dimensions.

Exhibit 2-31: Soakage Trench Dimensions

Trench Type	Area Ratio	Sizing based on 1000 sf			Design Infiltration Rate (in/hr)
		Length (ft)	Width (ft)	Height (ft)	
East Side	5%	20	2.5	1.5	2.00
West Side	9%	30	3.0	1.0	0.85

Area ratio = 100 x area of trench/impervious area treated
Trench size is the product of the impervious area treated and the area ratio (1000sf x 0.09 = 90sf)

- **Gravel drain rock:** A minimum of 12 or 18 inches of washed ¾- to 2½-inch round or crushed rock separated from soil by one layer of filter fabric depending on trench type.
- **Filter fabric (if required):** See [Exhibit 2-3](#) for geotextile specifications.
- **Piping:** The solid conveyance piping from a building or other source must be installed at a ¼-inch per linear foot slope prior to connection with perforated pipe.
 - A minimum 12-inch cover is required from the top of all piping to the finished grade.
 - All piping within 10 feet of a building must be 3-inch sch. 40 ABS, sch. 40 PVC, or cast iron for rain drain piping serving 1,500 square feet or less of

- impervious area. For an area greater than 1,500 square feet, 4-inch pipe must be used.
- The pipe within the trench shall be either PVC D2729 or HDPE leach field pipe.
 - Perforated pipe shall be laid on top of gravel bed and covered with filter fabric.
 - Optional silt traps will greatly extend the life of the soakage trench. The silt trap shall be installed between the dwelling and the trench, a minimum of 5 feet from the dwelling.

Gravel Pits

Gravel pits shall be sized and permitted the same as soakage trenches but can only treat up to 250 square feet.

Manufactured Chamber Technologies

Corrugated plastic stormwater chambers are generally made of high-density polypropylene or polyethylene. They are arched systems that can be rated for H-10 or H-20 loading, depending on the manufacturer, amount of cover, and type of cover.

Chamber systems function similarly to the standard soakage trench, but are often used in areas with limited infiltration because of high groundwater or shallow (<5 feet) infiltration barriers such as dense silt and clay layers. They provide temporary storage of stormwater prior to infiltration and may be able to be used with soils that infiltrate less than 2 inches per hour, with BES approval. Chambers are UICs and require DEQ registration (unless they are used exclusively for residential roof runoff from three units or less).

Sizing: Where the Simplified Approach can be used, the chambers must be designed to at least the same requirements as trenches. Chamber sizing shall be based on treating 90 percent of the average annual runoff, which is a storm event of 1.8 inches of precipitation as described in a 2004 storm analysis of City of Portland precipitation (see [Appendix E](#)). The sizing below is based on the SBUH method with a 24-hour NRCS type 1A hyetographic distribution. The east and west sides are designed with infiltration rates of 2.00 inches and 0.85 inch per hour, respectively. Pore space of the fill material is assumed to be 0.30. [Exhibit 2-32](#) shows manufactured chamber technologies dimensions.

Exhibit 2-32: Manufactured Chamber Technologies Dimensions

Soil Type	Area Ratio	Sizing Based on Standard Chamber Size			Design Infiltration Rate (in/hr)
		Length (10)	Width (in)	Height (in)	
East Side Chamber	1 per 600 sf IA*	~90	34	16 + 6" base rock	2.00
West Side Chamber	1 per 400 sf IA	~90	34	16 + 6" base rock	0.85

*IA = Impervious area treated

Setbacks: Manufactured chambers are typically 10 feet on center from all foundations and 5 feet from property lines. See [Exhibit 2-1](#) for more information on setbacks.

Fill: Six inches of washed drain rock is required below chamber. Additional depth or length will be required for infiltration rates less than the infiltration rates specified.

Construction Considerations

- Soakage trench areas shall be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular construction traffic, except that specifically used to construct the facility, shall be allowed within 10 feet of soakage trench areas.
- The bottom of the soakage trench shall be level, or clay check dams may be used to prevent water from collecting near the downstream end.
- The drain medium shall have filter fabric between the medium and native soils and covering the perforated pipe to prevent clogging.
- Soakage trench and perforated pipe must be installed level and parallel to the contour of the finish grade.

Resources

- Refer to OAR 340, Division 44: *Construction and Use of Waste Disposal Wells or Other Underground Injection Activities*, for additional design and regulatory requirements.

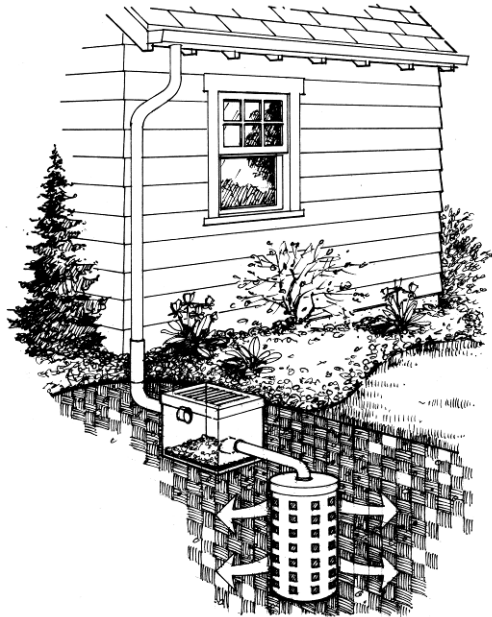


Exhibit 2-33: Drywell illustration. See [Appendix G.1](#), SW-170, for typical drywell details.

Facility Description

The typical drywell is a precast concrete ring in 5-foot-tall sections perforated to allow for infiltration. These facilities are vertical in nature and can range from just a few feet in depth to 20 feet in depth (see Exhibit 2-34 for sizing drywells). Drywells require a minimum of 5 feet of vertical separation between the bottom of the drywell and seasonal high groundwater (see Appendix F.1 for determining depth to groundwater). Drywells should not be located in dense silt or clay soils, and may only be located in areas with soils suitable for infiltration (see Design Requirements and Drywell Testing Procedures in the following sections).

Note: Drywells are "Class V Injection Wells" under the federal UIC Program. These facilities must be registered with DEQ and classified as exempt, authorized by rule, or authorized by permit. Since the UIC Program states that these types of wells can have a direct impact on groundwater, pollution reduction is required before discharging stormwater into them (unless they are used exclusively for residential roof runoff from three units or less).

For more information about UIC requirements, refer to [Section 1.4](#) or visit DEQ's website: <http://www.deq.state.or.us/wq/uic/uic.htm>. For technical questions, call the DEQ-UIC Program at 503-229-5886. For copies of applications or forms, call 503-229-5189. Any modification to a drywell that functions as a UIC must have prior approval from DEQ before modifications are made. Modifying any DEQ-approved drywell without DEQ approval voids the original approval.

Drywell systems are prohibited from use within the Columbia South Shore and Cascade Station/Portland International Center Plan Districts (see [Exhibit 1-8](#)). Additional requirements may be applicable within designated Wellhead Protection Areas. Complete Wellhead Protection Area requirements can be found at <http://www.portlandoregon.gov/water/29890> See [Section 4.3](#) for areas affected by source control requirements.

Design Requirements

- **Soil suitability:** Soil conditions are critical to the success of drywells. Because of this, an infiltration test or bore-log feasibility test must be performed and the results submitted to BES for approval. The Simplified Approach Form (See [Appendix D.3](#)) must be completed and signed by the applicant, where applicable; otherwise, the sizing and infiltration must be accounted for in the Stormwater Management Report. Drywells should be used only if the soils infiltrate at least 2 inches per hour or with documented approval from BES. Installation of drywells in fill material is not permitted. All drywells must be installed in native soils. Supporting geotechnical evidence is required for all slopes of 20 percent or greater or when requested.
- **Setbacks:** The drywell is typically 10 feet on center from all foundations and 5 feet from property lines. The top of the drywell shall be located downgrade from foundations and at a lower elevation than local basements. See [Exhibit 2-1](#) for more information on setbacks.
- **Sizing:** The chart provided in [Exhibit 2-34](#) shall be used to appropriately size the drywell(s), based on the amount of impervious area that each drywell is

designed to manage. This chart shall be used as guidance. It is based on field experience and should be used as minimums only.

- **Traps:** Silt traps are not required to be installed with drywells, but are strongly encouraged because they will lengthen the life of the facility.

Exhibit 2-34: Drywell Sizing Chart

Drywell Sizing: Once BES has issued approval for on-site infiltration, the following chart shall be used to select the number and size of drywells. Gray boxes indicate acceptable.

Impervious Area (sq-ft)	28" Diameter				48" Diameter			
	Drywell Depth				Drywell Depth			
	5'	10'	15'	20'	5'	10'	15'	20'
1000								
2000								
3000								
4000								
5000								
6000								
7000								
8000								
9000								
10000								
11000								
12000								
13000								
14000								
15000								
16000								
17000								
18000								
19000								
20000								

Manufactured Plastic Drywells

Manufactured plastic “mini-drywells” are made of hard plastic (foam polyolefin) and are very versatile. The excavations for these facilities can be hand-dug, the setbacks are not as great as typical drywells, and the drywells can be placed by hand rather than using equipment (as with typical concrete drywells).

Dimensions: 2-foot diameter, 2-foot depth, plus 1-foot gravel lens below and on the sides.

Sizing: 1 unit for every 500 square feet of impervious area, with BES approval.

Setbacks: From center: 5 feet to property line, 8 feet to any foundation, and 20 feet to existing cesspools.

Resources

Refer to OAR 340, Division 44: *Construction and Use of Waste Disposal Wells or Other Underground Injection Activities*, for additional design and regulatory requirements.

City of Portland Groundwater Protection Program
<http://www.portlandoregon.gov/water/29890>

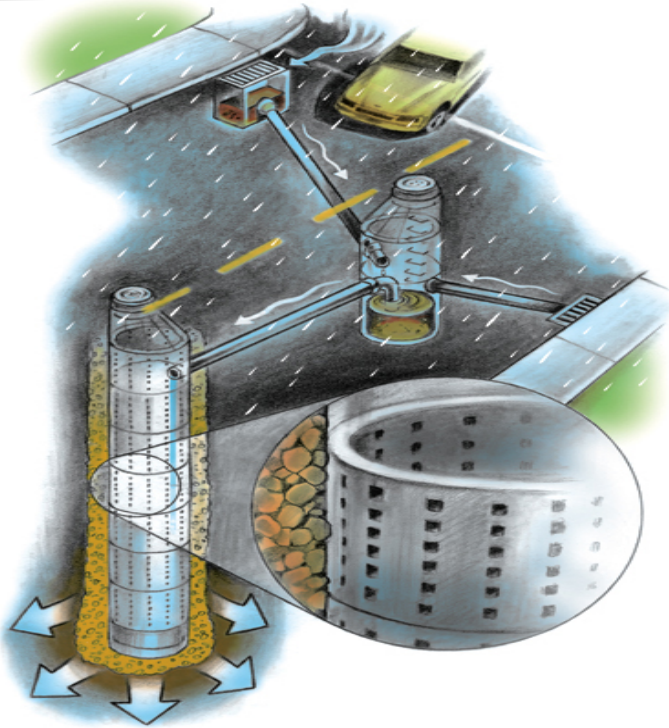


Exhibit 2-36: Sump Illustration. See City of Portland **Standard Plans 4-10 and 4-11** for typical details.

Facility Description

Public infiltration sump systems can be used to provide drainage from City-owned streets by collecting stormwater and infiltrating it into the ground. The use of sumps is dependent on soil type and depth to seasonal groundwater. Sumps are different from drywells in that they are designed using precast 4-foot-diameter concrete rings with perforations, typically 30 feet deep and located in the public right-of-way. Like drywells, sumps require a minimum 5 feet of vertical separation between the bottom of the sump and seasonal high groundwater.

Note: Sumps are "Class V Injection Wells" under the federal UIC Program. These facilities must be registered with DEQ and authorized by rule or authorized by permit. In the case of public sumps, BES administers the rule authorization process with DEQ. Because sumps can have a direct impact on groundwater, pollution reduction is required before discharging stormwater into them.

See [Section 1.4](#) for more information about UIC requirements or visit DEQ's website: <http://www.deq.state.or.us/wq/uic/uic.htm>. For technical questions, call the DEQ-UIC Program at 503-229-5886. For copies of applications or forms, call 503-229-5189. Any modification to a sump that functions as a UIC must have prior approval from

DEQ before modifications are made. Modifying any DEQ-approved sump without DEQ approval voids the original approval.

A sump system is the total of all sump components at a single location (e.g., an intersection) and consists of inlets, piping, a sedimentation manhole, and a sump. If one sump lacks adequate capacity to handle the design flow, a second sump may be placed in series with the first to provide additional capacity.

Sedimentation manholes with oil traps receive runoff from inlets before stormwater enters the sumps. The sedimentation manholes settle out most of the large particulate material that can clog sump drainage holes, which decreases maintenance needs and increases long-term effectiveness. Detailed drawings of a standard sump and standard sedimentation manhole can be found in the *Portland Office of Transportation Standards for Construction: Standard Drawings Environmental Services 4-10 (Sump) and 4-11 (Sedimentation Manhole)*.

When constructed according to the standard design procedures, the sump system achieves both flow control and pollution reduction benefits. The sedimentation manhole reduces pollution through removal of sediment, oils, and grease. Other types of pollution reduction facilities (e.g., swales or planters) may be used instead of sedimentation manholes. Additional pollution reduction facilities, such as street swales, planters, or filters, must be used in nonresidential streets or streets with over 1,000 average daily trips.

Design Requirements

Sumps are recognized as a disposal method for managing stormwater runoff. Sump systems are excluded from use within the following specific areas and land use types within the City:

- Columbia South Shore and Cascade Station/Portland International Center Plan Districts (see [Section 1.3.4](#)).
 - Major City traffic streets (including district collectors) in combined sewer areas, or neighborhood collectors in commercially zoned areas (Refer to *Transportation Element, Comprehensive Plan, Office of Transportation, 2000*).
 - Additional requirements may be applicable within designated Wellhead Protection Areas. Complete Wellhead Protection Area requirements can be found at <http://www.portlandoregon.gov/water/29890>.
 - See [Section 4.3](#) for areas affected by source control requirements.
-
- **Soil suitability:** Soil conditions are critical to the success of sump systems. The use of sumps will not be approved without supporting geotechnical evidence and a documented sump test to demonstrate they will work in the particular area of interest. The geotechnical evidence shall include test sump data to provide

information about local underground soil conditions and the potential infiltration capacity of the surrounding soil.

- **Sizing:** Public sump systems shall be designed to handle **twice** the flow from the calculated design storm.
- **Dimensions:**
 - A maximum of two sumps shall be used in series, unless approved by BES.
 - The minimum distance between sumps shall be 25 feet.
 - The desired distance between the sump and sedimentation manhole is 25 feet. This figure is a guideline and depends on site conditions.
 - Sumps shall not be located in areas with a constant or seasonally high groundwater table or shallow bedrock. The bottom of the sump shall be at least 5 feet above the seasonal high water table and at least 3 feet above bedrock.
 - Sumps shall not be located within 200 feet from the tops of slopes more than 10 feet high and steeper than 2h:1v.
 - The sump depth shall be 30 feet, unless otherwise approved by BES.
 - The sedimentation manhole depth shall be 10 feet.
- **Piping:**
 - The diameter of pipe between the sump and sedimentation manhole shall be 12 inches. (Note: The pipe leaving the sedimentation manhole is fitted with a 90-degree short-radius elbow. See City of Portland **Standard Plans 4-10** and **4-11**.)
 - See the City of Portland *Sewer and Drainage Facilities Design Manual* for acceptable pipe material types between the sump and sedimentation manhole.

Exhibit 2-37 provides standard sump notes.

SUMP NOTES for Plan Set

Design flows reflect a factor of safety of 2.

Design rates for the sump: _____

All sumps shall be tested by the contractor as directed and approved by the City inspector.

Sump testing shall take place after sump construction is complete and before the construction of the sedimentation manhole. Should a sump test fail to verify adequate capacity, an additional sump, constructed in series with the first sump (a maximum of two sumps per system) shall be required, as approved by BES. Should a test of two sumps in series fail to verify adequate capacity, an alternative public stormwater destination shall be required, as approved by BES.

Notify the BES inspector or BES construction office at 503-823-____ at least 48 hours before beginning sump testing. A BES representative must be present during all sump capacity tests.

Contractor shall contact the City Water Bureau or applicable water district to arrange for sump test water supply. Contractor shall be responsible for obtaining necessary permits, authorization, and any fees.

Contractor may lease sump testing equipment from the BES Materials Testing Laboratory, subject to leasing conditions and fees. Contact the laboratory, located at 1405 N. River, at 503-823-2340. Similar testing equipment from any vendor may be used, as approved by BES.

Provide water flow from fire hydrants to sump being tested, using 8-inch nominal diameter pipe. Deliver clean potable water to the sump. Introduction of sediment is not acceptable and may result in failure of sump capacity test and reconstruction of the sump.

Fill the sump with water at an initial rate of 300 gallons per minute (gpm), and record water elevation below the sump manhole lid every 5 minutes. When the water surface reaches a constant elevation, increase the flow rate to sump to 600 gpm. Record the water surface elevations every 5 minutes. Continue to increase the flow rate 300 gpm each time water surface elevation stabilizes, until maximum capacity is reached.

Immediately upon completion of the sump test, provide the BES inspector with recorded test data. The contractor shall sign the results and submit to the BES inspector.

The closest fire hydrant for sump testing is located at the intersection of _____ & _____ . Contact the Water Bureau to apply for a hydrant use permit.

BES Construction Contact information: 503-823-_____

Public Sump System Testing

Before being accepted by the City, all public sumps shall be tested after construction to ensure they meet or exceed the design capacity.

- Hydraulic calculations for public sumps shall be performed using the Rational Method. Information on the use and application of the Rational Method is found in BES's *Sewer and Drainage Facilities Design Manual*.
- Sumps shall be designed for a 10-year design storm, with a safety factor of 2.
- The time of concentration for sump design shall be 5 minutes.

The City may require the applicant to supply a sump testing table to determine if the sump is performing as designed or if an additional sump may be required.

Exhibit 2-38 shows a sump testing example.

Exhibit 2-38: Sump Testing Example

Example:	What is the design percolation rate that a sump system must achieve to adequately dispose of runoff from 10,000 square feet of paved street area?
Rational Formula:	$Q=C \times I \times A$
Assume:	Time of concentration = 5 minutes for the street area
Where:	Q = Flow, cfs C = Runoff coefficient (0.9 for paved surfaces) I = Intensity (2.86 inches per hour for a 10-year storm event and a time of concentration of 5 minutes) A = Area in acres (10,000 square-feet = 0.23 acres)
	$Q = (0.9) \times (2.86) \times (0.23) = 0.59 \text{ cfs}$
Apply safety factor of 2:	$Q = 2 \times 0.59 \text{ cfs} = \mathbf{1.18 \text{ cfs or } 530 \text{ gallons per minute}}$
	See <i>Sewer and Drainage Facilities Design Manual</i> Table 6.11 for rainfall intensity duration frequency at Portland International Airport.

O&M Requirements

- The applicant or contractor is required to maintain the public infiltration sump system for 2 years after construction is complete and signed off by BES.
- Turbid runoff from construction sites shall not be allowed to enter the system at any time.
- The sedimentation manhole shall be cleaned prior to BES acceptance of ownership and maintenance at the end of the warranty period.

Facility Description

BES has developed “Submission Guidelines for Evaluating Manufactured Stormwater Treatment Technologies,” located in [Appendix B](#). For a manufactured stormwater treatment technology to be approved for general use within the City of Portland, the manufacturer must submit all documentation required to evaluate if the device meets Portland’s pollution reduction standards. This information will be reviewed by BES’s Approval Committee, which will decide whether or not the facility can be approved for general use or for use with conditions. The list of approved manufactured stormwater treatment technologies is posted on the BES website.

Manufactured stormwater treatment technologies on BES’s approved list must be designed and constructed in accordance with the manufacturer’s recommendations.

Manufactured stormwater treatment technologies on BES’s approved list for general use may not be capable of meeting specific TMDL requirements for certain watersheds. In that case, the treatment technology will not be accepted as a stand-alone pollution reduction facility. Instead, a pollution reduction facility presumed by BES to meet the TMDL requirement must be used.

Manufactured stormwater treatment technologies not on the approved list can be submitted using the Performance Approach.

Submittal Requirements

In addition to design calculations provided in the Stormwater Management Report (see [Appendix D.4](#) for Presumptive Approach Requirements), the following must be submitted with each project proposing use of a manufactured stormwater treatment technology:

- pollution reduction capacity of the facility
- flow-through conveyance capacity (i.e., how much flow can be passed through the facility without stirring up and releasing trapped pollutants)

The following additional information may be required, depending on site conditions.

- facility dimensions and setbacks from property lines and structures
- profile view of facility, including typical cross-sections with dimensions

- all stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection



Exhibit 2-39: Rigler Rainwater Harvesting. See [Appendix G.2](#), SW-250, for a typical rainwater harvesting detail.

Facility Description

Stormwater can be collected and reused for non-potable water uses within a house or building, or for landscape irrigation purposes. Uses can include reusing water in toilets (in multi-unit dwellings, a separate cistern is needed for each residence) and at hose bibs (a shared cistern can be used for landscape irrigation). All toilets and hose bibs must have permanent signage that notifies users of non-potable water. Any such system must obtain plumbing approval from BDS.

The Water Bureau's Water Quality Inspections group also requires system containment backflow protection in the form of a reduced pressure (RP) type of backflow assembly. System containment RPs must be located on private property at the property line, immediately adjacent to the point of water service connection.

Rainwater harvesting can provide the following stormwater management benefits:

- **Flow control:** In many areas of the City (including much of the downtown district and inner east side) where onsite infiltration is not feasible and the only means of stormwater destination is offsite flow to a combination sewer system, rainwater harvesting can provide flow-reduction benefits. Depending on the size

of the water storage facility and the rate of use, a percentage of the annual runoff volume can be reused. Where it is not feasible for rainwater harvesting to meet a development site's full flow control obligation, it can be used to manage a portion of the flow and lessen the overall flow control requirement.

- **Pollution reduction:** The reduction in offsite flow volume that can be achieved can also reduce the pollutants associated with stormwater.

Design Considerations

Exhibit 2-40 represents an analysis of a 5,000-square-foot project site with 100 percent impervious surface. The analysis used 8.5 months of 5-minute rainfall intensity data from the Fernwood rain gage in Portland and shows the relationship between water storage volume and average daily water use rate for average annual runoff capture goals of 30, 50, and 70 percent.

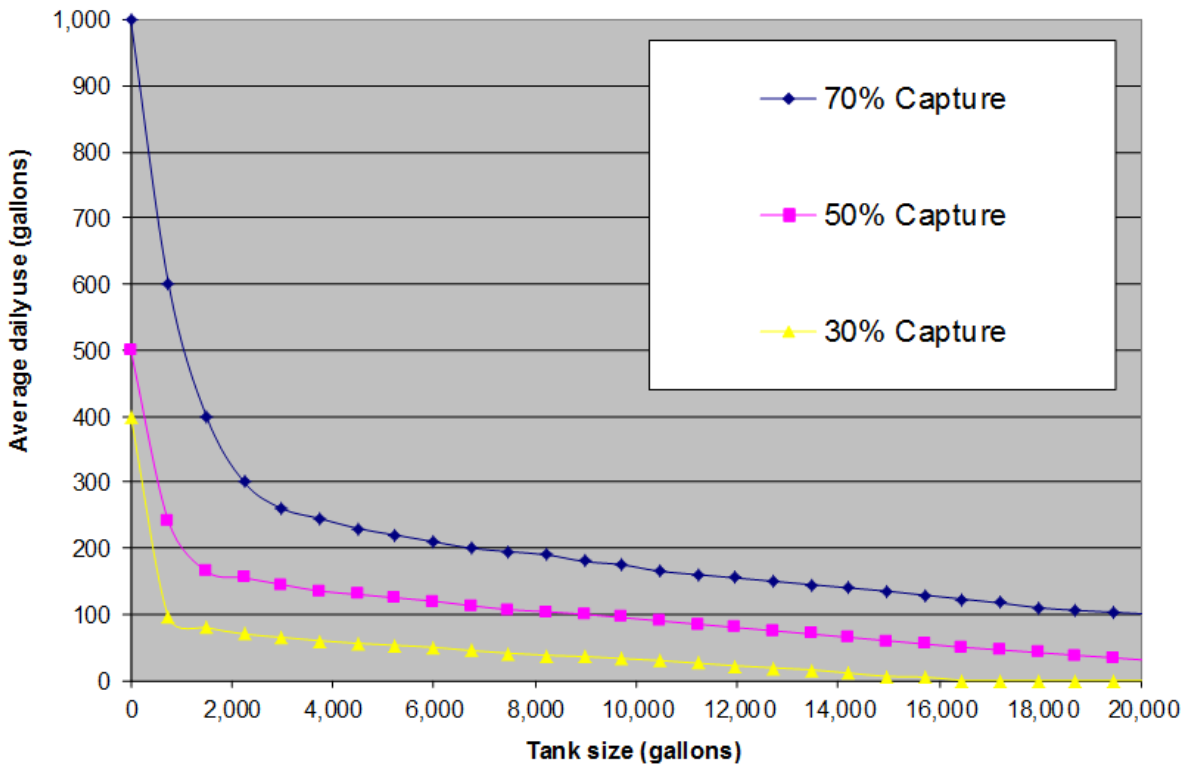
For example, if the stormwater management goal is 50 percent reduction of the annual release volume, the pink line shows that the average daily use would need to be approximately 160 gallons per day if a 2,000-gallon tank were used. A larger tank would need a smaller average daily use rate to achieve the same stormwater management goal of 50 percent annual volume reduction.

Submittal Requirements

Rainwater harvesting must be submitted in the Stormwater Management Plan under the Performance Approach. The following information must be included:

- tank size and material
- water storage facility details and specifications
- pollution reduction facility and efficiency details
- pump and associated electrical details and specifications
- piping size, material, and placement details and specifications
- average daily water use documentation
- hydraulic calculations demonstrating compliance with stormwater management requirements (pollution and flow control)
- approximate setbacks from property lines and structures
- overflow connection to approved stormwater destination, per **Section 1.3**
- property line system containment backflow protection in the form of a reduced pressure type of backflow assembly
- description of how the facility meets pollution reduction and flow control requirements

**Exhibit 2-40: Rainwater Harvesting: 5,000 Square-Foot Impervious Surface
Average Annual Stormwater Runoff Capture Rates**



Resources

The BDS website provides more information on reuse guidelines for interior use:
<http://www.portlandonline.com/shared/cfm/image.cfm?id=68621>.

For more Water Bureau information, refer to the Water Bureau website at
<http://www.portlandonline.com/water/index.cfm?c+29743>, or call 503-823-7336.

For information from the Oregon Specialty Plumbing Code, refer to the website:
<http://www.cbs.state.or.us/external/bcd/programs/plumbing/2008opsc.html>. See Appendix F.

See [Appendix G.2](#), SW-260 through SW- 265, for typical structural detention facility details.

Facility Description

Structural detention facilities such as tanks, vaults, and oversized pipes provide underground storage of stormwater as part of a runoff flow control system. As with any underground structure, they must be designed not only for their function as runoff flow control facilities, but also to withstand an environment of periodic inundation, potentially corrosive chemical or electrochemical soil conditions, and heavy ground and surface loadings. They must also be accessible for maintenance. Facilities in this section must be designed using acceptable hydrologic modeling techniques (see Section 2.2) to meet applicable flow control requirements. Additional facilities will be required to meet applicable pollution reduction requirements. Tanks and vaults can be used in conjunction with other detention storage facilities, such as ponds, to provide initial or supplemental storage.

Tanks and vaults typically do not have a built-in design feature for containing sediment, as do multi-cell ponds. Therefore, when tanks or vaults are used for detention storage, either a sedimentation manhole or surface sediment containment pond shall be placed upstream of the tank or vault, or the tank/vault shall be oversized to allow for the temporary accumulation of sediment. Maintenance is required to periodically remove sediment (See [Chapter 3](#) for O&M requirements).

Design Requirements

The following criteria apply to detention tank, vault, and oversized pipe design.

- All areas of a tank or vault shall be within 50 feet of a minimum 36-inch-diameter access entry cover. All access openings shall have round, solid locking lids.
- Publicly owned detention tanks, vaults, and pipes are permitted within public rights-of-way. If developments are served with publicly operated and maintained tanks and vaults that are not located within the right-of-way, the tanks/vaults shall be located in separate open space tracts with public sewer easements that are dedicated to the City of Portland. All privately owned and maintained facilities shall be located to allow easy maintenance and access. (See [Chapter 3](#), Operations and Maintenance)
- All tanks and vaults shall be designed as flow-through systems.

- Minimum size for a public detention pipe shall be 36 inches. If the collection system piping is designed also to provide storage, the resulting maximum water surface elevation shall maintain a minimum 1-foot of freeboard in any catch basin below the catch basin grate. Pipe capacity shall be verified using an accepted methodology approved by the City (see City of Portland's *Sewer and Drainage Design Manual*). The minimum internal height of a vault or tank shall be 3 feet, and the minimum width shall be 3 feet. The maximum depth of the vault or tank invert shall be 20 feet. Pipe material and surface treatment shall conform to the standards for detention tanks and vaults (see [Appendix G.2](#), SW-260 and SW-262).
- Where the tank or vault is designed to provide sediment containment, a minimum of ½ foot of dead storage shall be provided, and the tank or vault shall be laid flat (see [Appendix G.2](#), SW-260 and SW-262).
- To restrict flow rates, a flow control structure must be used (see specifications that follow).

Materials and Structural Stability:

- For public facilities, pipe materials and joints shall conform to the City of Portland *Sewer and Drainage Facilities Design Manual*. For private facilities, the pipe material shall conform to the Unified Plumbing Code.
- All tanks, vaults, and pipes shall meet structural requirements for overburden support and traffic loadings, if appropriate. H-20 live loads shall be accommodated for tanks and vaults under roadways and parking areas. End caps shall be designed for structural stability at maximum hydrostatic loading conditions.
- Detention vaults shall be constructed of structural reinforced concrete (3000 psi, ASTM 405). All construction joints shall be provided with water stops.
- In soils where groundwater may induce flotation and buoyancy, measures shall be taken to counteract these forces. Ballasting with concrete or earth backfill, providing concrete anchors, or other counteractive measures shall be required. Calculations shall be required to demonstrate stability.
- Tanks and vaults shall be placed on stable, consolidated native soil with suitable bedding. Tanks and vaults shall not be allowed in fill slopes, unless a geotechnical analysis is performed for stability and construction practices.

Flow Control Structures for Detention Systems

This section presents the methods and equations for the design of flow-restricting control structures, for use with structural detention facilities. It includes details and equations for the design of orifices and equations for rectangular sharp crested weirs and v-notch weirs.

Note: Because of minimum orifice size requirements (2 inches for public facilities, 1 inch for private facilities), detention facilities that rely on orifice structures to control flows for small projects (under 15,000 square feet of impervious development footprint area) are not allowed. In these cases, rather than constructing a detention facility onsite, the applicant may apply to pay an offsite management fee through an appeal process (see [Appendix D.7](#)). The appeal must clearly demonstrate that vegetated facilities (including ecoroofs) have been considered before the offsite management fee will be considered.

Design Requirements

The following criteria apply to control structure design:

- Weir and orifice structures must be enclosed in a catch basin, manhole, or vault and must be accessible for maintenance.
- The control structure shall be designed to pass the 100-year storm event as overflow, without causing flooding of the contributing drainage area.

Orifices

- Orifices may be constructed on a “tee” riser section (see [Appendix G.2 SW-263](#)) or on a baffle (see [Appendix G.2 SW-264](#)).
- The minimum allowable diameter for an orifice used to control flows in a public facility is 2 inches. Private facilities may use a 1-inch-diameter orifice if additional clogging prevention measures are implemented. The orifice diameter shall always be greater than the thickness of the orifice plate.
- Multiple orifices may be necessary to meet the 2- through 25-year design storm performance requirements for a detention system. However, extremely low flow rates may result in the need for small orifices (< 1 inch for private facilities, < 2 inches for public) that are prone to clogging. In these cases, retention facilities that do not rely on orifice structures shall be used to the maximum extent practicable to meet flow control requirements (see [Section 1.3.2](#)). Where this is not practicable, the applicant must pay the offsite management fee rather than constructing a flow control facility. Large projects may also result in high flow

rates that necessitate excessively large orifice sizes that are impractical to construct. In such cases, several orifices may be located at the same elevation to reduce the size of each individual orifice.

- Orifices shall be protected within a manhole structure or by a minimum 18-inch-thick layer of 1½ - 3-inch evenly graded, washed rock. Orifice holes shall be externally protected by stainless steel or galvanized wire screen (hardware cloth) with a mesh of ¾ inch or less. Chicken wire shall not be used for this application.
- Orifice diameter shall be greater than or equal to the thickness of the orifice plate.
- Orifices less than 3 inches shall not be made of concrete. A thin material (e.g., stainless steel, HDPE, or PVC) shall be used to make the orifice plate; the plate shall be attached to the concrete or structure.

Orifice Sizing Equation:

$$Q = C A \sqrt{2gh}$$

where:

Q = Orifice discharge rate, cfs

C = Coefficient of discharge, feet (suggested value = 0.60 for plate orifices)

A = Area of orifice, square feet

h = hydraulic head, feet

g = 32.2 ft/sec²

The diameter of plate orifices is typically calculated from the given flow. The orifice equation is often useful when expressed as an equivalent orifice diameter in inches.

$$d = \sqrt{\frac{36.88 Q}{\sqrt{h}}}$$

where:

Q = flow, cfs

d = orifice diameter, inches

h = hydraulic head, feet

Rectangular Notched Sharp Crested Weir:

$$Q = C (L - 0.2H) * H^{1.5}$$

where:

Q= Weir discharge, cfs

C = 3.27 + 0.40×H/P, feet

P = Height of weir bottom above downstream water surface, feet

H = Height from weir bottom to crest, feet

L = Length of weir, feet^{*}

* For weirs notched out of circular risers, length is the portion of the riser circumference not to exceed 50 percent of the circumference.

V-Notched Sharp Crested Weir:

$$Q = C_d \left(\tan \frac{\theta}{2} \right) H^{\frac{5}{2}}$$

where:

Q = Weir discharge, cfs

C_d = Contraction coefficient, feet (suggested value = 2.5 for 90 degree weir)

θ = Internal angle of notch, degrees

H = Height from weir bottom to crest, feet

Submittal Requirements

Structural detention facilities require the applicant to submit the Stormwater Management Plan under the Performance Approach. All plans must show:

- Facility dimensions and setbacks from property lines and structures.
- Profile view of facility, including typical cross-sections with dimensions.
- All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection.

Additional information may be required on the drawings during permit review, depending on individual site conditions.

Facility Description

Oil/water separator facilities are used for two main purposes: spill control (where a hazardous spill could contaminate downstream assets) and pollution reduction of runoff prior to discharge. All units use the same principles of separation and coalescence of oil/grease from water, which are based on the different properties of the miscible liquids. The result is distinct layers that can be discharged to separate disposal points. Source controls do not meet flow control or pollution reduction requirements, and additional stormwater management facilities must be used to meet those requirements.

There are various types of generally accepted oil/water separators, which are required for various kinds of applications. Oil/water separators must meet the design criteria in Section 4.3.3.

- Coalescing plate separators (CPS) and American Petroleum Institute (API) type separators (see Appendix G.5, SW-501) can provide separation of oil from water by providing additional coalescing surfaces and slower flows, respectively.
- API or spill control manholes must be used in the following applications:
 - fueling stations
 - wash racks/pads
- CPS units must be used in the following applications:
 - vehicle/heavy equipment repair, sales, or fueling yards,
 - impound yards
 - where high concentrations of oil or grease are expected to discharge to the storm-only sewer system

(See Section 1.3.3 and Sections 4.7 and 4.9.)

There may be other acceptable oil controls (e.g., oil/water separators), and applicants may propose an alternative oil control option. However, proposal of a new oil control will require an additional review process for approval, which may delay issuance of related building permits.

Design Considerations

The estimated peak stormwater flow rate dictates the number and size of separators needed on a site. The percent impervious surface, slope, average rainfall, and rainfall intensity are all factors in calculating the peak flow rate.

Several factors contribute to the capture efficiency of oil/water separators. These include placement, design, maintenance frequency, oil concentration, flow rate, pollutant loading, sedimentation rate, and particle size (sediment and oil).

The sump in a separator captures settleable solids under low flow conditions. Separators are not designed to remove TSS or soluble pollutants. Resuspension and discharge of sediments previously collected in these facilities is a potential problem during large storm events or “first flush” scenarios. In many units, efficiency can be improved by frequent maintenance and implementation of BMPs. See [Chapter 3](#) for O&M requirements, including BMPs.

Pollution Reduction Requirements

All types of oil/water separators must be used in combination with vegetated treatment systems, such as swales, ponds, or planters (as applicable to the requirements of this manual) to meet pollution reduction and flow control requirements prior to discharge. The type of separator and design requirements are prescribed in [Section 1.3.3](#) and [Section 4.3.3](#) of this manual and in Oregon State Plumbing Specialty Code. Source controls are required in areas designated for high-risk activities (i.e., fuel islands, hazardous materials storage/handling, wash pads, trash compactors, vehicular/equipment maintenance). High-risk areas are required to be hydrologically separated from the surrounding impervious area, and the approved discharge location is most often the sanitary system. Proposals installed per the requirements of this manual must be approved by BES and the BDS plumbing division. Elected controls must be approved by the BDS plumbing division.

Submittal Requirements

- The pollutant loading and spill potential of the area drained.
- The type and size of the receiving facility.
- The outlet location and type.
- The schedule of maintenance.
- Other BMPs the facility has implemented.
- Available stormwater monitoring data and oil/water separator data.

The following additional information may be required, depending on site conditions.

- Manufacturer testing information that supports the requirements in [Section 4.3.3](#).
- Facility dimensions and setbacks from property lines and structures.
- Profile view of facility, including typical cross-section details with dimensions. These details shall match the manufacturer's specifications and details.
- All piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection.

Facility Description

Spill control manholes rely on passive mechanisms that take advantage of oil being lighter than water. Oil rises to the surface and can be periodically removed. They consist of a simple underground manhole with a tee outlet designed with dead volume storage to trap small spills. The spill control manhole is not designed for and cannot be used for oil treatment purposes. The spill control manhole is strictly used to capture and store contents from a spill. See Appendix G.5, SW-500, for typical spill control manhole details.

Spill control manholes are required for fueling areas, per [Chapter 4](#). Spill control manholes will not be given credit for pollution reduction requirements.

Design Requirements

- Spill control manholes (see Appendix G.5, SW-500) are usually 4 feet in diameter and 5 feet deep. The outlet is through a trap 18 inches below the inlet.
- The spill control manhole tee section must extend 18 inches below the outlet elevation, and 60 cubic feet of dead storage volume must be provided below the outlet elevation for storage of oil, grease, and solids. The manhole must be located on private property.
- Any pumping devices shall be installed downstream of the spill control manhole to prevent oil emulsification.
- Engineered calculations are required, using the Rational Method ($Q=C \times I \times A$).

Submittal Requirements

- The pollutant loading and spill potential of the area drained.
- The type and size of the receiving facility.
- The outlet location and type.
- The schedule of maintenance.
- Other BMPs the facility has implemented. See [Chapter 3](#) for O&M requirements, including BMPs.

The following additional information may be required, depending on site conditions.

- Facility dimensions and setbacks from property lines and structures.

- Profile view of facility, including typical cross-section details with dimensions. These details shall match manufacturer's specifications and details.
- All piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection.

Chapter 3 OPERATIONS AND MAINTENANCE

This chapter presents operations and maintenance (O&M) requirements for the stormwater management facilities in this *Stormwater Management Manual*. It includes applicability information, submittal requirements, and guidance for developing an appropriate stormwater management O&M plan.

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3.1 APPLICABILITY OF O&M REQUIREMENTS

The O&M requirements in this chapter apply to all stormwater management facilities and related facility components identified in Chapters 1, 2, and 4 of this *Stormwater Management Manual*.¹

- The property owner must submit the O&M Form to the City for approval and record it with the County for all required stormwater management facilities, including trees. If multiple property owners share one onsite stormwater system, each property owner must record and file an O&M Form. Most common in multifamily residential developments are one onsite stormwater systems serving multiple tax lots that comprise the development. All property owners that are served by the stormwater system jointly own it and are equally responsible for its O&M.
- If the property served by the onsite stormwater system is subsequently divided, a new O&M Form must be submitted by that tax lot's property owner and recorded for each newly created tax lot that comprised the original property. For example, an O&M Form may be recorded against one tax lot that includes proposed construction of a private road, multiple residences, and associated onsite stormwater system at the time of permit application. Each property owner must file an O&M Form for the shared stormwater management facility upon becoming the first property owner of the newly created tax lot.

It is essential to maintain facilities so they function as intended and limit offsite environmental impacts. Owners are required to check their facilities regularly to determine maintenance needs. Routine inspection and maintenance can help keep overall maintenance costs at a minimum by detecting problems early and avoiding large repair or replacement costs.

The key goals of any O&M plans and specifications are to:

- Relay information between the designer/engineer and those actually providing the maintenance.
- Identify all facilities, runoff sources, stormwater conveyance including pipes and discharge points.
- Provide long-term guidance on items to address in order to prevent system deterioration and failure.

¹ See Portland City Code, Title 17.38.040 for the relevant code requirements.

- Define the visual indicators of diminished performance and maintenance requirements for each stormwater management facility that comprises the onsite stormwater system.
- Provide a schedule for inspection and maintenance.
- Designate property owners responsible for long-term ownership and O&M of the onsite stormwater management system.
- Provide inspection and maintenance logs to be filled out by maintenance personnel.

Access for O&M

Stormwater facilities must be accessible for monitoring and maintenance. Maintain paths, gates, and covers to ensure access is adequate to safely and efficiently locate and enter facilities. Public facilities must have access routes at least 8 feet wide, less than 10 percent in slope, and located adjacent to the public right-of-way wherever feasible. Where structural surfaces are needed to support maintenance vehicles, access routes must be constructed of gravel or other permeable paving surface where possible. Public facility vehicular access routes must be designed for H-20 loading.

3.2 O&M REQUIREMENTS

Every permitted project with at least one or more stormwater facility is required to submit the **Operations & Maintenance Form** provided in [Appendix D](#). The O&M Form must identify:

- all legal property owners' names, addresses, and phone numbers
- the site address
- site legal description of the property served by the stormwater management facilities
- the financial method used to cover future O&M
- parties responsible for inspecting and maintaining the facility
- size and sources of runoff entering the facility and ultimate stormwater discharge point

The O&M Form also provides a space to insert a site plan. If there is not sufficient space to detail the stormwater management facilities, a site plan must be attached. The Bureau of Environmental Services (BES) may require a more detailed site plan for plan review. The site plan must identify:

- type and size of all stormwater facilities on the site
- location of the facilities, using reference to an easily identified permanent point or geo-coordinates
- all property lines and dimensions for the impervious area managed by the stormwater management facilities
- all plumbing, associated storm utilities, connections to public or offsite systems and outfalls that lead to or from stormwater management facilities
- a North arrow and labeled cross streets

Additional submittal requirements differ, based on how the facility was sized (using the Simplified Approach, Presumptive Approach, or Performance Approach described in [Chapter 2](#)) and whether the facility is public or private:

- Property owners of private facilities that use the Simplified Approach must provide the O&M Specifications (described in [Section 3.2.1](#) and provided in [Section 3.3.1](#)).
- Property owners of private facilities that use the Presumptive Approach or Performance Approach must provide a site-specific O&M Plan (described in [Section 3.2.2](#) and outlined in [Section 3.3.2](#)).

- Property owners of facilities that deviate from the SWMM standards designs and typical details must provide facility design details.
- Public facilities that use the Presumptive Approach or Performance Approach must provide an O&M Plan to cover the warranty period (described in [Section 3.2.3](#) and outlined in [Section 3.3.2](#)).

City Code requires facility owners to keep an inspection and maintenance log. In general, the log must note all inspection dates, the facility components inspected, and any maintenance or repairs made. The logs must document deficiencies and corrective actions taken to keep structural and vegetative components in good working order. [Pages 56-57](#) provide an example of an inspection and maintenance log.

Exemptions from O&M Requirements

Single or dual family unattached residences are not required to provide the O&M Form if a drywell or soakage trench is the only stormwater facility on the permit.

The City of Portland and the Port of Portland are not required to record O&M Forms with the County for development-initiated required stormwater management facilities, but those entities must submit an O&M Form and/or Plans to the City prior to permit issuance.

A contract with the Watershed Revegetation Program (WRP) does NOT exempt facilities from O&M requirements. The WRP can accept maintenance of only the vegetation.

3.2.1 Simplified Approach for Private Facilities

When the Simplified Approach is used to design stormwater management facilities on private property, the required O&M submittal to BES is:

- ▶ a completed O&M Form (including a sketched or attached site plan that meets site plan requirements) that has been recorded with the appropriate county
- ▶ associated O&M specifications

[Section 3.3.1](#) provides facility-specific O&M Specifications for the Simplified Approach. The property owner must keep a copy of the recorded site plan and the appropriate O&M Specifications onsite. The property owner must comply with the version of the *Stormwater Management Manual* that was in effect when the original O&M Form was filed with the City. Facility design must meet the standards described in the applicable version of the *Stormwater Management Manual*. However, property owners are encouraged to follow the most current O&M practices and guidance.

3.2.2 Presumptive and Performance Approach for Private Facilities

When the Presumptive or Performance approach is used to design stormwater management facilities on private property, the required O&M submittal to BES is:

- ▶ a completed O&M Form (including a sketched or attached site plan that meets site plan requirements) that has been recorded with the appropriate county
- ▶ a site-specific O&M Plan

Using the outline provided in [Section 3.3.2](#), an O&M Plan must be prepared for review by BES. The O&M Plan must describe each type of facility servicing the site, the impervious area draining to the facilities, all stormwater conveyance pipes, and the facilities' discharge points. Additionally, the O&M Plan must detail the visual indicators and activities necessary to maintain each facility type.

[Section 3.3.2](#) also includes a sample O&M Plan that can be used for guidance.

3.2.3 Presumptive and Performance Approach for Public Facilities

A stormwater management facility that receives stormwater runoff from a public right-of-way becomes a public (City-maintained) facility unless the right-of-way is not part of the City's road maintenance system. Facilities that will become City-maintained must be constructed under a public works permit and must go through a warranty period prior to transfer.

For public facilities, the required O&M submittal to BES is:

- ▶ an O&M Form and Plan

A preliminary O&M Plan must be submitted before construction, as part of the property owner's permit application package. This plan will be finalized and in effect during the warranty period, when the City holds no responsibility for O&M. If a contract has been established with the Watershed Revegetation Program, the O&M Plan does not need to address those services provided (see [Section 2.3.2](#) under "Watershed Revegetation Plan"). The property owner must also demonstrate on the O&M Plan that the City can achieve the specified O&M activities. This may involve the construction of maintenance access roads and the dedication of public access easements.

Warranty Period Responsibilities and Inspections for Public Facilities

The contractor/permit authority that builds stormwater management facilities under a public works permit is responsible for maintaining all site stormwater management features during the maintenance warranty period. This includes maintaining, repairing,

and/or replacing the associated vegetative components; any structural or functional repairs; and the general maintenance of the facility. The contractor/permit authority is also responsible for reporting to BES on the condition of the facility on a scheduled basis over the warranty period, as outlined in [Exhibit 3-1](#). BES will inspect the facility to verify that the information in the reports is accurate. The warranty period is 2 years. The City reserves the right to perform any work necessary to correct deficiencies in the facility should the contractor/permit authority fail to perform the work after given notice. The City shall seek reimbursement from the contractor/permit authority for all costs associated with performance of the work to bring the facility into compliance with the permit conditions.

Facility condition reports must be submitted to the BES Watershed Revegetation Program (503-823-2335). WRP staff will use the report to inspect the facility and finalize the report and will send confirmation of inspection to the contractor.

Exhibit 3-1: Schedule of Warranty Period Reports for Public Facilities

- 1. 3-month establishment report and inspection:** Contractor/permit authority shall report on the condition of the facility, including landscape maintenance activities conducted to date and the schedule of anticipated upcoming activities, plant health and mortality, current percent cover of nondesirable vegetation, and any structural or functional concerns and/or observations.
- 2. 10-month establishment report and inspection:** Contractor/permit authority shall report on the condition of the facility, including landscape maintenance activities conducted to date and the schedule of anticipated upcoming activities, plant health and mortality, current percent cover of nondesirable vegetation, and any structural or functional concerns and/or observations.

If the facility does not pass BES inspection, BES will submit a letter to the contractor/ permit authority describing necessary remedial actions to be performed. This letter shall serve as final notice to the contractor/ permit authority and its sureties that failure to correct the deficiencies in accordance with the permit conditions and prior to the end of the warranty period will result in the City performing the work and seeking reimbursement from the contractor/ permit authority for all costs associated with the City performing the work.

- 3. 18-month establishment report and inspection:** Contractor/permit authority shall report on the condition of the facility, including landscape maintenance activities conducted to date and the schedule of anticipated upcoming activities, plant health and mortality, current percent cover of nondesirable vegetation, and any structural or functional concerns and/or observations.
- 4. 24-month establishment report and inspection:** Contractor/permit authority shall report on the condition of the facility, including landscape maintenance activities conducted to date and the schedule of anticipated upcoming activities, plant health and mortality, current percent cover of nondesirable vegetation, and any structural or functional concerns and/or observations.

*At this time, if **all** inspections have passed, the warranty period ends and the facility is turned over to BES for long-term maintenance.*

3.2.4 Summary of Thresholds for Maintenance

Maintenance is required for the following facilities under several categories.

In Vegetative Facilities	Page
Vegetative cover is less than 90percent	3-41
Nuisance and invasive plants are present.....	3-41
Facility has erosion in more than 2 inches deep.....	3-44
Structure is damaged or is otherwise not functioning as designed	3-45

In all Facilities	Page
Sediment accumulation exceeds facility's capacity	3-37
Pollution can be seen, smelled, or identified within the facility	3-37
Inlets and/or outlets are 50 percent blocked	3-37
Structure is damaged or is otherwise not functioning as designed	3-45
Drawdown time exceeds standards	3-46
Safety concerns	3-49
Pests are present within the facility.....	3-47
The stormwater management facility (SMF) is not accessible for maintenance or inspection.....	3-58

These are general maintenance indicators and do not include all indications that maintenance is necessary. Refer to the O&M Specifications or Plans (Section 3.3) for more explicit guidance on how to identify and correct maintenance issues.

These indicators must be addressed in the Inspection & Maintenance Log that is kept onsite to document compliance with the O&M Specifications and Plan.

3.3 O&M SUBMITTAL DOCUMENTS AND GUIDANCE

3.3.1 O&M Facility-Specific Specification for the Simplified Approach

The specifications on the following pages can be used for private facilities that use the Simplified Approach.

The main objectives of the facility-specific O&M Specifications are to:

- provide long-term guidance on individual stormwater management facility O&M in order to prevent system deterioration and failure
- provide a list of visual indicators to prompt effective maintenance activities necessary to restore optimal performance

Facility	Page
Trees	3-11
Downspout extension	3-12
Ecoroofs	3-14
Swales	3-16
Planters	3-18
Basins	3-20
Drywells and Soakage Trenches	3-22
Pervious Pavement	3-23
Vegetated Filters	3-24
Sand Filters	3-26
Water Quality Manholes	3-28
Oil/Water Separators	3-29
Detention Pipes, Vaults, and Tanks	3-30

Simplified O&M Specifications TREES

Maintenance Indicator	Corrective Action
➤ Dead or stressed tree	<ul style="list-style-type: none"> ➤ Replant per original planting plan, or substitute from Appendix F.4 plant list. ➤ Irrigate as needed. ➤ Mulch or amend soil as needed. ➤ Prune branches and dead limbs and remove clippings. ➤ Manually remove weeds. Do not use pesticides.

Annual Maintenance Schedule

All seasons: Mulch or amend soil as needed. Prune tree as necessary to protect sight lines. Irrigate and weed as needed. Inspect trees for damage and disease.

Maintenance Records: *All facility operators are required to keep an annual inspection and maintenance log.*

Record date, description, and contractor (if applicable) for all landscape maintenance. Keep work orders and invoices on file and make available upon request of the City inspector.

Irrigation: Adjust irrigation program or consult a professional to set the system at the correct watering system. Irrigation is required during the establishment period to ensure tree survival. Hand watering is preferred, but a drip irrigation system may also be used.

Pollution Prevention: All sites shall implement best management practices (BMPs) to prevent hazardous wastes from contaminating stormwater. Record the time/date, weather, and site conditions when site activities contaminate stormwater. Record the time/date and description of the corrective action taken.

Vectors (Mosquitoes and Rodents): Trees shall not harbor mosquito larvae or rodents that pose a threat to public health or that undermine the health of the tree. Record the time/date, weather, and site conditions when vector activity is observed. Record when vector abatement started and ended.

Simplified O&M Specifications DOWNSPOUT EXTENSION

Maintenance Indicator	Corrective Action
<p>Structural Components shall freely convey stormwater.</p> <ul style="list-style-type: none"> ➤ Clogged gutters or downspouts ➤ Damaged or missing pipes, gutters, and downspouts ➤ Blocked downspout extension 	<ul style="list-style-type: none"> ➤ Remove sediment, debris, and blockages from downspouts, gutters, and pipes to maintain at least 50% conveyance at all times. Recommend cleaning at least twice a year, or more often depending on the presence of overhanging trees. ➤ Repair or replace broken gutters and downspouts as needed. Identify possible leaks and verify that roof flashing directs water into gutters. Look for low spots or sagging areas along the gutter line and repair as needed with new hangers. ➤ Clear any build up of soil, bark dust, and/or vegetative growth from around downspout extension and/or splash blocks. Verify that there is sufficient slope so that water flows away from the foundation.
<p>Vegetation shall cover 90% of the receiving area.</p> <ul style="list-style-type: none"> ➤ Dead or strained vegetation ➤ Tall grass ➤ Weeds 	<ul style="list-style-type: none"> ➤ Replant per original planting plan, or substitute from Appendix F.4 plant list. ➤ Irrigate as needed. Mulch as needed. DO NOT apply fertilizers, herbicides, or pesticides. ➤ Cut back to 4-6 inches 1-2 times each year. ➤ Manually remove weeds. Remove all plant debris.
<p>Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 48 hours.</p> <ul style="list-style-type: none"> ➤ Gullies, erosion, and/or exposed soils ➤ Scouring at the inlet(s) ➤ Ponding 	<ul style="list-style-type: none"> ➤ Fill-in and, lightly compact areas of erosion with City-approved soil mix. Restore or create splash blocks where necessary. ➤ Replace splash blocks or inlet gravel/rock. ➤ Remove the top 2-4 inches of sediment at the end of the downspout extension and replace with City-approved soil mix. Rake, till, or amend with City-approved soil mix to restore infiltration rate.

Annual Maintenance Schedule

Summer: Make structural repairs. Clean gutters and downspouts. Remove any build up of weeds or organic debris.

Fall: Replant exposed soil and replace dead plants. Remove sediment and plant debris.

Winter: Clear gutters and downspouts to maintain conveyance.

Spring: Remove sediment and plant debris. Replant exposed soil and replace dead plants.

All seasons: Weed as necessary.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record the date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make them available upon request of the City inspector.

Access: Maintain ingress/egress to design standards.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record the time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact Spill Prevention & Citizen Response at 503-823-7180 for immediate assistance responding to spills. Record the time/date, weather, and site conditions if site activities contaminate stormwater. Record the time/date and description of corrective action taken.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date, weather, and site conditions when vector activity is observed.

Simplified Operations and Maintenance Specifications ECOROOF

Maintenance Indicator	Corrective Action
<p>Structural Components, including the waterproof membrane, shall be operated and maintained in accordance with the manufacturer's and design specifications.</p>	
<ul style="list-style-type: none"> ➤ Clogged drains ➤ Tears or perforation of membrane 	<ul style="list-style-type: none"> ➤ Remove sediment and debris if necessary. ➤ Repair any leaks or structural deficiencies. ➤ Contact manufacturer for repair or replacement.
<p>Vegetation shall cover 90% of the facility.</p>	
<ul style="list-style-type: none"> ➤ Dead or stressed vegetation ➤ Dry grass or other plants ➤ Weeds 	<ul style="list-style-type: none"> ➤ Replant per original planting plan, or substitute from Appendix F.4 plant list. ➤ Irrigate and mulch as needed. ➤ Prune tall, dry grasses and remove clippings. ➤ Manually remove weeds. Do not use pesticides.
<p>Growing Medium shall sustain healthy plant cover and infiltrate within 48 hours.</p>	
<ul style="list-style-type: none"> ➤ Exposed soil ➤ Eroded soils and gullies ➤ Crusting, dry, or shrinking medium ➤ Ponding or excessive moisture 	<ul style="list-style-type: none"> ➤ Cover with plants and mulch as needed. ➤ Fill, hand tamp or lightly compact, and plant vegetation to disperse flow. ➤ Rake or amend to restore filtration or flow. ➤ Amend soils and clear drains.

Annual Maintenance Schedule

Summer: Make necessary repairs. Improve growing medium as needed. Irrigate as needed.

Fall: Replant exposed soil and dead plants.. Provide erosion control for bare soil if necessary.

Winter: Monitor infiltration/flow-through rates.

Spring: Replant exposed soil and dead plants.

All seasons: Weed as necessary. Clean drains as necessary.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record date, description, and contractor (if applicable) for all repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Access: Maintain ingress/egress to design standards.

Irrigation: Adjust irrigation program or consult a professional to set the system at the correct watering system.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement BMPs to prevent hazardous wastes from contaminating stormwater. Record the time/date, weather, and site conditions when site activities contaminate stormwater. Record the time/date and description of corrective action taken.

Vectors (Mosquitoes and Rodents): Ecoroofs shall not harbor mosquito larvae or rodents that pose a threat to public

health or that undermine the facility structure. Record the time/date, weather, and site conditions when vector activity observed. Record when vector abatement started and ended.

Simplified O&M Specifications SWALES

Maintenance Indicator	Corrective Action
<p>Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.</p>	
<ul style="list-style-type: none"> ➤ Clogged inlets or outlets ➤ Broken inlets or outlets ➤ Cracked or exposed drain pipes ➤ Check dams missing, scattered, or with gaps 	<ul style="list-style-type: none"> ➤ Remove sediment and debris from catch basins, trench drains, curb inlets, and pipes to maintain at least 50% conveyance capacity at all times. ➤ Repair or replace broken downspouts, curb cuts, standpipes, and screens as needed. ➤ Repair/seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage. ➤ Maintain rock check dams as per standard details. See typical details SW-340 and SW-341 in Appendix G.3.
<p>Vegetation shall cover 75% of the facility.</p>	
<ul style="list-style-type: none"> ➤ Dead or strained vegetation ➤ Tall grass and vegetation ➤ Weeds 	<ul style="list-style-type: none"> ➤ Replant per original planting plan, or substitute from SWMM Appendix F.4 plant list. ➤ Irrigate as needed. Mulch banks as needed. DO NOT apply fertilizers, herbicides, or pesticides. ➤ Prune to allow sight lines and foot traffic. Prune to ensure inlets and outlets freely convey stormwater into and/or out of facility. ➤ Manually remove weeds. Remove all plant debris.
<p>Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 48 hours.</p>	
<ul style="list-style-type: none"> ➤ Erosion, and/or exposed soils ➤ Scouring at the inlet(s) ➤ Slope slippage ➤ Ponding 	<ul style="list-style-type: none"> ➤ Fill-in and lightly compact areas of erosion with City-approved soil mix. Stabilize soils with plants from Appendix F.4. ➤ Replace splash pads at inlet(s) with gravel/rock. ➤ Stabilize 3:1 slopes/banks with plantings from Appendix F.4 plant list. ➤ Remove the top 2-4 inches of sediment at the inlet(s). Add City-approved soil mix to match elevation of inlet. Rake, till, or amend with City-approved soil mix to restore infiltration rate.

Annual Maintenance Schedule

Summer: Make structural repairs. Improve filter medium as needed. Clear drains. Irrigate as needed.

Fall: Replant exposed soil and replace dead plants. Remove sediment and plant debris.

Winter: Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.

Spring: Remove sediment and plant debris. Replant exposed soil and replace dead plants. Mulch as needed, but do not block the inlets, outlets, or flow path with mulch.

All seasons: Weed as necessary.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Access: Maintain ingress/egress to design standards.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact Spill Prevention & Citizen Response at 503-823-7180 for immediate assistance responding to spills. Record the time/date, weather, and site conditions if site activities contaminate stormwater. Record the time/date and description of corrective action taken.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date, weather, and site conditions when vector activity is observed.

Simplified O&M Specifications PLANTERS

Maintenance Indicator	Corrective Action
<p>Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.</p>	
<ul style="list-style-type: none"> ➤ Clogged inlets or outlets ➤ Broken inlets or outlets ➤ Damaged liners and walls ➤ Cracked or exposed drain pipes 	<ul style="list-style-type: none"> ➤ Remove sediment and debris from catch basins, trench drains, curb inlets, and pipes to maintain at least 50% conveyance capacity at all times. ➤ Repair or replace broken downspouts, curb cuts, standpipes, and screens as needed. ➤ Extend and secure liner to planter walls above the high water mark. The facility must be water tight to protect abutting foundations from moisture damage. ➤ Repair/seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage.
<p>Vegetation shall cover 90% of the facility.</p>	
<ul style="list-style-type: none"> ➤ Dead or strained vegetation ➤ Tall or overgrown plants ➤ Weeds 	<ul style="list-style-type: none"> ➤ Replant per original planting plan, or substitute from Appendix F.4 plant list. ➤ Irrigate as needed. DO NOT apply fertilizers, herbicides, or pesticides. ➤ Prune to allow sight lines and foot traffic. Prune to ensure inlets and outlets freely convey stormwater into and/or out of the facility. ➤ Manually remove weeds. Remove all plant debris.
<p>Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 48 hours.</p>	
<ul style="list-style-type: none"> ➤ Erosion and/or exposed soils ➤ Scouring at the inlet(s) ➤ Ponding 	<ul style="list-style-type: none"> ➤ Fill, lightly compact areas of concern with City-approved soil mix. Stabilize soils with plantings from Appendix F.4. ➤ Replace splash pads at inlet(s) with gravel/rock. ➤ Remove the top 2-4 inches of sediment at the inlet(s). Add City-approved soil mix to match elevation of inlet. Rake, till, or amend with the City-approved soil mix to restore infiltration rate.

Annual Maintenance Schedule

Summer: Make any structural repairs. Improve filter medium as needed. Clear drain. Irrigate as needed.

Fall: Replant exposed soil and replace dead plants. Remove sediment and plant debris.

Winter: Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.

Spring: Remove sediment and plant debris. Replant exposed soil and replace dead plants.

All seasons: Weed as necessary.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record the date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Access: Maintain ingress/egress to design standards.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record the time/date, weather, and site conditions when ponding occurs. **Pollution Prevention:** All sites shall implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact Spill Prevention & Citizen Response at 503-823-7180 for immediate assistance responding to spills. Record the time/date, weather, and site conditions if site activities contaminate stormwater. Record the time/date and description of the corrective action taken.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date, weather, and site conditions when vector activity is observed.

Simplified O&M Specifications BASINS

Maintenance Indicator	Corrective Action
<p>Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.</p>	
<ul style="list-style-type: none"> ➤ Clogged inlets or outlets ➤ Broken inlets or outlets, including grates ➤ Cracked or exposed drain pipes ➤ Check dams 	<ul style="list-style-type: none"> ➤ Remove sediment and debris from catch basins, trench drains, curb inlets, and pipes to maintain at least 50% conveyance capacity at all times. ➤ Repair or replace broken downspouts, curb cuts, standpipes, and screens as needed. ➤ Repair/seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage. ➤ Maintain rock check dams per design standards.
<p>Vegetation shall cover 90% of the facility.</p>	
<ul style="list-style-type: none"> ➤ Dead or strained vegetation ➤ Tall grass and vegetation ➤ Weeds 	<ul style="list-style-type: none"> ➤ Replant per original planting plan, or substitute from Appendix F.4 plant list. ➤ Irrigate as needed. Mulch banks as needed. DO NOT apply fertilizers, herbicides, or pesticides. ➤ Prune to allow sight lines and foot traffic. Prune to ensure inlets and outlets freely convey stormwater into and/or out of the facility. Manually remove weeds. Remove all plant debris.
<p>Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 48 hours.</p>	
<ul style="list-style-type: none"> ➤ Erosion, and/or exposed soils ➤ Scouring at inlet(s) ➤ Slope slippage ➤ Ponding 	<ul style="list-style-type: none"> ➤ Fill and lightly compact areas of erosion with City-approved soil mix. Stabilize soils with plantings from Appendix F.4. ➤ Replace splash pads at inlet(s) with gravel/rock. ➤ Stabilize 3:1 slopes/banks with plantings from Appendix F.4. ➤ Remove the top 2-4 inches of sediment at the inlet. Add City-approved soil mix to match elevation of the inlet. Rake, till, or amend with City-approved soil mix to restore infiltration rate.

Maintenance Schedule:

Summer: Make any structural repairs. Improve filter medium as needed. Clear drains and inlets. Irrigate as needed.

Fall: Replant exposed soil and replace dead plants. Remove sediment and plant debris.

Winter: Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.

Spring: Remove sediment and plant debris. Replant exposed soil and replace dead plants. Mulch as needed but do not block the inlets, outlets, or flow paths with mulch.

All seasons: Weed as necessary.

Maintenance Records:

All maintenance operators are required to keep an annual inspection and maintenance log.

Record the date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Access: Maintain ingress/egress, including access roads, to design standards.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record the time/date, weather, and site

conditions when ponding occurs.

Pollution Prevention: All sites shall implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact Spill Prevention & Citizen Response at 503-823-7180 for immediate assistance responding to spills. Record the time/date, weather, and site conditions if site activities contaminate stormwater. Record the time/date and description of corrective action taken.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date, weather, and site conditions when vector activity is observed.

Simplified O&M Specifications DRYWELLS AND SOAKAGE TRENCHES

Maintenance Indicator	Corrective Action
<p>Structural Components include pipes, manholes (drywells), and rock/sand reservoirs (soakage trenches), storm chambers, and silt traps (soakage trenches).</p>	
<ul style="list-style-type: none"> ➤ Clogged inlets, manholes, or silt traps ➤ Cracked drain pipes or manholes 	<ul style="list-style-type: none"> ➤ Clean gutters, rain drains, and silt traps twice a year. ➤ Repair/seal cracks. Replace when repair is insufficient.
<p>Vegetation includes surface cover and nearby plantings.</p>	
<ul style="list-style-type: none"> ➤ Large shrubs and trees 	<ul style="list-style-type: none"> ➤ Prevent large root systems from damaging subsurface structural components.
<p>Filter Layer includes rock/gravel bed.</p>	
<ul style="list-style-type: none"> ➤ Ponding water 	<ul style="list-style-type: none"> ➤ Remove sediment and debris from all accessible components. ➤ May require decommissioning and replacement. Consult with the City prior to subgrade work.

Maintenance Schedule:

Summer: Make necessary structural repairs. Clean silt traps.

Fall: Clean gutters and rain drains.

Winter: Monitor infiltration rate.

Spring: Clean gutters and rain drains.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record the date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Access: Maintain ingress/egress to design standards.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record the time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact Spill Prevention & Citizen Response at 503-823-7180 for immediate assistance responding to spills. Record the time/date, weather, and site conditions if site activities contaminate stormwater. Record the time/date and description of corrective action taken.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date, weather, and site conditions when vector activity is observed.

Simplified O&M Specifications PERVIOUS PAVEMENT

Maintenance Indicator	Corrective Action
<p>Structural Components, including surface materials, shall evenly infiltrate stormwater.</p>	
<ul style="list-style-type: none"> ➤ Clogged surface ➤ Unraveling or settled pavement 	<ul style="list-style-type: none"> ➤ Vacuum or dry sweep at least twice a year. ➤ Repair per manufacturer specifications. ➤ Do not apply sealants to pervious pavement.
<p>Vegetation</p>	
<ul style="list-style-type: none"> ➤ Large shrubs or trees ➤ Weeds 	<ul style="list-style-type: none"> ➤ Sweep leaf litter and sediment to prevent surface clogging and ponding. ➤ Prevent large root systems from damaging subsurface structural components. ➤ Permeable pavers: manually remove weeds. Do not use herbicides. Mow, torch, or inoculate with preferred vegetation. Many pavers are designed to have pore space vegetation.
<p>Filter Medium</p>	
<ul style="list-style-type: none"> ➤ Aggregate loss in pavers 	<ul style="list-style-type: none"> ➤ Replace paver pore space with aggregate per original design.

Maintenance Schedule:

Summer: Make necessary structural repairs.

Fall: Vacuum sweep.

Winter: Monitor infiltration rate.

Spring: Vacuum sweep.

All seasons: Weed as necessary.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record the time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Do not apply, transfer, or store chemicals or fine-grained material on pervious pavement. Contact Spill Prevention & Citizen Response at 503-823-7180 for immediate assistance responding to spills. Record the time/date, weather, and site conditions if site activities contaminate stormwater. Record the date/time and description of corrective action taken.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date, weather, and site conditions when vector activity is observed.

Simplified O&M Specifications VEGETATED FILTERS

Maintenance Indicator	Corrective Action
<p>Structural Components, including inlets and outlets, check dams, and flow spreader, shall slowly and evenly treat and infiltrate stormwater.</p> <ul style="list-style-type: none"> ➤ Clogged inlets or outlets ➤ Ineffective flow spreaders ➤ Cracked drain pipes 	<ul style="list-style-type: none"> ➤ Remove sediment, debris, and vegetation blockage from catch basins, trench drains, curb inlets, and pipes to maintain at least 50% conveyance capacity at all times. ➤ Repair structure to evenly disperse flow. ➤ Repair/seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage.
<p>Vegetation shall cover 90% of the facility.</p> <ul style="list-style-type: none"> ➤ Dead or stressed vegetation ➤ Tall Grass ➤ Weeds 	<ul style="list-style-type: none"> ➤ Replant per planting plan, or substitute from Appendix F.4 plant list. ➤ Irrigate as needed. Mulch as needed. DO NOT apply fertilizers, herbicides, or pesticides. ➤ Cut back above the crown to prevent plant damage and maintain upright stature. ➤ Manually remove weeds. Remove plant debris.
<p>Growing/Filter Medium, including soil and gravels, shall</p> <ul style="list-style-type: none"> ➤ Erosion, gullies and/or exposed soils ➤ Slope slippage ➤ Ponding 	<p>sustain healthy plant cover and infiltrate within 48 hours.</p> <ul style="list-style-type: none"> ➤ Fill and lightly compact areas of erosion with City-approved soil mix. Stabilize soils with plantings from Appendix F.4. Install a flow spreader or plant vegetation to evenly disperse flow. Restore or create check dams or splash blocks where necessary. ➤ Stabilize slopes with deep-rooted plants. ➤ Remove accumulated sediment. Rake, till, or amend with City-approved soil mix to restore infiltration rate.

Maintenance Schedule:

Summer: Make any structural repairs. Improve filter medium as needed. Clear inlets and outlets. Prune or mow. Irrigate as needed. Remove sediment.

Fall: Replant exposed soil and replace dead plants. Remove plant debris.

Winter: Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.

Spring: Remove plant debris. Replant exposed soil and replace dead plants.

All seasons: Weed as necessary.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Access: Maintain ingress/egress to design standards.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record the time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact Spill Prevention & Citizen Response at 503-823-7180 for immediate assistance responding to spills. Record the time/date, weather, and site conditions if site activities contaminate stormwater. Record the time/date and description of corrective action taken.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date, weather, and site conditions when vector activity was observed.

Operations and Maintenance Specifications SAND FILTERS

Maintenance Indicator	Corrective Action
<p>Structural Components, including inlets and outlets/overflows, liners and walls, shall freely convey stormwater.</p>	
<ul style="list-style-type: none"> ➤ Clogged inlets or outlets ➤ Cracked drain pipes ➤ Damaged liners and walls 	<ul style="list-style-type: none"> ➤ Remove sediment and debris from silt traps, trench drains, inlets, and pipes to maintain at least 50% conveyance capacity at all times. ➤ Manually remove sediment accumulation. ➤ Repair/seal cracks. Replace when repair is insufficient. ➤ Extend and secure liner to planter walls above the high water mark. The facility must be water tight to protect abutting foundations from moisture damage.
<p>Vegetation</p>	
<ul style="list-style-type: none"> ➤ Weeds ➤ Large shrubs and trees 	<ul style="list-style-type: none"> ➤ Manually remove weeds. Remove all plant debris. ➤ Prevent large root systems from damaging subsurface structural components. ➤ DO NOT apply herbicides or pesticides.
<p>Filter Medium, including sand and gravels or similar material, shall infiltrate within 48 hours.</p>	
<ul style="list-style-type: none"> ➤ Ponding ➤ Gullies ➤ Erosion 	<ul style="list-style-type: none"> ➤ Rake and remove layer of oil and sediment to restore infiltration rate. ➤ Fill, lightly compact, and install flow spreader or plant vegetation to disperse flow. ➤ Restore splash blocks if missing or not installed.

Maintenance Schedule:

Summer. Make necessary structural repairs. Rake to remove accumulated sediment and debris.
Fall. Clear inlets and outlets/overflows to maintain conveyance.
Winter. Monitor flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.
Spring. Clear inlets and outlets/overflows to maintain conveyance.
All seasons. Weed as necessary.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.
 Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Access: Maintain ingress/egress to design standards.

Infiltration/Flow Control: All facilities shall drain within 48 hours. Record time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact Spill Prevention & Citizen

Response at 503-823-7180 for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.

Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.

O&M Specifications Water Quality Manholes

ONLY professionals with Occupational Safety and Health Administration (OSHA) confined space certification may enter water quality manholes	
Maintenance Indicator	Corrective Action
Structural Components , including inlets, outlets, concrete chambers, pipes and covers, shall be operated and maintained in accordance with the manufacturer's and design specifications	
<ul style="list-style-type: none"> ➤ Missing elbow or T (sedimentation manhole) ➤ Hand pull stuck (spill control manhole) ➤ Clogged catch basins, gutters, inlets or pipes ➤ Diminished capacity of manhole ➤ Cracked drain pipe or concrete 	<ul style="list-style-type: none"> ➤ Install elbow or T on outlet. ➤ Remove rust, dirt, and oils from the pull handle and valve. Remove items blocking the valve and pull handle. Do not use any solvents or chemicals in water quality manholes. ➤ Remove sediment, oil, and debris from catch basins when 1/3 full and from gutters, inlets, outlets and pipes to maintain at least 50% conveyance capacity at all times. ➤ Remove oil, sediment, and debris when sediment is 30% of the capacity or oil is 1 inch deep. ➤ Repair with grout or City-approved material or replace when cracks are 1 inch wide or more.
Vegetation , including surface cover and nearby plantings.	
<ul style="list-style-type: none"> ➤ Large shrubs and trees 	<ul style="list-style-type: none"> ➤ Prevent large root systems from damaging subsurface structural components.

Annual Maintenance Schedule

Summer: Make necessary structural repairs. Remove sediment, oil, and debris from conveyance system and manholes.

Winter: Monitor water level and sediment level.

Spring: Test the pull handle of the spill control manhole.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record the date and description (and cost and contractor for hired work) for all structural repairs, landscape maintenance, and cleaning activities. Keep contracts and receipts for maintenance work on file and prepare to make available to City inspectors upon request.

Access: Maintenance equipment and labor shall have safe access to facilities at all times.

Pollution Prevention: All sites must implement BMPs to prevent contaminating stormwater. Contact Spill Control at 503-823-7180 for immediate assistance responding to spills. Record the nature and extent of a spill and the response if it impacts stormwater.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for mosquito larvae. Fill holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the nature and extent of vector activity if observed.

O&M Specifications Oil/Water Separators

Maintenance Indicator	Corrective Action
Structural Components , including inlets, outlets, pipes, coalescing plates, and vaults.	
<ul style="list-style-type: none"> ➤ Clogged catch basins, inlets, or pipes ➤ Diminished capacity of coalescing plates or vault ➤ Saturated absorbent pads or socks ➤ Missing elbow or T ➤ Cracked pipe or vault 	<ul style="list-style-type: none"> ➤ Remove sediment, oil and debris from catch basins when 1/3 full and from gutters, inlets, outlets, and pipes to maintain at least 50% conveyance capacity at all times. ➤ Vacuum vault when sediment is 4 inches deep or when oil is 2 inches deep or when oil covers 50% of the coalescing plates. ➤ Close effluent shutoff valve before cleaning facility. Clean coalescing plates upstream or in the facility. Use low pressure, cool temperature, and biodegradable chemicals (if necessary). ➤ Change absorbent pads or socks when 50% of surface is coated in oil and sediment. ➤ Install elbow or T on outlet. ➤ Repair with grout or City-approved material or replace when cracks are 1 inch wide or more.
Vegetation , including surface cover and nearby plantings.	
<ul style="list-style-type: none"> ➤ Large shrubs and trees 	<ul style="list-style-type: none"> ➤ Prevent large root systems from damaging subsurface structural components.

Annual Maintenance Schedule

Summer: Remove sediment, oil, and debris from conveyance system. Make necessary structural repairs.

Fall: Test shut-off valve. Clean vault and/or coalescing plates. Change absorbent pads or socks.

Winter: Monitor.

Spring: Test shut-off valve. Clean vault and/or coalescing plates. Change absorbent pads or socks.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities.

Access: Maintain ingress/egress to design standards.

Pollution Prevention: All sites should implement BMPs to prevent contaminating stormwater. Contact Spill Control at 503-823-7180 for immediate assistance responding to spills. Record the time/date and weather and site conditions if site activities contaminate stormwater.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date and weather and site conditions when vector activity was observed.

O&M Specifications Detention Pipes, Vaults, and Tanks

ONLY professionals with OSHA confined space certification should enter below-ground stormwater systems.	
Maintenance Indicator	Corrective Action
Structural Components , including inlets, outlets, pipes, vaults, and/or tanks shall be operated and maintained in accordance with the manufacturer and design specifications.	
<ul style="list-style-type: none"> ➤ Clogged inlets or outlets ➤ Diminished pipe, vault or tank capacity ➤ Cracked pipe or vault or tank 	<ul style="list-style-type: none"> ➤ Remove sediment, oil, and debris from catch basins when 1/3 full and from gutters, inlets, outlets, and pipes to maintain at least 50% conveyance capacity at all times. ➤ Remove oil, sediment, and debris when sediment is at 30% of the capacity or oil is 2 inches deep. ➤ Repair with grout or City-approved material or replace when cracks are 1 inch wide or more.
Vegetation , including surface cover and nearby plantings.	
<ul style="list-style-type: none"> ➤ Large shrubs and trees 	<ul style="list-style-type: none"> ➤ Prevent large root systems from damaging subsurface structural components.

Annual Maintenance Schedule

Summer: Remove sediment, oil and debris from conveyance system and pipes, vaults and tanks. Make necessary structural repairs.

Winter: Monitor flow through rate.

Spring: Inspect the pipes, vaults, and tanks for structural concerns and sediment accumulation.

All Seasons: Clean gutters/rain drains as needed.

Maintenance Records:

All facility operators are required to keep an annual inspection and maintenance log.

Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities.

Access: Maintain ingress/egress to design standards.

Pollution Prevention: All sites should implement BMPs to prevent contaminating stormwater. Contact Spill Control at 503-823-7180 for immediate assistance responding to spills. Record the time/date and weather and site conditions if site activities contaminate stormwater.

Vectors (Mosquitoes and Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance to eradicate vectors. Record the time/date and weather and site conditions when vector activity was observed.

3.3.2 O&M Site-Specific Plan for Presumptive and Performance Approaches

A site-specific O&M Plan is required for:

- Private facilities that use the Presumptive Approach or Performance Approach.
- Public facilities are required to have an O&M Plan during the warranty period (see [Section 3.2.3](#)). The O&M Plan for these facilities is preliminary and is in effect until the facility is turned over to the City.

If the property owner enters into an agreement with the Watershed Revegetation Program, the owner is not responsible for establishing the vegetation. Refer to [Section 2.3.2](#) for the list of services the WRP provides.

The site-specific O&M Plan is a component of the Stormwater Management Report. It defines the O&M procedures, schedule, and persons responsible for implementing and documenting O&M activities. The O&M Plan must fully assess the requirements of the site and the proposed stormwater infrastructure.

[Exhibit 3-2](#) outlines the requirements for a site-specific O&M Plan. The following text then gives additional information about each of the outline sections.

Exhibit 3-2: O&M Plan Outline

<p>I. Description</p> <ul style="list-style-type: none">• Summary of onsite stormwater system.• Table identifying each stormwater facility, including stormwater source, square footage managed, and discharge point.• Location of stormwater facilities in relation to permanent structures or landmarks.
<p>II. Inspection and Visual Indicators of Diminished Performance</p> <ul style="list-style-type: none">• When and how often facilities will be inspected.• Definition of what size storms require additional inspections.• Description of visual indicators that would trigger maintenance activities.
<p>III. Maintenance Activities</p> <ul style="list-style-type: none">• Specific procedures for each facility type.• Likely deficiencies and corrective actions.• Course of action for unexpected deficiencies.• Site BMPs for effective stormwater management.
<p>IV. Who Shares Financial Responsibility</p> <p>Designation and contact information of entity responsible for site operation and maintenance.</p>
<p>V. Inspection and Maintenance Logs</p> <p>Example and instructions for maintaining required logs.</p>

I. Description

The summary of the Stormwater Management Plan (SMP) must adequately describe the overall water quality objectives and property owner responsibilities. The summary must include the Stormwater Hierarchy, specifically whether the managed stormwater is infiltrated onsite or discharged offsite. It must also describe the onsite stormwater system, include the function of each stormwater management facility in detail.

A table must be included that identifies each stormwater facility, including the facility type, size, location, source of stormwater (rooftop, parking lot, or road runoff), source area (square footage) managed by the facility, discharge point, and accessibility.

The location of each stormwater facility must be identified on a site map. The location must be clarified by a measurement from a permanent structure or GPS coordinates.

II. Inspection and Visual Indicators of Diminished Performance

Facilities must be inspected at least:

- quarterly for the first 2 years
- twice a year thereafter
- within 48 hours of major rainfall events (more than 1 inch of rain over a 24-hour period)

Some inspections are recommended more often, as noted under the **Facility Maintenance Requirements** beginning on page **3-10**. For at least the first 2 years, inspections must be conducted with the facility drawings and the O&M Plan in hand to help the inspector understand how the facility is supposed to function. The O&M Plan will help the inspector recognize signs that indicate diminished performance. Visual indicators that maintenance is needed should be outlined for each individual facility.

III. Maintenance Activities

Each type of facility must have its own section that describes the duties required to maintain that facility and keep it in working order. It is expected that variations in facilities as well as variations in sources (rooftop, parking lot, or roadway runoff) will result in different procedures. The **Facility Maintenance Requirements** beginning on page **3-10** detail the types of activities necessary for facility maintenance. Maintenance indicators and their corrective actions must also be described.

Maintenance activities must also include BMPs specific to site activities and functions, such as lot sweeping or catch basin cleaning, that will improve system performance and lower maintenance costs.

IV. Financial Responsibility

The party responsible for current and ongoing O&M activities must be identified. The name of the responsible party must be updated as needed whenever the facility is inspected under BES's Maintenance Inspection Program (MIP).

V. Inspection and Maintenance Logs

City Code requires facility owners to keep an Inspection and Maintenance Log. In general, the log must note all inspection dates, the facility components that were inspected, and any maintenance or repairs performed. The intent is to demonstrate compliance with O&M requirements.

If there is a manufactured facility or a maintenance contract with the manufacturer, the manufacturer's maintenance logs must generally include the same type of information and level of detail shown in the sample monitoring log that is included in the **Sample O&M Plan** on page **3-51**. Owners who are not sure their log sheet is sufficient can call BES at 503-823-7740 for proposed O&Ms or 503-823-5320 for existing O&Ms to get review and approval of their forms.

Facility Maintenance Requirements

This section contains specific procedures for each type of maintenance activity. These documents must be used for guidance in developing a site-specific O&M Plan under the Presumptive Approach or Performance Approach.

<u>Maintenance Activity</u>	<u>Page</u>
Site Best Management Practices	3-35
Sediment and Oil Removal and Disposal	3-37
Vegetation Management	3-41
Erosion, Bank Failure, and Channel Formation	3-44
Structural Repairs or Replacement	3-45
Ponding Water	3-46
Pests	3-47
Safety	3-49
Paying for Maintenance	3-50

SITE BEST MANAGEMENT PRACTICES (BMPs)

This applies to all sites with stormwater management systems and stormwater management facilities.

IMPORTANCE TO FACILITY PERFORMANCE

BMPs are site maintenance activities that can improve the performance of the onsite stormwater system and lower overall maintenance costs by managing sediment upstream from the point of discharge. Stormwater facilities often collect a variety of trash and debris. Trash and debris, especially floating debris, can clog pipes or treatment media. It can also cause odors through decay or by collecting spilled or dumped materials. Stormwater facilities are designed to help prevent pollutants from entering rivers and streams. Any visible water quality pollutants may wash out of the facility, spreading the pollution problem.

WHAT TO LOOK FOR

- sediment, oil and debris accumulation in parking lots, catch basins, and conveyance systems such as trench drains and gutters
- broken or missing grates, hood covers or elbows in catch basins and conveyance structures
- chemical and waste storage, handling and transfer practices exposed to rainfall and stormwater runoff
 - trash and debris
 - any unusual or unpleasant smells from sources, such as:
 - natural plant decay or algae
 - a spill or leak (e.g., gasoline or sewage)
 - visible pollution, such as:
 - sheens
 - turbid (cloudy) water
 - discoloration
 - other pollutants on the surface of the water

MAINTENANCE

- Minimize outside sources of sediment, such as eroding soil upstream of the facility.
- Do not let water from washing or fueling vehicles or equipment drain to the stormwater facility.
- Vacuum or dry-sweep parking lots when sediment build-up is visible.
- Manually remove or commercially vacuum sediment from catch basins when 1/3 full of sediment.
- Remove sediment from conveyance systems. Do not hose through stormwater system.

- Dewater and dispose of sediment. Dispose of decant water to sanitary sewer and dry sediment to solid waste according to current Department of Environmental Quality (DEQ) regulation.
- Repair or replace broken or missing grates, hood covers, or elbows in catch basins and conveyance structures.
- Handle, transfer, and store chemicals and waste in designated areas to protect the storm sewer system.
 - Regularly remove trash and debris.
 - Store hazardous material under cover.
 - Ensure garbage bins are closed on solid waste containers.
 - If there is a spill or leak, immediately stop the leak, isolate the spill, and contact a professional laboratory or sampling firm to assess whether the material needs specialized removal, treatment, and disposal. Use trained professional staff for any cleanup and remediation.
 - Report all spills that threaten or enter the sanitary or storm sewer system (503-823-7180).

ADDITIONAL RESOURCES

BMPs, including catch basin cleanout: BES Industrial Stormwater Program, 503-823-5320 or <http://www.portlandoregon.gov/bes/31844>

Disposal of sediment or hazardous waste: Metro Recycling and Solid Waste Hotline, 503-234-3000 or <http://www.oregonmetro.gov/index.cfm/go/index.cfm/go/by.web/id=571>

Oregon DEQ, 503-229-5263 or 800-452-4011, and ask for the Solid Waste duty officer

SEDIMENT AND OIL REMOVAL AND DISPOSAL

FACILITIES AND SYSTEM COMPONENTS THIS APPLIES TO:

- **Vegetated facilities:** ecoroofs, basins, planters, ponds, sand filters, swales, vegetated filters, and wetlands
- **Structural facilities:** catch basins, inlets, outlets and conveyance structures, manufactured stormwater treatment technologies, sedimentation manholes, and oil/water separator vaults
- **Underground infiltration facilities:** soakage trenches and drywells
- **Pervious pavement**

IMPORTANCE TO FACILITY PERFORMANCE

The purpose of a stormwater treatment facility is to remove pollutants, including suspended solids, by capturing sediment. Sediment can include dirt, leaves, and litter. These materials can restrict or clog the facility. Timely removal of sediment will improve infiltration rates and water quality and prevent clogging and flooding.

The area within a stormwater management facility that is intended to detain sediment requires routine clean-out to ensure continued function. General thresholds that indicate sediment removal is necessary are listed in **Exhibit 3-3**. If a stormwater management facility varies from the design standard, the sediment capacity will need to be measured. The total sediment capacity within a facility is the distance between the base of the facility and the base of the outlet. Sediment should be removed from a stormwater management facility when sediment accumulation reaches 30 percent of the total capacity. Thirty percent of a facility's capacity is calculated by multiplying the total capacity by 0.30. The depth of sediment in the stormwater management facility should be measured during routine maintenance events and noted in the maintenance log.

Exhibit 3-3. Standard sediment removal thresholds*

Type of stormwater management facility	Sediment removal threshold
Vegetated	2-4"
Filter Vault	4"
Sedimentation Manhole	1.5'

*Always check design details, O&M Plans, and manufacturer's guidelines for variance from the design standards.

MAINTENANCE INDICATOR

Check the depth of accumulated sediments. Sediment markers can be placed in the facility to help identify depths. Remove accumulated sediment according to the following guidelines.

Vegetated Facilities:

- sediment is filled to 30 percent of capacity (4 inches deep in a vegetated facility)
- sediment depth is damaging or killing vegetation
- sediment is preventing the facility from draining in the time specified in the O&M Plan
- sediment is blocking inlets and causing stormwater to bypass the facility

Structural Facilities:

- Sediment is blocking 50 percent of the conveyance system
- Sediment is filled to 30 percent of the capacity of the structure of the facility
- The catch basin is 1/3 full of sediment
- Sediment is 1½ feet deep in a standard sedimentation manhole
- Sediment is 4 inches deep in a standard oil/water separator vault

Underground Infiltration Facilities and Pervious Pavement:

- Sediment is preventing the facility from draining in the time specified in the O&M Plan

CORRECTIVE ACTION

Sediment often can be removed by hand. Large facilities and underground facilities will need to be cleaned with heavy equipment by trained professionals.

- Remove sediment during dry months when it is easier to remove, weighs less, and creates fewer secondary environmental impacts (such as wet sediment running off the site).
- Dewater sediment and dispose of decant water to the sanitary sewer system through an approved location with appropriate pretreatment.
- Generally, sediment can be disposed of in a designated solid waste collection bin. If sediment is an off-color or odorous, test first to determine the appropriate disposal requirements.

Vegetated Facilities:

- Use rakes and shovels to dig out accumulated sediment.
- If sediment is deep, plants may need to be removed in order to excavate sediment. Avoid damage to vegetation.
- Replant and mulch disturbed areas to prevent erosion.
- Excavate sand or gravel and clean or replace.

Structural Facilities, Drywells, Soakage Trenches, and Pervious Pavement:

- Catch basins: Clean debris off the grate. Lift the grate and use a bucket to remove water and a shovel to dig out sediment. Alternatively, hire a vacuum service to remove sediment from catch basins.

- Curb cuts, piping, and other conveyance structures: Use a shovel, air hose, or other dry method to clear sediment and debris.
- Drywells: Vactor sediment from inside facility.
- Soakage trenches: Consult with the City prior to excavating sand or gravel that requires cleaning or replacement.
- Pervious pavement: Remove accumulated sediment from the surface with a dry broom or vacuum system.

HIRING PROFESSIONALS

Cleaning certain facilities will require professional assistance:

- Underground facilities, such as manholes, drywells, and manufactured facilities, must be cleaned by a vactor truck. Do not enter these facilities. They are defined by the Oregon Occupational Safety and Health Division as confined spaces and require proper certification to enter.
- Certain components, such as collection basins, piping, or pervious pavement systems, may require vacuuming with a vactor truck or street sweeping equipment.

DISPOSAL

When deciding how to dispose of sediment, consider the types of activities and pollutants onsite. Sediment from commercial or industrial sites is usually not considered hazardous waste. However, as the generator of this waste, you are responsible for deciding how to properly manage the removed solids.

Contaminated Water and Sediment

Catch basins and stormwater facilities in areas used for chemical or hazardous waste storage, material handling, or equipment maintenance may collect the chemicals used in these activities from spills or via stormwater runoff. If you observe an oily sheen, odors, discoloration, or other signs of pollution, hire a professional laboratory or sampling firm to assess whether the material needs specialized hauling, treatment, or disposal to comply with Oregon DEQ rules. If you need assistance deciding whether the solids must be managed as hazardous waste, contact DEQ.

Noncontaminated Water and Sediment

Dispose of the water in a sanitary sewer through a shop drain, sink, toilet, or other appropriate drain. Let the solids dry out, then properly dispose of them. Temporary erosion control measures may be needed to contain the material onsite. Dry materials can be disposed of in a designated soil waste collection bin.

ADDITIONAL RESOURCES

Catch basin cleaning, material handling, and other BMPs:

BES Industrial Stormwater Section,
www.portlandonline.com/bes/index.cfm?c=34618

Hazardous waste:

DEQ, 503-229-5913, hw@deq.state.or.us, or www.deq.state.or.us/wmc/hw/hw.htm

Sediment removal: Look in Yellow Pages under “Sewage” or “Waste Disposal.”

VEGETATION MANAGEMENT

This applies to vegetated facilities: ecoroofs, basins, planters, ponds, sand filters, swales, trees, vegetated filters, and wetlands.

IMPORTANCE TO FACILITY PERFORMANCE

Plants play an important role in stormwater facilities. They absorb water, improve infiltration rates of soil, prevent erosion by stabilizing soil, cool water, and capture pollutants. Plants create habitat for birds and other wildlife and provide aesthetic value to a property. Proper maintenance of vegetation improves the appearance and performance of facilities.

MAINTENANCE INDICATOR

When identifying maintenance needs, it is helpful to have a copy of the landscape plan; this shows the required plants for the facility. Facilities must be checked for maintenance needs quarterly for the first 2 years and twice a year after that.

A facility needs maintenance when:

- Areas of soil are bare.
- Vegetation is buried by sediment.
- Vegetation appears unhealthy or has died.
- Nuisance and invasive plants are present.
- Vegetation is compromising the facility's structure by blocking inlets or outlets, or roots are intruding into a component of the facility.
- Vegetation is compromising public safety by blocking lines of sight or foot traffic in a public right-of-way.
- Dropped leaves and other debris are contributing to sediment accumulation or are blocking inlets or outlets.

CORRECTIVE ACTION

Maintenance activities can easily be incorporated into existing site landscape maintenance contracts. Vegetation can be maintained with a formal or more natural appearance, depending on your preference.

General Maintenance

- Remove dropped leaves, dead plants, and grass, and other plant clippings. Plant debris adds nutrient pollution as it breaks down and can clog facility piping and reduce infiltration.
- Avoid using fertilizers, herbicides, or pesticides in the facility. These products add to the pollution problems the facilities are designed to remedy.

- Use mulch to inhibit weed growth, retain moisture, and add nutrients. Replenish when needed. Mulch must be fine to medium hemlock bark or well-aged organic compost and must be placed in the facility only in areas above the high-water line. Mulch must be weed-free and applied 2-3 inches thick to cover all soil between plants. Ensure that mulch does not inhibit water flow in the flow path, inlets, or outlets.
- Irrigate all new plantings as needed for the first 2 years.
- Do not apply fertilizers, herbicides, pesticides, fungicides or other chemicals to stormwater management facilities. Nonchemical fertilizers may be used in limited amounts, during dry weather, and under the supervision of a trained professional.
- In facilities located in high-traffic areas, prune tall, dense vegetation to allow clear line-of-sight or designated foot paths.

Caring for Vegetation

Facility owners are responsible for maintaining healthy vegetation and must replace any plants that have died or been removed.

- You are required to maintain vegetation to the density approved on your landscape plan or specified in the facility description in [Chapter 2](#).
- Replant with vegetation approved for use in the original planting plan or from the recommended plant list in [Appendix F.4](#).
- Plant in late fall or early spring so plant roots can establish during the cool, rainy seasons, before winter and summer.
- Amend, aerate, and/or till compacted soils before replanting by adding well-aged compost to increase nutrients and enhance soil texture.
- If plants are not surviving, determine the reason for the plant die-off. Survivability may be improved by planting vegetation better suited for the site conditions or by irrigating more. You may need to test planting bed soils for pH, moisture, and other factors such as nutrient levels, soil structure, and organic matter content.
- Grassy facilities are designed for routine mowing. Mow at least twice a year.
- Grass must be mowed to keep it 4 to 9 inches tall.
- Grass that is at least 4 inches tall captures more pollutants and is hardier. Grass over 10 inches tall is considered a nuisance by City regulations.
- Manually remove nuisance and invasive vegetation such as Himalayan blackberry, English ivy, and reed canarygrass before it goes to seed in the spring. Do additional weeding in the fall. A list of nuisance plants can be found in the Portland Plant List. (See Additional Resources.)
- Immediately remove vegetation that is clogging or impeding flow into or out of the facility.
- Remove potentially large and deep-rooted trees or bushes when they might impede the flow path or compromise facility structures.
- Provide erosion control on any dirt exposed by vegetation removal.

Wildlife

Vegetated facilities create habitat, especially for birds. The Migratory Bird Treaty Act protects all native bird species. Birds and other animals will generally adjust to human activity. However, there are simple measures that must be taken to avoid disturbance:

- Walk the site before you do maintenance. Look for nests, burrows, and animals in the facility.
- Reroute around animal areas by at least a few yards or delay activities until animals are fledged or old enough to move out of the area.

ADDITIONAL RESOURCES

City of Portland naturescaping courses, native and invasive plant posters:

www.portlandonline.com/bes/index.cfm?c=dcbec

BES Watershed Revegetation Program:

www.portlandonline.com/bes/index.cfm?c=dffci

Portland Plant List (native and nuisance plants):

www.portlandonline.com/shared/cfm/image.cfm?id=58951

Environmentally Responsible Landscape Services BMP Guide for Landscape Businesses: <http://www.ecobiz.org/LANDSCAPE.pdf>

Plant Identification:

Native Plant Society, 503-460-3198 or www.npsoregon.org

Master Gardeners, www.orst.edu/extension/mg

Native Plant Nurseries:

Plant Native, www.plantnative.org

EROSION, BANK FAILURE, AND CHANNEL FORMATION

This applies to vegetated facilities: ecoroofs, basins, planters, ponds, sand filters, swales, trees, vegetated filters, and wetlands.

IMPORTANCE TO FACILITY PERFORMANCE

Stormwater flowing through a facility can cause erosion. Erosion can increase sediment buildup, clog outlets, reduce water quality benefits, add to pollution, and cause facility components to fail. Eroded channels create an easy path for water to travel down, reducing the ability of the facility to filter pollutants and infiltrate water.

MAINTENANCE INDICATOR

Any area with erosion more than 2 inches deep needs maintenance. Signs of erosion and common problem areas are:

- the formation of flow-restricting channels in the bottom of the facility, around inlet pipes and curb cuts, or at overflows
- undercutting, scouring, and slumping along banks or berms
- channels and undercutting through check dams

CORRECTIVE ACTION

- Fill the eroded area with City-approved soil mix, compact it lightly, and replant, seed, or cover with mulch.
- Plant banks with deep or heavily rooted plants to permanently stabilize soil.
- Plant the bottom of the facility with bunch grasses to slow water and stabilize soil.
- Install or repair structures designed to dissipate energy and spread flow, such as splash blocks on downspouts, or riprap around inlet pipes and curb cuts.
- Install temporary erosion prevention and sediment control measures in accordance with the *City of Portland Erosion Control Manual* until the problem is resolved and permanent measures are fully established.
- If erosion continues to be a problem, consult a professional to determine the cause and a solution.

STRUCTURAL REPAIRS OR REPLACEMENT

FACILITIES THIS APPLIES TO

Most stormwater facilities have some structural components. Some facilities, such as vaults, drywells, and sediment manholes, are completely structural. In vegetated facilities, structural components often control how water enters, travels through, or exits a facility. Common structural components include:

- inflow and outflow pipes
- valves, orifices, trash racks, and pipes, screens, baffles, weirs and covers
- concrete, metal, and plastic structures and components such as curbs, retaining walls, manholes, chambers, and vaults
- earthworks such as embankments, check dams, dikes, berms, and side slopes
- riprap and other flow-spreading elements
- access roads, gates, and signs

IMPORTANCE TO FACILITY PERFORMANCE

These elements need to be in good working order to route flows into and out of a facility and for the facility to function properly.

MAINTENANCE INDICATOR

Inspect the general condition of these elements. Assess if they need repair, replacement, or realignment. Look for the following:

- cracks, scratches, dents, rust, or other conditions of wear
- loose fittings, broken or missing components
- insufficient oil/grease for moving parts
- appropriate gravel cover or bedding to support the structures
- misaligned parts or other impediments to the component's ability to convey flow and contain sediment

MAINTENANCE

- Immediately repair or replace any major damage to prevent catastrophic failure. This includes any structural component that is cracked, loose, or askew. You may need to consult a professional engineer or hire a trained contractor to design and perform any repairs.
- Minor damage, such as dents or rust spots, may not need immediate replacement but must be monitored.

Maintain access to the facility by keeping the access route open and structurally sound, fence gates and vault lids oiled, and locks functioning. Access must be available for routine inspection and maintenance and in an emergency.

PONDING WATER

FACILITIES THIS APPLIES TO

- **Vegetated facilities:** dry ponds, basins, planters, sand filters, swales, and vegetated filter strips
- **Underground infiltration facilities:** soakage trenches and drywells
- **Structural facilities:** manufactured facilities and pervious pavement

Note: Some facilities are specifically designed to always hold water, such as wet ponds, spill control manholes, and sedimentation manholes.

IMPORTANCE TO FACILITY PERFORMANCE

Most facilities are designed to drain in a certain amount of time. This varies from 2 to 48 hours, depending on the type of facility. This time is stated in the facility design description in [Chapter 2](#) and in the O&M Plan. Ponding water for over 48 hours is usually a sign that the facility's outlet is clogged or the facility is not infiltrating properly.

MAINTENANCE INDICATOR

- clogging of overflows or outlets with debris, trash, or other obstructions
- fine sediments filtering into the soil or other filtration media (such as sand or gravel) that can prevent proper infiltration
- water that has remained ponded for more than 48 hours

MAINTENANCE

- Remove sediment. For more thorough instructions on removing sediment, see the previous Sediment and Oil Removal and Disposal subsection.
- For surface facilities, first try raking the top few inches of soil to break up clogged sections and restore infiltration.
- Clean out overflows and outlets with hand tools, if possible. Difficult or hard-to-access blockages may require a professional contractor.
- Identify sources of sediment and debris to prevent them from entering the facility. For more information on limiting sediment and debris from entering the facility, see previously discussed BMPs.
- Make sure the facility has enough vegetation. Vegetation absorbs water, and roots help keep soil loose so it can infiltrate water.
- If ponding still occurs, contact a landscape architect or engineer for more assistance.

PESTS

- This applies to all types of facilities.

IMPORTANCE TO FACILITY PERFORMANCE

Mosquitoes can breed in ponded or other stagnant water. Vegetated areas can be attractive habitat for rats, nutria, beaver, and a variety of birds and amphibians. While some species are desirable, others can be public health or nuisance concerns. In particular, mosquitoes and rats can breed quickly and cause a public health hazard if not removed. The presence of pests does not necessarily impact the ability of your facility to treat and manage stormwater, but may indicate maintenance needs, such as lack of proper infiltration.

MAINTENANCE INDICATOR

- Check for mosquito adults and larvae in any system with open, slow, or nonmoving waters, especially during warmer weather. Larvae look like tiny wiggling sticks floating perpendicular to the water's surface.
- Look for nutria, rat, and other animal droppings year-round. Also check for structural indicators such as beaver dams and rodent holes and burrows.

CORRECTIVE ACTION

Mosquitoes

- The best way to avoid breeding mosquitoes is to prevent ponding water. Mosquitoes need standing water to lay their eggs and for their larvae and pupae to develop. Most stormwater facilities are designed to drain in at least 48 hours. If your facility is not draining properly, see the previous Ponding Water and Sediment and Oil Removal and Disposal subsections.
- As a temporary control for mosquitoes, the county or other licensed professionals can apply pesticides to kill mosquito larvae in the water or adult insects in the air. However, pesticide application reduces the water quality benefits and must only be done as a last resort.
- Enclosed facilities, such as ponds, may be eligible to receive gambusia fish (also known as mosquito fish) from the county. Gambusia feed on mosquito larvae. See Additional Resources for contact information.

Rats

Rats need shelter, food, and water to survive.

- Remove plant debris that may provide shelter for rats from the facility.
- Remove fruits and nuts that fall to the ground.
- Fill in burrows.
- Contact Multnomah County Vector Control for trapping and removal.

Other Wildlife

Other nonnative and invasive animal species may take up residence in your facility. Contact the Oregon Department of Fish and Wildlife (ODFW) to help identify these species and suggest removal processes. Permits from ODFW are required to capture and relocate native wildlife.

Some common nonnative species are:

- Opossum
- Eastern cottontail
- Bullfrog
- Fox squirrel
- Nutria
- Red-eared slider turtle
- Eastern gray squirrel
- Egyptian goose
- Snapping turtle

ADDITIONAL RESOURCES

Rats and mosquitoes:

Multnomah County Vector Control, 503-988-3464,
vector.nuisance@co.multnomah.or.us, or www.mchealth.org/vector

Other wildlife:

Oregon Department of Fish and Wildlife, 503-947-6000 or 800-720-ODFW (6339) or
www.dfw.state.or.us/wildlife

SAFETY

In addition to keeping the facility in good working order, maintenance must also strive to meet safety goals that protect site workers and visitors. Consider establishing maintenance triggers and practices that respond to the following issues. Keep in mind the safety of both the employees who maintain the facility and the general public.

MAINTENANCE INDICATOR

Site Conditions

Conditions such as steep slopes, slick surfaces, covers in disrepair, and vegetation debris can create a falling hazard to employees and visitors.

Public Safety

If not regularly maintained, facilities can attract undesirable activity, vandalism, or use that could be harmful to public safety. Further, do not allow vegetation in facilities to block walkways or street intersections.

CORRECTIVE ACTION

- Use barrier plantings or fencing to bar entry into the facility area.
- In high-traffic areas, prune tall, dense vegetation to clear sight-lines and designated walkways around vegetated facilities.
- Install road bollards, lighting, and signage to discourage facility entry and illegal dumping.
- Avoid maintaining facilities in wet weather to reduce the risk of injuries from slipping. Always make sure that appropriate safety gear (e.g., harness, gloves, face shields, safety line) is used.
- For underground facilities, avoid entering anything defined as a confined space. Vaults, deep ponds, manufactured facilities, or manholes are examples of confined spaces. These areas require special permits, training, and entry techniques. Some can be inspected and cleaned from above without entering. Always use caution when working with underground facilities. You are legally required to meet Oregon Occupational Safety and Health Division requirements for such activities.

ADDITIONAL RESOURCES

Confined space entry:

Occupational Safety and Health Division confined space entry requirements, 503-229-5910 or www.orosha.org/subjects/confined_spaces.html

PAYING FOR MAINTENANCE

Maintenance costs depend on the characteristics of the facility or combination of facilities, the site, and the area draining to the onsite stormwater system. The general rule is that annual maintenance costs will be 5 to 10 percent of the facility's total capital cost. Routine scheduled maintenance can help keep overall costs down by addressing problems before they require major attention.

FINANCING MAINTENANCE

Clearly designate the entity responsible for long-term ownership, O&M.

Determine how to finance maintenance needs. A facility maintenance fund is recommended for both capital maintenance procedures (e.g., facility replacement and nonroutine maintenance such as major sediment removal, facility component repair or replacement, major replanting, or safety structure construction) and operating maintenance procedures (routine activities such as facility inspection, debris removal, and vegetation management). For homeowner associations, this could be a portion of homeowner fees or a specific assessment.

HOW MUCH TO SAVE

- An average of 5 to 10 percent per year of the facility's capital cost for annual routine maintenance.
- A percentage of the nonroutine maintenance costs per year (e.g., for sediment removal, vegetation replacement), based on the needed frequency. For example, if the facility is designed to need mechanical sediment removal every 5 years, 20 percent of the total cost must be put aside each year.
- An additional 3 to 5 percent of the facility's capital cost per year for eventual facility replacement (based on the facility's life expectancy). Most of these facilities have a life expectancy of 25 to 50 years. Property owners are expected to fully finance and replace facilities at the end of their lifecycles with facilities that provide the same function.

Vegetated Facilities

- Most required routine maintenance (excluding major repair and replacement) is estimated to have an annual cost of \$200 to \$600 dollars per acre of facility, above current landscape maintenance costs. Costs can vary, depending on the types and level of maintenance practices used.
- The cost and intensity of maintenance activities are usually higher during the 2-year plant establishment period. During that time, plants will need additional watering, and plants that die will need to be replaced.

Stormwater Operations & Maintenance Plan

Modified Example of

Ulysses S. Grant Middle School

2008 Gym with Parking and Play Area Expansion

February 29, 2008

Prepared by: Mr. Consultant
Project Manager
Stormwater Consulting LLC
Portland, Oregon

Property Owner: Ms. Doe
Facilities Director
Portland Public Schools
Portland, Oregon

Site O&M Responsible Party

The facility is to be maintained by Portland Public Schools. The preparer has worked closely with PPS personnel to design a system that can be easily maintained by maintenance staff and as educational projects for students.

PPS contact is Jane Doe, PPS Maintenance Manager, 503-555-0884.

A copy of the O&M Plan shall be provided to all property owners and tenants.

ONSITE STORMWATER SYSTEM DESCRIPTION

All of the runoff from the new gym rooftop will infiltrate into the ground through onsite swales and basins or overflow to an existing drywell. Water from the parking lot and paved areas will be treated by an infiltration planter with maximum infiltration; overflow will be directed to the combined sewer overflow. *See attached site plan.*

FACILITIES DESCRIPTION TABLE

Facility Name	Type	Size (sf)	Area Managed	IA Managed (sf)	Facility Base	Discharge Point
SW - A	Swale	360	Roof	3,000	30 mil membrane	Infiltration with overflow to trench - B
TR - B	Infiltration trench	100	Roof	3,000	None	Overflow from SW- A
BA - C	Basin	300	Roof	2,400	None	Infiltration with

						overflow to existing drywell
PL - D	Infiltration planter	250	Parking lot	3,200	None	Infiltration with overflow to sewer
PL - E	Flow-through planter	150	Playground	2,200	Concrete Bottom	To sewer
PP - F	Pervious pavers	1,200	Playground & parking	1,200	None	Infiltration
Total IA				12,000		

- ❖ Infiltration planters are landscaped reservoirs used to detain and filter stormwater runoff, allowing pollutants to settle and filter out as stormwater infiltrates into the ground. Higher flows are allowed to overflow the planter and flow to a trench.
- ❖ Flow-through planters are landscaped reservoirs used to detain and filter stormwater runoff, allowing pollutants to settle and filter out as stormwater percolates through the growing medium and landscaped area. Water is collected from the base and directed to the sewer. Higher flows are allowed to overflow the planter and flow to the combined sewer.
- ❖ Swales are vegetation-lined depressions with a longitudinal slope. They are used to detain, filter, and infiltrate stormwater. They are also used to direct stormwater away from the foundation and to the trench through two vertical 4-inch overflow pipes.
- ❖ Basins are vegetation-lined depressions used to detain, filter, and infiltrate stormwater. The basin is sized to infiltrate all of the water directed to it, but it does have two vertical 4-inch overflow pipes directed to an existing drywell.
- ❖ Permeable pavers are a pervious pavement with an underlying stone reservoir that temporarily stores and treats surface runoff, with final discharge through infiltration.
- ❖ Infiltration trenches are excavated areas lined with filter fabric, filled with gravel, and covered; water is piped to the top of the gravel lens. The trench detains the stormwater and allows for full infiltration.

INSPECTION/MAINTENANCE SCHEDULE

The property owner must inspect and maintain each part of the system shall be quarterly for the first 2 years of operation. Following the first 2 years of operation, the facility owner must inspect each part of the system twice a year. At any time, the facility owner must inspect and maintain each part of the system within 48 hours after a major storm event. For this O&M Plan, a major storm event is defined as 1.0 inches of rain in

24 hours or more. All components of the storm system as described above must be inspected and maintained according to City maintenance requirements or they will cease to function effectively. The facility owner shall keep a log to record all inspection and maintenance activities (see Sample Log). The facility owner must keep work orders, invoices and receipts on file to provide upon City request to document compliance with this site-specific O&M Plan.

INSPECTION / MAINTENANCE PROCEDURES

The following items shall be inspected and maintained as stated:

Planters and Swales

- Vegetation or roots from large shrubs and trees that limit access or interfere with planter operations shall be prevented.
- Fallen leaves and debris from deciduous plant foliage shall be raked and removed biannually.
- Nuisance and prohibited vegetation of all species shall be removed biannually. Invasive vegetation shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10 percent of area coverage or when planter function is impaired. Vegetation shall be replaced within 3 months or immediately if the season is appropriate in order to maintain cover density and control erosion where soils are exposed.
- The infiltration planter shall infiltrate within 48 hours after a storm event. If water continues to pond after that time, sources of possible clogging shall be identified and corrected. If necessary, the top layers shall be tilled and amended with compost; if this is not sufficient, they shall be removed and replaced with new freely draining growing medium.
- Inlets and outlets shall be inspected quarterly and after any large rain event.
- Any trash or debris that collects in the planter and may inhibit planter function shall be removed quarterly.

Permeable Pavers

- Vegetation, large shrubs, and trees that limit access or interfere with porous pavement operations shall be pruned.
- Vacuum sweeping of the pavers and the area draining to the pavers shall be implemented.
- More aggregate material shall be added to refill drainage voids in pavers if necessary after cleaning.
- Leaves and debris shall be raked and removed biannually.
- Poisonous, nuisance, dead, or odor-producing vegetation shall be removed.
- Pavers or pavement settling more than ½ inch or with visible damage shall be replaced or repaired.

Catch Basins, Trench Drains, and Piped Storm System

- Sediment shall be removed biannually.
- Debris shall be removed from inlets and outlets quarterly.
- Quarterly inspection for clogging shall be performed.
- Grates shall be tamper-proof.

Best Management Practices (BMPs) prevent pollutants from mixing with stormwater. Typical nonstructural control measures include raking and removing leaves, street sweeping, vacuum sweeping, and limited and controlled application of pesticides, herbicides, and fertilizers.

Spill prevention measures shall be exercised when handling substances that can contaminate stormwater. Virtually all sites, including residential and commercial, present dangers from spills. It is important to exercise caution when handling substances that can contaminate stormwater. Activities that pose the chance of hazardous material spills shall not take place near collection facilities.

- The proper authority and the property owner shall be contacted immediately if a spill is observed.
- A spill kit shall be kept near spill-prone operations and refreshed annually.
- Employees shall be trained on spill control measures.
- Shut-off valves shall be tested quarterly.
- Releases of pollutants shall be corrected within 12 hours.

Insects and Rodents shall not be harbored in any part of the storm system.

- Pest control measures shall be taken when insects/rodents are found to be present. Standing water and food sources shall be prevented.
- If sprays are considered, a mosquito larvicide such as *Bacillus thurendensis* or Altoside formulations can be applied only if absolutely necessary and shall not be used where it will enter groundwater or come into contact with any standing water. Sprays shall be applied only by licensed individuals or contractors.
- Holes in the ground located in and around the storm system shall be filled.
- Outfalls draining into vegetated swales shall be inspected and cleaned regularly to ensure no rodent activity, which can clog or decrease the efficiency of the storm system.

Access shall be maintained for all facilities so O&M can be performed as regularly scheduled.

- Existing drywells shall be raised with a locking manhole cover to ensure access.

SAMPLE ONSITE STORMWATER SYSTEM INSPECTION AND MAINTENANCE LOG

Inspection Log – Record the date and the personnel who conducted the site inspection. Record the infiltration rate if greater than 48 hours, a description of any and all spills and vector issues, sediment & oil depth, the percentage of vegetation coverage (desirable and undesirable), and the condition of the system components every quarter for the first 2 years of operation and twice a year after a major storm event thereafter.

Infiltration/Flow Control - All facilities shall drain within 48 hours. Time/date, weather, and site conditions when ponding occurs shall be recorded.

Pollution Prevention - All sites shall implement BMPs to prevent hazardous wastes, litter, or excessive oil and sediment from contaminating stormwater. Contact Spill Prevention & Citizen Response at 503-823-7180 for immediate assistance with responding to spills. Record time/date, weather, and site conditions if site activities are found to contaminate stormwater.

Vectors (mosquitoes and rodents) - Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Multnomah County Vector Control at 503-988-3464 for immediate assistance with eradicating vectors. Record time/date, weather, and site conditions when vector activity is observed.

Depth of Sediment & Oil – Take and record measurement at catch basins, conveyance systems, inlets, outlets and within the facility itself. Compare to capacity thresholds defined in the *Stormwater Management Manual* Section 3.2.4, Summary of Thresholds for Maintenance, or the site-specific O&M Plan.

Percent Vegetation Coverage – Record percent cover of desirable, dead, and invasive vegetation.

Condition of Structural Components – Record type and size of missing or broken components (i.e., width of cracks and/or extent of settling).

Maintenance:

Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities.

SAMPLE MAINTENANCE LOG

Date: <u>10/1/07</u>	Initial <u>BJK</u>
Work performed by: <u>AAA Landscaper under 3 yr contract.</u>	
Work performed: <u>Replanted parking lot swale with sedges & rushes.</u>	
Work Area or specific stormwater facility: _____	
Details: <u>*Work Order on file and available upon request.</u>	

Date: _____ Initials: _____
Work performed by: _____
Work performed: _____

Work area or specific stormwater facility area: _____
Details: _____

Date: _____ Initials: _____
Work performed by: _____
Work performed: _____

Work area or specific stormwater facility area: _____
Details: _____

Date: _____ Initials: _____
Work performed by: _____
Work performed: _____

Work area or specific stormwater facility area: _____
Details: _____

Date: _____ Initials: _____
Work performed by: _____
Work performed: _____

Work area or specific stormwater facility area: _____
Details: _____

Date: _____ Initials: _____
Work performed by: _____
Work performed: _____

Work area or specific stormwater facility area: _____
Details: _____

Date: _____ Initials: _____
Work performed by: _____
Work performed: _____

Work area or specific stormwater facility area: _____
Details: _____

3.4 O&M ENFORCEMENT

The City has the right to ensure site compliance with the recorded O&M Form and Plan filed with BES. City Code Section 17.38.040.C.2 states:

Failure to properly operate or maintain the water quality or quantity control facility according to the operation and maintenance plan may result in an enforcement action, including civil penalty, as specified in 17.38.045, Enforcement.

The Enforcement section of City Code authorizes BES right of entry to the property for inspections of the facility, the ability to issue a code violation, and the ability to take enforcement actions and levy civil penalties. The details of the BES enforcement process can be found in the Maintenance Inspection Program Administrative Rules (ENB-4.31) and the BES Enforcement Program Administrative Rules (ENB-4.15) available on the City Auditor's Office website at:

<http://www.portlandonline.com/auditor/index.cfm?c=28044&a=154207>

In general, BES inspectors will strive to work with site owners and operators to ensure proper facility O&M. If technical assistance still does not yield tangible O&M improvements, however, BES may take enforcement action. BES staff inspects sites to verify that the property owner is properly operating and maintaining stormwater management facilities. Upon completion of an inspection, the inspector provides a report addressed to the property owner and/or site contact that outlines any required corrective action, deadline to correct and City notification(if needed).

3.5 O&M REVISIONS

Stormwater system or individual stormwater management facility modifications subject to City review and approval include changes to the point of discharge, source of runoff, structural or vegetated components further described in the Maintenance Inspection Program Administrative Rules ENB-4.31.

Property owners and operators must consult with BES (503-823-5320) to determine if a permit and/or new O&M Plan is required prior to making onsite stormwater system or stormwater management facility modifications.

The City may require property owners to record a new O&M Form if the O&M Form on file with BES is inaccurate or otherwise insufficient. Insufficiencies include but are not limited to not fully describing the onsite stormwater system and not clearly identifying all responsible parties for O&M. The property owner must submit a draft O&M Plan to the City and receive approval prior to recording it with the County. A final recorded O&M Plan must be filed with BES. (See the O&M Form template and directions.)

Additionally, when applicable, updates to O&M Plans must meet City approval and approved Plans must be filed with BES. The City may require property owners to record updated O&M Plans, site maps, or facility details with the County and submit a recorded copy to BES.

Facility owners are encouraged to follow O&M maintenance activities in the current version of the *Stormwater Management Manual*.

Chapter 4 SOURCE CONTROLS

This chapter presents storm and sanitary source controls required for site uses and characteristics that generate, or have the potential to generate, specific pollutants of concern.

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4.1 OVERVIEW

Goals

Some site characteristics and uses may generate specific pollutants of concern or levels of pollution that are not addressed solely through implementation of the pollution reduction facilities identified in Chapter 2. The site characteristics and uses in this chapter have been identified as potential sources for chronic loadings or acute releases of pollutants such as oil and grease, toxic hydrocarbons, heavy metals, toxic compounds, solvents, abnormal pH levels, nutrients, organics, bacteria, chemicals, and suspended solids. This chapter presents structural source controls for managing these pollutants at their source.

Stormwater discharge benchmarks for pollutants exist in NPDES industrial stormwater general permits issued by the State of Oregon for facilities with industrial activities that are exposed to rainfall and stormwater runoff. The state also has water quality standards listed in Oregon Administrative Rules (OAR) 340 Division 041 for discharges to surface waters. The City used the state standards and industrial stormwater NPDES benchmarks in developing this manual's source controls to better enable stormwater discharges to meet those state criteria.

The specific source control requirements are based on the following goals and objectives:

- 1) Prevent stormwater pollution by eliminating pathways that may introduce pollutants into stormwater.
- 2) Protect soil, groundwater, and surface water by capturing acute releases and reducing chronic contamination of the environment.
- 3) Segregate stormwater and wastewater flows to minimize additions to the sanitary and combined sewer systems.
- 4) Direct wastewater discharges and areas with the potential for relatively consistent wastewater discharges (such as vehicle washing facilities) to the sanitary or combined sewer system.
- 5) Direct areas that have the potential for acute releases or accidental spills and are not expected to regularly receive flow or require water use (such as covered fuel islands or covered containment areas) to an approved method of containment or discharge.

- 6) Safely contain spills onsite, avoiding preventable discharges to sanitary or combined sewers, surface water bodies, groundwater, and underground injection control structures (UICs).
- 7) Emphasize structural controls over operational procedures. Structural controls are not operator dependent and are considered to provide more permanent and reliable source control. Any proposals for operation-based source controls need to follow the special circumstances review process and/or appeals process located in **Appendix D.9**. A proposal for operation-based controls must describe the long-term viability of the maintenance program in the **Source Control Special Circumstances Form**.

Laws

The requirements of this chapter are separate from requirements or conditions required by state or federal regulations or permits and in some areas are or can be more stringent.

Some discharges are prohibited from entering the City's storm sewer systems; those prohibitions are listed in City Code Chapter 17.39. See the website at <http://www.portlandonline.com/auditor/index.cfm?c=28866>

Section Overview and Use

Section 4.3 lists the site uses and characteristics that are subject to the requirements of this chapter and will therefore be subject to Bureau of Environmental Services (BES) Source Control review. **Sections 4.4 through 4.13** then provide detailed information about the required source controls. **Appendix D.8** and **Appendix D.9** outline the procedures and requirements for dewatering and source control special circumstances, respectively. **Appendix G.5, SW-511 and SW-510** includes an example of the sign and trash requirements.

- 1) Determine if the project has any of the characteristics or site uses listed in **Section 4.3**.
- 2) If yes, go to the applicable section for that characteristic or site use (**Sections 4.4 through 4.13**) and follow the requirements to design source controls for the project.
- 3) The site use may require submittal of the **Source Control Special Circumstances Form** with the permit application, as discussed in **Appendix D.9**, or submittal of the **Dewatering Form 4** and any associated applications, as outlined in **Section 4.4** and **Appendix D.8**.

4.2 APPLICABILITY

These source controls apply to all projects with the defined or proposed uses or characteristics listed in [Section 4.3](#), including new development, redevelopment, tenant improvements, violation cases, and existing sites proposing new offsite discharges.

For tenant improvements, only those areas of a structure or activity area being disturbed are required to make the relevant structural changes identified in this chapter. Existing activity areas that will have new activities that are listed in any of this chapter's sections must meet the requirements of the applicable section(s).

For facilities with new offsite discharges, only those proposed areas draining offsite are subject to these regulations.

The requirements of this chapter are in addition to the applicable pollution reduction, flow control, and infiltration/discharge requirements identified in [Chapter 1](#).

Development sites discharging to combined sewers are required to provide pollution reduction and flow control for stormwater in accordance with the standards outlined in [Chapter 1](#), and onsite storm and sanitary flows must remain separated until the offsite connection point.

Dewatering

Commercial building permit applications for new construction, additions, or improvements that will perform below grade excavation or discharge groundwater; or perform work during the winter months (Oct - May) and discharge construction-related stormwater (channelized/collected or pumped) to a City sewer system; or have a long-term discharge, must comply with [Section 4.4](#) and must submit the **Dewatering Form 4** located in [Appendix D.8](#).

Special Circumstances

Applicants may propose alternatives to the source controls identified in this chapter. In that case, the applicant must complete the [Source Control Special Circumstances Form](#) located in [Appendix D.9](#). Proposal of an alternative source control or alternative design element will require an additional City administrative review process and may delay issuance of related building or public works permits.

Chapter 4 sections are grouped into different categories for the purpose of special circumstances reviews:

- A technical review process applies to [Sections 4.5, 4.6, 4.7, 4.9, and 4.12](#).
- An advanced technical and engineering review process applies to [Sections 4.4, 4.8, 4.10, 4.11, and 4.13](#).

If the alternative source control is not approved and the applicant wishes to appeal the decision, the appeal process is described in [Appendix D.9](#).

Note: Developments that cite special circumstances in prior chapters are not exempt from the source control requirements of this chapter.

4.3 REQUIREMENTS

4.3.1 Site Uses and Characteristics That Trigger Source Controls

Projects with the following site uses and characteristics are subject to the requirements of this chapter:

- Site Dewatering and Discharges ([Section 4.4](#))
- Solid Waste Storage Areas, Containers, and Trash Compactors ([Section 4.5](#))
- Material Transfer Areas/Loading Docks ([Section 4.6](#))
- Fuel Dispensing Facilities and Surrounding Traffic Areas ([Section 4.7](#))
- Above-Ground Storage of Liquid Materials, Including Tank Farms ([Section 4.8](#))
- Equipment and/or Vehicle Washing Facilities ([Section 4.9](#))
- Exterior Storage of Bulk Materials ([Section 4.10](#))
- Soil, Stormwater, and Groundwater Management for Development on Land with Suspected or Known Contamination or Adjacent to Contaminated Sites ([Section 4.11](#))
- Covered and Uncovered Vehicle Parking Areas ([Section 4.12](#))
- Water Reclaim and Reuse Systems ([Section 4.13](#))

Detailed descriptions of these site uses and characteristics are found in each applicable section. Definitions of terms used are provided in [Definitions](#).

Applicants are required to address all of the site characteristics and uses listed in [Sections 4.4](#) through [4.13](#). For example, if a development includes both a fuel dispensing area and a vehicle washing facility, the source controls in both [Section 4.7](#) and [Section 4.9](#) will apply.

4.3.2 Groundwater Facility Design Requirements

[Section 4.4](#) requires the use of infiltration facilities for long-term groundwater discharges and in some cases construction-related stormwater or temporary groundwater discharges. The facility is required to be sized adequately to account for the anticipated flows. The design, depending on the receiving system, may need to incorporate water quality and flow control. An O&M agreement is required for long-term discharges and must follow the same standards as stormwater facilities, which are outlined in [Chapter 3](#) and [Appendix D.6](#).

4.3.3 Oil/Water Separator Design Requirements

Oil/water separators are required in [Chapter 1 Section 1.3.3](#) and [Chapter 4 Section 4.9](#). When an oil/water separator is required, then the following design criteria must be followed. See [Chapter 2 Section 2.3.2](#) for additional information about oil/water separators.

Areas Protected with a Cover or Located Inside a Structure:

Sanitary dischargers are allowed to use a baffled/API oil/water separator or a coalescing plate separator that must be designed to achieve 100 parts per million (ppm) non-polar oil and grease in the effluent from the peak flow generated by the activity. Manufacturer testing information that supports the 100-ppm effluent standard at the calculated flow rate must be submitted with the plans. See the typical detail in [Appendix G.5, SW-501](#).

- Standard flow from a 5/8-inch hose is estimated to be 10 gallons per minute (gpm).
- For specially designed washing units, check the vendor specifications for maximum flow rates.

Any pumping devices must be installed downstream of the separator to prevent oil emulsification.

Separator details must be shown on the building plans submitted at the time of the building permit application and must match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.

Areas Exposed to Rainfall:

In addition to the above requirements, a coalescing oil/water separator (no baffles) in an area exposed to rainfall must be designed with a high-flow bypass to route flows greater than the operational rate around the unit, unless the operational rate exceeds the flow rate generated by a 10-year storm, as calculated with the Rational Method ($Q=C*I*A$, $I=2.86''$ /hour for 10-year storm). A separator discharging to the storm system must be designed to achieve 10 parts per million (ppm) total oil and grease in the storm effluent in the peak flow generated by the activity. Manufacturer testing information that supports the 10-ppm effluent standard at the calculated flow rate must be submitted with the plans. See the typical detail in [Appendix G.5, SW-501](#).

Washing and fueling areas exposed to rainfall will be accepted by approval of a special circumstance only. See [Appendix D.9](#) for the special circumstance submittal requirements. The City will charge the owner sanitary volume charges for the

stormwater discharged to sanitary or combined sewer systems. The sanitary volume charges will be based on the impervious area and average rainfall minus the onsite stormwater management impervious area charge or by the installation of a discharge meter through the BES submeter program. The discharge will be charged at sanitary sewer volume rates, per City Code Chapter 17.36.

4.3.4 Laboratory Testing Requirements

Laboratory reports are required for dewatering discharges, development on or near contaminated sites, or water reclaim and reuse systems, as specifically outlined in [Sections 4.4, 4.11](#) and [4.13](#).

Laboratory analysis reports are required to identify the characteristics and levels of pollutants or contamination in the soils, stormwater, or groundwater.

The analytical data is required to be submitted with the development plans, and is required as part of the BES Source Control review. The data will be used to determine appropriate pretreatment, volume control, and discharge location requirements. The sampling plan must be comprehensive and representative of the media being evaluated. The analytical data must provide information on the contaminants of concern (COCs). Sometimes a current Environmental Site Assessment Phase II contains the needed analytical data or can provide guidance on where additional sampling is needed.

The laboratory analytical results will be assessed and compared against City code, water quality standards, local limits, or additional or other applicable standards for the media type, or receiving system.

Depending on the receiving system and media, a DEQ or City permit may be required if pollutants or contaminants are found or if a discharge that there is a reasonable potential the discharge may become polluted in the future. This may delay issuance of related building permits because BES Source Control will not sign off on permits that are still being evaluated for pollutants or contaminants in the stormwater, groundwater, or soils.

Laboratory analysis reports must include the following information:

- The method of laboratory testing, the detection level and analytical method for detection, and the depth of any contaminants found in the soils must be identified;
- Minimum test parameters for baseline contaminants must include metals (arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver,

and zinc), TPH (total petroleum hydrocarbons), and BTEX (benzene, toluene, ethyl benzene and xylene);

- Test parameters for known contaminants of concern;
- Test parameters may be required to include other contaminants identified through historical data, research, and environmental assessments (as required under [Section 4.11](#));
- The elevation of the seasonal water table and identify the depth of any perched water tables (aquifers) must be identified.

4.3.5 Signage Design Requirements

Informational signage is required for some site uses and activities that have the potential to contaminate stormwater. [Sections 4.6, 4.7, and 4.8](#) require signage. Signage addresses good housekeeping rules and provides emergency response measures in case of an accidental spill.

Any applicable spill response supplies need to be clearly marked and located where the signage is posted and near the high-risk activity area. More than one spill response kit may be necessary to accommodate larger activity areas. The City expects spill response supplies, such as absorbent material and protective clothing, to be available at all potential spill areas. Employees should be familiar with the site's operations and maintenance plan and/or proper spill cleanup procedures.

All signage must conform to the requirements described below. Signage requirements for specific activities are noted in applicable sections, and spill signage examples are provided in [Appendix G.5, SW 5-11](#)

- Signs must be located where they are plainly visible from all activity areas. More than one sign may be needed to accommodate larger activity areas.
- Signs must be water-resistant.
- Signs must provide safety precautions.
- Signs must provide immediate spill response procedures – for example: “Turn the valve located at . . .” and “Use absorbent materials.”
- Signs must have emergency contact(s) and telephone number(s) – for example: “Call 911” and “City of Portland (BES) Spill Response Number 503-823-7180.”

4.3.6 Other Requirements

Conformance with this chapter's requirements does not relieve the applicant of other applicable local, state, or federal regulatory or permit requirements. This chapter is intended to complement any additional requirements and is not expected to conflict with, exclude, or replace those requirements. In case of a conflict, the most stringent local, state, or federal regulations generally apply. Any conflict will be resolved by a City review representative in consultation with appropriate agencies. Some of the more common additional requirements that may apply are summarized below.

Stormwater and Wastewater Discharge Permit Requirements

Some facilities may be required to obtain a State of Oregon NPDES industrial stormwater permit, City of Portland discharge permit, or enter into a discharge authorization with the City of Portland before discharging to the City's separated storm sewer system or to waters of the state. Applicants may also be required to obtain an industrial wastewater permit for discharges to the sanitary sewer system.

Facilities subject to these requirements are generally commercial or industrial. Typical discharges include process wastewater, cooling water, groundwater, or other discharges generated by some of the sources in this chapter that drain to a City sewer system (storm, sanitary, or combined).

Industrial Discharge and Development Permit Review Process:

An evaluation will be performed during the building permit review process to determine if an industrial discharge permit is required. If a discharge permit is required, the permit application process will be independent of the building permit review/issuance process, except for the DEQ 1200-C NPDES general construction permit. The 1200-C permit must be issued prior to BES Source Control's approval of the development permit(s). In addition, the BES Source Control plan reviewer of the building permit application(s) may require revisions to accommodate industrial permitting compliance requirements (e.g., sampling points, pretreatment facilities). If industrial permitting is not applicable at the time of building permit submittal, changes in regulations or site activities could trigger industrial permitting requirements in the future.

For questions regarding these requirements, contact BES Industrial Source Control Division Plan Review at 503-823-7122.

Private Underground Injection Control (UIC)

If discharge to a private UIC (drywells, sumps, and piped soakage trenches) is desired, the federal Safe Drinking Water Act requires a state-issued UIC Authorization by Rule

or a Water Pollution Control Facility permit for facilities that have subsurface discharges of stormwater or wastewater. These permits must be obtained from DEQ before any subsurface injection system is constructed. Site uses that are classified as high risk under this chapter are generally not allowed to use UICs for stormwater discharge. The use of UICs for stormwater discharge is prohibited for:

- **Section 4.6:** Material Transfer Areas/Loading Docks
- **Section 4.7:** Fuel Dispensing Facilities and Surrounding Traffic Areas
- **Section 4.9:** Equipment and/or Vehicle Washing Facilities

See **Chapter 1, Section 1.4** for information on infiltration prohibitions in certain areas of the City and additional UIC requirements.

Wellhead Protection Program

The storage, use, and transportation of hazardous/toxic materials in designated wellhead areas is regulated under the Water Bureau's *Columbia South Shore Well Field Wellhead Protection Area Reference Manual* (June 25, 2003). The manual can be found on the Water Bureau's website at <http://www.portlandoregon.gov/water/29880> See the SWMM **Section 1.3.5** for additional information.

Other Local, State, and Federal Regulations

The requirements presented in this chapter do not exclude or replace the requirements of other applicable codes or regulations, such as the hazardous substances storage requirements of articles 79 and 80 of the Oregon State Fire Code, the spill prevention control and containment (SPCC) regulations of 40 CFR 112 (EPA), the Resource Conservation and Recovery Act (RCRA), or any other applicable local, state, or federal regulations or permit requirements.

4.4 SITE DEWATERING AND DISCHARGES

4.4.1 Overview

Ground water may be pumped and put to beneficial use under statutes regulating the use of waters of the State. For purposes of development, however, ground water is increasingly pumped to waste (discharge of groundwater as a waste). BES has substantial concerns with long-term pumping of groundwater for dewatering and long-term groundwater remediation. Pumping groundwater has the following potential consequences:

- Subsidence (soil settlement that may compromise City infrastructure or adjacent structures).
- Lack of watershed recharge.
- Exacerbating migration of hazardous substances (pollutant/contaminant) onsite or on adjacent properties.
- Exceeding the design capacity of the sewer system. The existing City sewer system was designed to accept only stormwater and/or sanitary flows, depending on the receiving system. It was not designed to accommodate groundwater discharges and therefore has limited capacity.

In addition, BES has been implementing programs to remove stormwater from the combined sewer system in order to reduce combined sewer overflow (CSO) events and treatment costs at the wastewater treatment plant. BES also has established the stormwater hierarchy in this manual to dispose of stormwater onsite in order to ensure the availability of conveyance system capacity for future urban growth and anticipated increased densities and to mimic pre-development hydrologic conditions to meet the goals of the *Portland Watershed Plan*. Pumping groundwater and discharging to a City conveyance system counters the policy decisions that BES has promulgated in the past and foresees for the future.

For these reasons, sites that are proposing or are required to install temporary or long-term groundwater dewatering systems, including dewatering wells, perimeter drains or piping around, under, or near a structure, are required to meet the criteria in this section.

4.4.2 Applicability

This section applies to temporary or long-term dewatering pumping and discharge to waste of ground water (discharge of groundwater as a waste), typically associated with development or remedial action activities. This includes, commercial building permit applications for new construction, additions, or improvements that will perform below

grade excavation or discharge groundwater; or perform work during the winter months (Oct - May) and discharge construction-related stormwater (channelized/collected or pumped) to a City sewer system; or have a long-term discharge. These discharges must comply with this section and must submit the [Dewatering Form 4](#) located in [Appendix D.8](#). In addition, there are requirements in this section for structures located in flood areas.

Private discharges to a City UIC system are prohibited. Other alternatives must be selected, which include onsite discharge, sanitary sewer discharge, or hauling the water offsite to an approved discharge location.

If the property is known or suspected to have contamination or is adjacent to a property with known or suspected contamination, refer to [Section 4.11](#) for additional requirements.

Not Applicable

This section does not apply to stormwater-only sheet flow discharges that are covered under a NPDES 1200-C state permit or City Code Chapter 10 and the City *Erosion Control Manual*.

USING THE DEWATERING & DISCHARGES SECTION:

1. Discharges associated with flood waters are required to design their mechanical systems to meet the requirements as described in [Sub-Section 4.4.3](#) below. The other sub-sections are not applicable to flood waters but are applicable to the temporary or long-term groundwater discharges that may be part of the project design.
2. Discharges that are temporary only (as defined in the [Definitions](#) Section) must comply with [Sub-Sections 4.4.4, 4.4.6, 4.4.7 and 4.4.8](#).
3. Discharges that are long-term (as defined in the [Definitions](#) Section) must comply with [Sub-Section 4.4.5, 4.4.6, 4.4.7, 4.4.8](#).

4.4.3 Requirements for Structures Designed to Flood

Structures designed to flood during a flood event (also called wet flood proofing) are typically designed to allow flood water to enter the structure (i.e., snorkel system). For this type of design, the sewer ejector sumps must be shut down when water is allowed to accumulate in the structure. Typically, the snorkel (or similar device) is equipped

with a sensor that trips the power and turns the sewer ejector sumps off. Once the flood waters subside, the pumps must be manually turned on.

The discharge is subject to the City's discharge authorization program requirements. A batch discharge authorization and discharge approval granted by the City is required prior to discharging this water to a City system.

Signs must be posted next to the sumps' control panel, outlining the discharge procedure for the accumulated water. The sumps must be designed to limit the pumping rate to 50 gallons per minute or another site-specific, approved flow rate.

4.4.4 Discharge Assessment for Temporary Discharges into City Systems

The following standards apply to proposed temporary discharges. Temporary discharges include both stormwater and groundwater as defined in the applicability section above.

1. The applicant for a Batch Discharge must demonstrate that they have reduced the proposed discharge to the greatest extent practical.
2. The City will not accept private discharges to its Underground Injection Control facilities (UICs).
3. The City will not accept discharges that are prohibited by Titles 17.34 and 17.39 do not meet Water Quality Standards or do not meet other rules or limitations.
4. In general, the City will accept temporary discharges into its systems only if the system has sufficient capacity to handle the discharges. In areas where the existing City conveyance system has limited capacity for the proposed temporary dewatering discharge, the City may deny the request or require the discharger to substantially reduce the discharge to a de minimis standard or require additional detention, limited discharge rates, or impose day/time restricted discharge requirements.

4.4.5 Discharge Assessment for Long-Term Discharges

The following standards apply to proposed long-term discharges. Long-term discharges usually only include groundwater discharges.

1. The City will not accept private discharges to its Underground Injection Control facilities (UICs).
2. The City will not accept discharges that are prohibited by Titles 17.34 and 17.39 do not meet Water Quality Standards or do not meet other rules or limitations.
3. In areas where there is limited capacity to accept additional flows and in areas that are required to detain stormwater under other parts of this SWMM, groundwater discharges will also be held to the same or more stringent detention requirements as those found in other parts of the SWMM.
4. In general, the City will allow long-term groundwater pumping and discharge to waste only after the applicant has demonstrated the development will fully implement, in priority order described here, measures designed to substantially reduce flows to a de minimis standard. Measures that must be implemented in priority order include:
 - a. The proposed discharger has first reduced, to the greatest extent practical, the rate and volume of required pumping and discharge. This can include building design and construction measures that substantially reduce infiltration of water into buildings, such as dry waterproofing with membrane liners and waterstops at all the points of connections or other technologies that will substantially dry waterproof without the need for piping or drainage. The reductions must, at a minimum, remove seepage that is greater than a cumulative four (4) inches of water over a continuous 24-hour period. The calculation will be based on the total square footage of each floor the water seepage/weeping will be occurring on.
 - b. The proposed discharger must establish management policies designed to allow effective use of structures and properties in the presence of some groundwater infiltration. For instance, BES may disapprove pumping and discharges when the groundwater pumping is to prevent or reduce cosmetic or aesthetic effects of

groundwater infiltration, rather than to protect structures or to allow reasonable use of structures.

- c. When pumping and discharge to waste is permitted, to the greatest extent practical discharge shall be on-site through, for instance, vegetated swales and other infiltration facilities. The responsible party must consult with the DEQ to determine what private discharge methods are appropriate. BES will also coordinate with the DEQ. Failure of DEQ or other regulatory bodies to grant specific permits for such discharges does not automatically justify discharges into City systems. Failure of DEQ or other regulatory bodies to grant permits for such discharges does not automatically constitute adequate justification for discharge into the City system.

(Note: On contaminated sites, to ensure migration of contaminants from the soil do not contaminate groundwater, or to ensure the increased hydrologic loadings do not further exacerbate or migrate groundwater contamination, infiltration facilities may be required to be lined with an impervious liner, which, creates a flow through facility. These sites are assessed on a case-by case basis by the DEQ and the BES. Required lining will depend on the level and type of contamination and the contaminants mobility in groundwater and stormwater. In addition, injection facilities may not be allowed due to the possibility of further exacerbating and mobilizing soil and groundwater contaminants. For contaminated sites, please also reference [Section 4.11.](#))

- d. If on-site discharge is not practical for all the pumped groundwater, the discharger shall, to the greatest extent practical, use a private conveyance system and dispose of the discharge directly to a surface water body. The responsible party must consult with the DEQ to determine if proposed discharge methods are appropriate. BES will also coordinate with the DEQ. Failure of DEQ or other regulatory bodies to grant specific permits for such discharges does not automatically justify discharges into City systems.
5. The City will accept groundwater discharges into its own sewer systems only if the proposed discharge has been reduced to the greatest extent practical and there is adequate capacity in the intended City receiving system to convey the discharges.

Groundwater discharges to a City sanitary sewer or combined sewer system is prohibited if there is a storm only sewer or other alternative available.

Capacity will be evaluated by City modeling staff and others. Depending on the receiving system, capacity calculations will consider future development that will need capacity for the 10-yr stormwater event or future sanitary domestic and industrial needs. Groundwater discharges will not take precedence over future developments capacity needs for stormwater or domestic/industrial discharges. Capacity is defined in the *Sewer and Drainage Facilities Design Manual* and in [Appendix A.1](#) of this Manual. If the existing City conveyance system has limited or no available capacity for a long-term dewatering discharge, the City may accept ground water discharges only after sewer or drainage conveyance systems are constructed or extended through the public works permitting process.

4.4.6 Choosing the Proper City System for Discharge

After the applicable requirements in [Sub-Sections 4.4.4 and/or 4.4.5](#), located directly above, have been met and if discharge to a City system is still needed, the proposed dewatering discharges will be evaluated and assessed by using the regulatory review described below. Based on the regulatory review, BES will determine whether it will accept discharges into its system and which conveyance system may accept the proposed discharge.

Regulatory Review: Laboratory analysis reports are required to be submitted and are used to identify the characteristics and levels of possible pollutants or contaminants in the soils, stormwater, and groundwater at a site. See [Section 4.3.4](#) for minimum laboratory testing and analyte requirements. The analytical data is required to be submitted with the development plans, and will be used to determine appropriate pretreatment, volume control, and discharge location requirements. The sampling plan must be comprehensive and representative of the flow/discharge being evaluated. The analytical data must provide information on the contaminants of concern (COCs). Sometimes a current Environmental Site Assessment Phase II contains the needed analytical data or can provide guidance on where additional sampling is needed.

The laboratory analytical results will be assessed and compared against City code, water quality standards, local limits, or additional or other applicable standards for the receiving system. Based on the assessment of the data, the City will determine the best system to accept the discharge and choose the appropriate system below using the criteria specified throughout the Dewatering and Discharges Section.

The discharge will be directed to the City storm only system:

In general, uncontaminated discharges will typically be directed to an available storm only sewer system and after all requirements in the applicable Sections above are met.

If discharging to a drainageway as defined in City code Chapter 17.38, the requirements in that Chapter also apply and must be met before approval of discharge can be granted.

Depending on the receiving system, a City or State permit may be required. If a City or State permit is not issued at this time, a City and/or State permit may be required in the future as discharge characteristics, circumstances or rules change.

The discharge will be directed to the City sanitary or combined system:

Discharge to the City sanitary sewer is allowed only if the discharge is considered to be contaminated and can not discharge to the storm sewer. If the discharge is not contaminated, it is not allowed to discharge into the sanitary or combined sewer (if alternatives exist) unless a Special Circumstance has been granted through the Source Control Administrative Advanced Technical and Engineering Review process in [Appendix D.9](#).

Contaminated discharges or regulated flows into the sanitary sewer system may need to be regulated under a City pretreatment permit. If a pretreatment permit is not required, a batch discharge is required for temporary discharges and a long-term authorization is required for long-term discharges. See [Sub-Section 4.4.7](#) for batch discharge and long-term discharge requirements.

A pretreatment permit may be required in the future as discharge characteristics, circumstances or rules change.

4.4.7 Compliance and Submittal Requirements

The sampling point below is required to monitor continued compliance with the City's requirements. The O&M and property deed recording of the Notice of Conditions are also compliance related requirements; in addition, these items along with the forms must be addressed and submitted at the time of building plan review.

1. **Sampling points.** A sampling point for both temporary and long-term discharges is required in order to obtain samples of the discharge and ensure compliance with all applicable regulations and discharge limitations. The sampling point must be in an area that receives the representative flow and is not commingled with other flows. The City reviewer will coordinate the sampling structure location with the

applicant. An acceptable sample location includes a sampling manhole, 6-inch clean-out, or sample box/vault.

2. **Submittal Package.** [Appendix D.8](#) outlines the materials and information that must be submitted as part of the building and/or connection permit package submittal. Some of the requirements include: analytical data, identification of source controls, treatment devices, sampling points, and the discharge location. Rates, volumes, and a discharge timeline must also be submitted in order for the City to assess capacity in the receiving system. All connections to a public system require a BES connection permit and are subject to connection requirements. In addition, the following discharge specific requirements apply.

Additional requirements that apply to specific discharges:

Temporary Discharges

Authorization Forms: When a temporary discharge of groundwater or construction-related stormwater (channelized/collected or pumped) is proposed to a City conveyance system, AND section 4.4.4 above has been met, a City Batch Discharge Authorization must be issued by the BES Source Control Division. The Batch Discharge Authorization Application located in [Appendix D.8, Form 5](#) must be completed and submitted with the building or connection permit application. The batch authorization procedures are outlined and implemented by the appropriate work group within the BES Source Control Division.

Long-Term Discharges

Authorization Forms: When a long-term discharge is proposed to a City system, AND section 4.4.5 above has been met, the Long-Term City Discharge Authorization located in [Appendix D.8, Form 7](#) must be completed and submitted with the building or connection permit application. The Long-Term Authorization procedures are outlined by the appropriate work group within the BES Source Control Division.

O&M Agreement: Infiltration is required for long-term discharges. The responsible party must submit a recorded O&M agreement for the groundwater infiltration facility and meet the same requirements as stormwater infiltration facilities, which are outlined in [Chapter 3](#) and [Appendix D.6](#). For infiltration facility design requirements, see [Section 4.3.2](#).

Recording Notice of Conditions against the property deed: Long-term dewatering dischargers must record a notice of conditions of the discharge against the property.

The conditions notice will inform property owners of the groundwater discharge, the City's authorization of the discharge, and provide the City's notification mailing address to inform the City when the characteristics of the discharge change, or when there is a new owner of the property. See **Appendix D10** for a sample Notice of Conditions form. This Notice must be submitted during the plan review process.

4.4.8 Associated Charges

1. **Submeter program and volume fees:** Temporary and long-term groundwater discharges are subject to the submeter program, and procedures identified within that program. Stormwater discharges associated with construction may also incur volume fees. The installation of a charge submeter must be placed on the final discharge (after the final treatment, if applicable) to the City sewer system in order to assess volume charge fees. Depending on the receiving conveyance system, volume fees may not apply. The fees and requirements are located in City Code Chapter 17.36. If the submeter is located inside a building, a remote reader must be placed outside the building on private property, in a location easily accessible to City personnel. The Submeter Program Application is required to be submitted at the time of plan review and is located in **Appendix D.8, Form 6**.
2. **Sewer Development Charge (SDC):** Payment of the SDC fee at the time of issuance of the building permit, or if no building permit, before the issuance of the BES connection permit for long-term dewatering connections. The approved groundwater discharge will be assessed the receiving systems applicable SDC which will be based on the requirements in City Code Chapter 17.36 and associated rules.

4.5 SOLID WASTE STORAGE AREAS, CONTAINERS, AND TRASH COMPACTORS

4.5.1 Applicability

A solid waste storage area is an indoor or outdoor place where solid waste containers are collectively stored. Solid wastes include both food and non-food waste or recycling. Solid waste containers include compactors, dumpsters, compost bins, grease bins, recycling areas, and garbage cans.

Applicable

- All commercial and industrial development with facilities that store solid wastes, both food and non-food.
- Indoor and outdoor solid waste storage areas.
- Multi-family residential sites if a shared trash collection area is proposed.
- Activity areas used to collect and store refuse or recyclable materials, such as can or bottle return stations and debris collection areas.

New Buildings (Including Shell-only Permits) or Activity Area Construction

New constructed buildings and storage areas will house or accept many different activities over the structure's life; therefore, all new construction must meet all of the requirements of this section and cannot follow the tenant improvement track below, unless accepted through the administrative review process outlined in [Appendix D.9](#).

Tenant Improvements

Because of different tenant activities, solid waste characteristics change; therefore, all tenant improvements must have the facility's solid waste categorized as low or high risk by BES Plan Review, using the following definitions.

- **High-risk** solid wastes are putrescible, toxic, greasy or oily; or attract vectors, such as flies and rodents; or have an odor or high moisture content. Some examples of uses that generate high-risk solid waste include, but are not limited to, restaurant, deli, bakery, grocery store, hotel, hospital, and metal fabrication.
- **Low-risk** solid wastes are non-putrescible (or very low) or nontoxic and free of excessive liquids. Some examples of uses that generate low-risk solid wastes include, but are not limited to, realtor office, dental office, shoe store, or movie store.

If the stored waste generated by the tenant is categorized as high-risk, all of the structural changes outlined in this section apply. This is required even if no plumbing changes are proposed as part of the overall improvements.

If the stored waste generated by the tenant is categorized as low-risk, all of the structural changes outlined in this section apply if the solid waste storage area is new, is being moving from its existing location, or is being changed or altered.

Not Applicable

- Single-family homes.
- Debris collection areas used only for the storage of wood pallets or cardboard. Facilities that are processing/recycling wood pallets or cardboard, and that is their business, are not exempt and will need to follow the requirements.

A trash area detail is provided in [Appendix G.5, SW-510](#). This detail is for reference only. Note that the BES regulation does not require walls and screening.

4.5.1 Requirements

The table below summarizes the design requirements that apply to the areas described above and are required for an approval of solid waste storage and handling activity areas in the City of Portland. The following text provides additional information about each requirement.

ACTIVITY/USE	REQUIREMENTS		
	(1) Cover	(2) Pavement	(3) Drainage
Multi-family (with shared trash areas)	X	X	X*
Commercial	X	X	X
Industrial	X	X	X
Compactors (regardless of use)		X	X
Can and bottle return stations	X	X	X
* If gravity service to the sanitary sewer lines cannot be obtained, a special request can be made to direct the drainage from the hydraulically isolated activity area to the development's stormwater pollution reduction facility. This applies only to multi-family uses. For more information, refer to the Administrative Review section below.			

COVER

A permanent canopy, roof, or awning must be provided to cover the solid waste storage activity area. It must be constructed to cover the activity area so rainfall cannot come in contact with the waste materials being stored.

The cover must be sized relative to the perimeter of the hydraulically isolated activity area it is to cover.

Runoff must be directed from the cover to a stormwater discharge point that meets all applicable code requirements.

PAVEMENT

The area beneath the cover must be a hydraulically isolated area (no stormwater run-on or liquids running off this area) and paved with asphalt or concrete. The paved area must be sized adequately to cover the activity area intended for refuse storage or the trash compactor(s) and associated equipment.

DRAINAGE

The area beneath the cover must be a hydraulically isolated area, which means the area must be designed to prevent uncontaminated stormwater run-on from entering the sanitary drain or entering the storage area and carrying pollutants away in runoff. This can be accomplished by grading or berms.

Drainage must be provided for the hydraulically isolated area and directed to a sanitary sewer.

Runoff occurring outside the hydraulically isolated area must be directed to a stormwater discharge point that meets all applicable code requirements. This can be achieved by reverse grading at the perimeter of an activity area, perimeter curbing or berming, or the use of area drains to collect and divert runoff.

Non-gravity option: Activity areas that do not have gravity sanitary sewer service may be allowed to install a pressurized system. With these types of installations, the following items must be provided at the time of building permit application:

- Verification or evidence that gravity service cannot be obtained.
- Details of an electronic sump pump system equipped with a float switch.

Pressurized system installations are considered “permanent equipment” and deemed the property owner’s liability in the event of system failure or if the property becomes vacated.

The Bureau of Development Services (BDS) Commercial Plumbing Division will review all sump pump or sewage ejector installations for compliance with the Uniform Plumbing Code and Oregon State Plumbing Specialty Code.

ADMINISTRATIVE REVIEW

Multi-family developments with shared trash areas may be allowed an alternative to the sanitary drain for the hydraulically isolated solid waste storage area. This activity area may be allowed to drain to the site’s privately owned and operated stormwater pollution reduction facility if gravity service to the sanitary sewer pipe of the development cannot be obtained. For the alternative to be considered information showing that gravity service cannot be obtained and a completed **Source Control Special Circumstances Form** located in **Appendix D.9** must be submitted. All other requirements previously outlined for multi-family uses apply.

4.6 MATERIAL TRANSFER AREAS/LOADING DOCKS

4.6.1 Applicability

Applicable

The requirements in this section apply to all developments proposing the installation of new material transfer areas or structural alterations to existing material transfer areas (e.g., access ramp regrading, leveler installations) with the following characteristics.

- The area is designed (size, width, etc.) to accommodate a truck or trailer being backed up to or into it, and
- The area is expected to be used specifically to receive or distribute materials to and from trucks or trailers.

Two standard types of material transfer areas associated with buildings are:

- Loading/unloading facilities with docks
- Large bay doors without docks

The requirements apply to all material transfer areas, including loading/unloading docks, bay doors, and any other building access point(s).

Not Applicable

The requirements do not apply to areas that are used strictly for mid-sized to small-sized passenger vehicles and that are restricted by lease agreements or other regulatory requirements to storing, transporting, or using materials that are classified as domestic use. Examples of domestic uses include primary educational facilities (elementary, middle, or high school), buildings used for temporary storage (a lease agreement must be provided), and churches. Contact BES's Industrial Source Control Division at 503-823-7122 for help in determining if requirements apply.

4.6.2 Requirements

PAVEMENT

A paved material transfer area of asphalt or concrete must be placed underneath and around the loading and unloading activity area and must meet all applicable building code requirements. This will reduce the potential for soil contamination and associated impacts on groundwater.

DRAINAGE

Loading Docks: The first 3 feet of the paved area, measured from the building or dock face, must be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away.

Drainage from the hydraulically isolated area must be directed to an approved City sanitary sewer or authorized pretreatment facility. Drainage from the hydraulically isolated area is not allowed to discharge to a stormwater management facility or storm system. Surrounding runoff and drainage from the access ramp must be directed away from the hydraulically isolated area to a stormwater discharge point that meets all applicable requirements of this manual.

Bay Doors and Other Interior Transfer Areas: Bay doors and other interior transfer areas must be designed so that stormwater runoff does not enter the building. This can be accomplished by grading or drains.

Because interior material transfer areas are not expected to accumulate precipitation, installation of floor drains is not required or recommended. It is preferable to handle these areas with a dry mop or absorbent material. If interior floor drains are installed, they must be plumbed to an approved City sanitary sewer or authorized sanitary pretreatment facility.

Non-gravity Drainage Option: Activity areas that do not have gravity sanitary sewer service may be allowed to install a pressurized system. With these types of installations, the following items must be provided at the time of building permit application:

- Verification or evidence that gravity service cannot be obtained.
- Details of an electronic sump pump system equipped with a float switch.

Pressurized system installations are considered “permanent equipment” and deemed the property owner’s liability in the event of system failure or if the property becomes vacated.

The BDS Commercial Plumbing Division will review all sump pump or sewage ejector installations for compliance with the Uniform Plumbing Code and Oregon State Plumbing Specialty Code.

BES may waive the requirement for drainage from the hydraulically isolated area of the loading dock to be directed to an approved City sanitary sewer or authorized sanitary pretreatment facility if it determines there is no gravity sanitary service available and an appropriately sized, underground temporary storage structure (such as a catch basin with no outlet or dead-end sump) is provided. For the exception and alternative to be

considered, a completed **Source Control Special Circumstances Form**, located in [Appendix D.9](#), must be submitted, with information showing that gravity service cannot be obtained.

Shut-Off Valves

Shut-off valves are required to protect the City sewer system or onsite infiltration facilities from spills of chemicals and other constituents that may provide a danger of widespread contamination, system damage, or risk to public health.

A shut-off valve may be required for the sanitary drainage facilities of the material transfer area. BES will make this determination, based on the type of material being transferred and the proposed system receiving the discharge.

Shut-off valves are required for any of the following situations:

- Site activity areas that are exposed to corrosives or oxidizers (such as battery acid) that can harm conveyance system components.
- Substances (such as oil and grease) that do not settle or that remains in one location and are capable of being dissolved in or floating on top of water. These substances can spread rapidly into downstream systems, causing widespread impacts and difficult cleanup situations.
- Substances that are known to infiltrate through soils and contaminate groundwater.

Valves located in material transfer areas are typically left open to facilitate drainage during normal conditions and immediately closed in the event of a spill.

The valves must be closed prior to transfer activities of harmful substances and reopened only after the transfer is complete. The shut-off valves must be located on private property and downstream of the exposed area's collection system.

All valves must be installed and maintained in accordance with manufacturer specifications. For more information about shut-off valves and associated valve boxes, contact the BDS Commercial Plumbing Department at 503-823-7302.

SIGNAGE

Signage must be provided at the storage area and at shut-off valves if hazardous materials or other materials of concern are stored (as determined by BES). Signage must be located so it is plainly visible from all storage activity areas and located next to the shut-off valve. More than one sign may be needed to accommodate large storage areas. Additional information is provided in [Section 4.3.5](#), and signage examples are located in [Appendix G.5, SW-511](#).

ADDITIONAL REQUIREMENTS

Wellhead Protection Areas: Transport and handling of hazardous materials in designated wellhead protection areas are subject to additional requirements, as identified in the Water Bureau's *Columbia South Shore Well Field Wellhead Protection Area Reference Manual* (June 25, 2003).

4.7 FUEL DISPENSING FACILITIES AND SURROUNDING TRAFFIC AREAS

4.7.1 Applicability

Applicable

The requirements in this section apply to all development where vehicles, equipment, or tanks are refueled on the premises, whether a large-sized gas station, a single-pump maintenance yard, or a small-sized fuel tank. These requirements also apply to truck loading and off-loading areas located at bulk fuel terminals.

A fuel dispensing facility is defined for this section as the area where fuel is transferred from bulk storage tanks to vehicles, equipment, and/or mobile containers (including fuel islands, above- or below-ground fuel tanks, fuel pumps, and the surrounding pad).

If any improvements are made to the fueling activity area and/or pad, such as regrading or surface replacement, retrofits are required to comply with all fueling activity source controls identified in this chapter.

Not Applicable

Propane and oxygen tanks are exempt from these requirements.

Existing fueling areas are not required to install source controls identified in this section if the scope of work is limited to the following:

- A new canopy installation over an existing fuel pad that is not being upgraded.
- An underground tank replacement for compliance with state regulations.
- Replacement of a fuel pump on an existing fuel pad that is not being upgraded.

Temporary fueling areas associated with construction activities are exempt from these requirements. These activities require implementation of the associated best management practices (BMPs) outlined in the City's *Erosion Control Manual* (in the section titled "Development Activity Control BMPs"). The *Erosion Control Manual* can be found online at <http://www.portlandonline.com/shared/cfm/image.cfm?id=94539>

4.7.2 Requirements

COVER

The fuel dispensing area must be covered with a permanent canopy, roof, or awning so precipitation cannot come in contact with the fueling activity area. Rainfall must be directed from the cover to a stormwater discharge point that meets all applicable code requirements.

- Covers **10 feet high or less** must have a minimum overhang of 3 feet on each side. The overhang must be measured relative to the perimeter of the hydraulically isolated fueling activity area it is to cover.
- Covers **higher than 10 feet** must have a minimum overhang of 5 feet on each side. The overhang must be measured relative to the perimeter of the hydraulically isolated fueling activity area it is to cover.

The requirement to cover the fuel dispensing area can be appealed if the fuel dispensing area is generally used to service oversized equipment (e.g., cranes) that cannot maneuver under a roof or canopy. An Administrative Review is required. See [Appendix D.9](#) for the Administrative Review process.

PAVEMENT

A paved fueling pad of asphalt or concrete must be placed under and around the fueling activity area and must meet all applicable building code requirements. Sizing of the paved area must be adequate to cover the activity area, including placement and number of the vehicles or pieces of equipment to be fueled by each pump. Fuel pumps or fuel islands must be located a minimum of 7 feet from the edge of the fueling pad.

DRAINAGE

- The paved area beneath the cover must be hydraulically isolated through grading, berms, or drains. This will prevent uncontaminated stormwater from running onto the area and carrying pollutants away. Drainage from the hydraulically isolated area must be directed to an approved City sanitary sewer or authorized sanitary pretreatment facility.
- A spill control manhole must be installed on the sanitary discharge line of the fueling pad (before the domestic waste line tie-in). The tee section must extend 18 inches below the outlet elevation, and 60 cubic feet of dead storage volume must be provided below the outlet elevation for storage of oil, grease, and solids. The

manhole must be located on private property. The spill control manhole is not designed for or to be used for oil treatment purposes. The spill control manhole is strictly used to capture and store contents from a spill.

For more information about spill control manholes, see [Chapter 2.3.3](#) and for examples [Appendix G.5, SW-500](#). An oil/water separator may be used instead of the spill control manhole. The oil/water separator must be sized appropriately and meet the requirements for oil/water separators in [Section 4.3.3](#).

Shut-Off Valves

- A shut-off valve is required on the sanitary discharge line of the fueling pad, downstream of the spill control manhole. Valves installed on sanitary sewer systems must be installed before the domestic waste line tie-in. These valves must be kept closed, and opened only to allow incidental drainage activities that do not pose a threat or risk to the discharge point system. The valve must be closed immediately after drainage activities are completed.

Shut-off valves must be located on private property and downstream of the exposed area's collection system. All valves must be installed and maintained as per manufacturers' recommendations. For more information about shut-off valves and associated valve boxes, contact the City's Commercial Plumbing Department at 503-823-7302.

- Surrounding runoff must be directed away from the hydraulically isolated fueling pad to a stormwater discharge point that meets all stormwater management requirements of this manual and other applicable code requirements.

Traffic pathways that surround fueling pads are considered high-use/high-risk areas and will require a valve on the storm drainage system. Valves installed on storm drainage systems must be installed downstream of all applicable private stormwater quality facilities to accommodate spill containment. These valves must be left open to facilitate stormwater flows during normal conditions, and immediately closed in the event of a spill.

SIGNAGE

Signage must be provided at the fuel dispensing area and must be plainly visible from all fueling activity areas. Signage must also be provided at the shut-off valve areas directing personnel to turn the valve in the event of a spill. Additional information is provided in [Section 4.3.5](#), and signage examples are located in [Appendix G.4, SW-511](#)

ADDITIONAL REQUIREMENTS

- Installation, alteration, or removal of above-ground fuel tanks larger than 55 gallons, and any related equipment, is subject to additional permitting requirements by the Portland Fire Marshall's Office. For technical questions and permitting, call the Fire Marshall's Office permit center at 503-823-3712, or visit the permit center at 1300 SE Gideon, Portland, Oregon 97202.
- If applicable, the requirements in [Section 4.8](#) (Above-Ground Storage of Liquid Materials, Including Tank Farms) must be met in addition to other relevant sections of this manual.
- Underground fuel tanks less than 4,000 gallons in size are subject to additional permitting requirements by DEQ, and tanks larger than 4,000 gallons are referred to the federal Environmental Protection Agency (EPA). For technical questions and permitting, call DEQ's Northwest Region main office at 503-229-5263 and ask for the Underground Storage Tank Permitting Department.

4.8 ABOVE-GROUND STORAGE OF LIQUID MATERIALS, INCLUDING TANK FARMS

4.8.1 Applicability

Applicable

The requirements in this section apply to all development where there is any exterior permanent or temporary storage of liquid chemicals, food products, waste oils, solvents, process wastewaters, or petroleum products in above-ground containers, in quantities of 50 gallons or more.

Not Applicable

Underground storage tanks or installations that require a water pollution control facility (WPCF) permit are exempt from these requirements, but must comply with DEQ's WPCF permit process.

Quantity thresholds of products that are exempt from these spill containment measures include:

- Janitorial and cleaning supplies of less than 100 pounds net weight or 15 gallons net volume. These supplies must be packaged for consumer use in containers of 5 gallons or less or having a net weight of less than 30 pounds per container.

Cleaners or solvents used for cleaning machinery or motor vehicle and machine parts are NOT exempt.

- Office and stationery supplies of less than 100 pounds net weight. These supplies must be packaged for consumer use in containers of less than 5 gallons in size or 30 pounds in weight.

Double-walled containers are exempt from the 110% or 10% of total volume containment requirements in subsection 1, below. All other requirements apply.

Temporary storage areas associated with construction activities are exempt from these requirements. These activities require implementation of the associated best management practices (BMPs) outlined in the City's *Erosion Control Manual* (in the section titled "Development Activity Control BMPs"). The *Erosion Control Manual* can be found online at <http://www.portlandonline.com/shared/cfm/image.cfm?id=94539>

4.8.2 Requirements

CONTAINMENT

Liquid materials must be stored and contained in such a manner that if the container(s) is ruptured, the contents will not discharge, flow, or be washed into a receiving system.

- A containment device and/or structure for accidental spills must have enough capacity to capture a minimum of 110 percent of the product's largest container or 10 percent of the total volume of product stored, whichever is larger.
- City Code Title 17.39 states that water coming in contact with coupling areas is defined as process wastewater. Therefore, there must be a separate containment area for all valves, pumps, and coupling areas, with sub-bermed areas either in front of or inside the main containment areas. These sub-bermed areas must have rain shields and be directed to a City sanitary sewer system for disposal. If no City sanitary sewer is available, drainage must be directed to a temporary holding facility for proper discharge and may require a WPCF permit from DEQ's Water Quality Division.

COVER

Storage containers (other than tanks) must be completely covered so rainfall cannot come in contact with them. Runoff must be directed from the cover to a stormwater discharge point that meets all applicable code requirements.

- Covers **10 feet high or less** must have a minimum overhang of 3 feet on each side. The overhang must be measured relative to the perimeter of the hydraulically isolated activity area.
- Covers **higher than 10 feet** must have a minimum overhang of 5 feet on each side. The overhang must be measured relative to the perimeter of the hydraulically isolated activity area.

PAVEMENT

The storage area must be paved with asphalt or concrete and must meet all applicable building code requirements. The floors must be sealed (e.g. with epoxy) to prevent spills from contaminating the groundwater. The floor materials and sealant must be compatible with the material being stored. Sizing of the paved areas must be adequate to cover the area intended for storage.

DRAINAGE

All paved storage areas must be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater run-on to a storage area.

Covered storage areas: Significant amounts of precipitation are not expected to accumulate in covered storage areas, and drainage facilities are not required for the contained area beneath the cover.

- If the applicant elects to install drainage facilities, the drainage from the hydraulically isolated area must be directed to an approved City sanitary sewer or authorized pretreatment facility.
- A shut-off valve will be required for the covered storage area if the applicant elects to install drainage facilities to an approved City sanitary sewer.

Uncovered storage areas with containment, such as tank farms (also called bulk fuel terminals):

- Water will accumulate in uncovered storage areas during and after rain. Before the accumulated water is drained and to determine proper discharge location, the water must be collected, inspected for oil sheen and/or a low or high pH. If it is contaminated, depending on the level of contaminants, discharge to the sanitary sewer may be required or treatment may be necessary prior to storm discharge.
- A shut-off valve must be installed on the drainage line for the storage area. This will allow the excess stormwater to be collected and inspected. If free of contaminants, the stormwater can be drained out of the activity area and directed to the storm drainage facilities. If contaminated, the stormwater must be pumped from the containment area and hauled offsite for disposal at a permitted treatment storage and disposal (TSD) facility, discharged to the City sanitary sewer, or discharged to an authorized sanitary pretreatment facility.
- Except when excess stormwater is being discharged, the valve must always be kept closed so any spills within the activity area can be effectively contained.

Short-term and intermittent discharges (less than 6-months in duration) to the sanitary sewer are considered to be batch discharges and require approval and possible pretreatment prior to discharge. Pretreatment requirements are set as part of the discharge approval process and are based on the types and quantities of the material to be discharged.

A discharge evaluation must be performed before discharge and connection to a sanitary sewer. Testing may be required to establish characteristics of the wastewater or contaminated stormwater and to verify that local discharge limits are not exceeded. For batch discharge applications, call BES Industrial Source Control Division at 503-823-5320.

Shut-Off Valves

Shut-off valves are required to protect City sewer systems or onsite infiltration facilities from spill risks from chemicals and other constituents that pose a danger of widespread contamination, system damages, or risk to public health.

Shut-off valves are required for the following situations:

- The stormwater draining from the immediate area around the above-ground storage tank (AST) must be equipped with a valve on the storm drainage system. In the event of a spill, the valve must be closed to adequately isolate the area and contain the spill. Valves installed on storm drainage systems must be installed downstream of all applicable private stormwater quality facilities to accommodate spill containment. These valves must be left open to facilitate stormwater flows during normal conditions, and immediately closed in the event of a spill.
- Valves are required for site or activity areas that are exposed to corrosives or oxidizers (such as, but not limited to, battery acid) that can harm conveyance system components.
- Valves are required for substances (such as, but not limited to, oil and grease) that do not settle or remain in one location and are capable of being dissolved in or floating on water. These substances can spread rapidly into downstream conveyance and discharge systems, causing widespread impacts and difficult cleanup situations.
- Valves are required for substances that are known to react with or leach through the asphalt or pavement and/or infiltrate through soils into the groundwater.

SIGNAGE

Signage must be provided at the liquid storage area and must be plainly visible from all surrounding activity areas. Signage must also be provided at the shut-off valve areas directing personnel to turn the valve in the event of a spill. More information is provided in [Section 4.3.5](#), and signage examples are located in [Appendix G.4, SW-511](#).

ADDITIONAL REQUIREMENTS

- Storage of hazardous materials located in designated wellhead protection areas is subject to additional requirements, as identified in the Water Bureau's *Columbia South Shore Well Field Wellhead Protection Area Reference Manual* (June 25, 2003). The manual can be found on the Water Bureau website at <http://www.portlandonline.com/water/index.cfm?c=29602>
- Storage of reactive, ignitable, or flammable liquids must comply with the Uniform Fire Code as adopted by the State of Oregon. Source controls presented in this section are intended to complement, not conflict with, current fire code requirements. Contact the Portland Fire Bureau (503-823-7366) and/or BES Industrial Source Control Division (503-823-7122) for further information and requirements.

4.9 EQUIPMENT AND/OR VEHICLE WASHING FACILITIES

4.9.1 Applicability

Applicable

The requirements in this section apply to all development with a designated equipment and/or vehicle washing or steam cleaning area. This includes smaller activity areas, such as wheel-washing stations.

Not Applicable

Single-family and duplex residential sites are exempt.

Temporary washing areas associated with construction activities are exempt. These activities require implementation of the associated best management practices (BMPs) outlined in the City's *Erosion Control Manual* (in the section titled "Development Activity Control BMPs). The *Erosion Control Manual* can be found online at <http://www.portlandonline.com/shared/cfm/image.cfm?id=94539>

4.9.2 Requirements

COVER

The washing area must be covered with a permanent canopy or roof so precipitation cannot come in contact with the washing activity area. Precipitation must be directed from the cover to a stormwater discharge point that meets all applicable code requirements.

- Covers **10 feet high or less** must have a minimum overhang of 3 feet on each side. The overhang must be measured relative to the perimeter of the hydraulically isolated washing activity area it is to cover.
- Covers **higher than 10 feet** must have a minimum overhang of 5 feet on each side. The overhang must be measured relative to the perimeter of the hydraulically isolated washing activity area it is to cover.

Cover Exception: If a washing activity area is generally used to service oversized equipment that cannot maneuver under a roof or canopy (cranes, sail boats, etc.), an exception to the roof or canopy requirement will be granted. A **Source Control Special Circumstances Form**, located in **Appendix D.9**, must be submitted as part of the building permit application to evaluate exception qualifications.

PAVEMENT

A paved wash pad of asphalt or concrete must be placed under and around the washing activity area and must meet all applicable building code requirements. Sizing of the paved area must adequately cover the activity area, including the placement of the vehicle or piece of equipment to be cleaned.

DRAINAGE

The paved area beneath the cover must be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away.

- Drainage from the hydraulically isolated area must be directed through an oil/water separator and must meet the oil/water separator design requirements in [Section 4.3.3](#). The discharge from the oil/water separator must drain to an approved City sanitary sewer or authorized sanitary pretreatment facility.
- Wash water is not allowed to enter a storm drainage system. Surrounding runoff must be directed away from the hydraulically isolated washing pad to a stormwater discharge point that meets all applicable requirements of this manual.

On-site wash recycling systems must meet the above requirements, unless one of the exceptions below applies:

- Wash recycling systems may be used for oil control instead of using an oil/water separator as long as they can meet effluent discharge limits for the City's sanitary sewer system. A detail of the wash recycling system and vendor specifications identifying effluent efficiencies must be submitted as part of the building plans at the time of the building permit application.
- If an evaporation unit is installed as part of a wash recycling system, an exception to the sanitary sewer connection will be granted. Note: The cover requirement cannot be waived for evaporation units because of the sizing and capacity limitations of the individual units. A [Source Control Special Circumstances Form](#), located in [Appendix D.9](#), must be submitted as part of the building permit application to evaluate exception qualifications.

4.10 EXTERIOR STORAGE AND/OR PROCESSING OF BULK MATERIALS

4.10.1 Applicability

Applicable

The requirements of this section apply to developments that stockpile materials or store them in outdoor containers, or process the materials outdoors and those materials may erode and/or contribute pollutants to stormwater runoff.

The materials are separated into three categories, based on risk assessments for each material stored: high-risk, low-risk, and exempt. These include, but are not limited to, the general types of materials listed in the table below. Materials not on this list will be evaluated on a case-by-case basis.

Outdoor areas where materials are processed (rather than just stored) are generally considered to be high risk. Outdoor processing, shredding, grinding, and sorting exposes the materials to stormwater and contributes pollutants to stormwater, including, but not limited to, dissolved metals, total metals, total suspended solids, dissolved solids, oil and grease, biochemical oxygen demand (BOD), and bacteria (such as *E. coli*). Therefore, when any material is processed, shredded, ground, or sorted outdoors and will contribute pollutants to stormwater as described above, the area is considered high risk and must follow the high-risk requirements.

High-Risk Materials	Low-Risk Materials	Exempt Materials
<ul style="list-style-type: none"> • Materials to be recycled, with potential effluent or the potential to contribute pollutants to stormwater runoff • Corrosive materials (e.g., lead-acid batteries) • Scrap or salvage goods with potential effluent • Storage and processing of food items • Chalk/gypsum products • Feedstock/grain • Material byproducts with potential effluent • Fertilizer • Pesticides • Lime/lye/soda ash • Animal/human wastes 	<ul style="list-style-type: none"> • Materials to be recycled, without potential effluent or the potential to contribute pollutants to stormwater runoff • Scrap or salvage goods • Metal • Sawdust/bark chips • Sand/dirt/soil (including contaminated soil piles) • Material byproducts without potential effluent • Unwashed gravel/rock • Compost • Asphalt 	<ul style="list-style-type: none"> • Washed gravel/rock • Finished lumber • Rubber and plastic products (hoses, gaskets, pipe, etc.) • Clean concrete products (blocks, pipe, etc.) • Glass (new, clean, or free of residual product) • Inert products

Not Applicable

Storage and processing areas that are exempt from the requirements of this section have materials that meet any of the following criteria:

- Have no measurable solubility or mobility in water and no hazardous, toxic, or flammable properties.
- Exist in a gaseous form at ambient temperature.
- Contained in a manner that prevents contact with stormwater (excluding pesticides and fertilizers) – e.g., covered inside a building.
- Temporary storage areas associated with construction activities. These activities require implementation of the associated best management practices (BMPs) outlined in the City’s *Erosion Control Manual* (in the section titled “Development Activity Control BMPs”). The *Erosion Control Manual* can be found online at <http://www.portlandonline.com/shared/cfm/image.cfm?id=94539>

4.10.2 Requirements

COVER

Low-risk materials must be covered and secured with a temporary plastic film or sheeting at a minimum.

High-risk materials must be permanently covered with a canopy or roof to prevent stormwater contact and minimize the quantity of rainfall entering the storage area. Runoff must be directed from the cover to a stormwater discharge point that meets all applicable code requirements.

- Covers **10 feet high or less** must have a minimum overhang of 3 feet on each side. The overhang must be measured relative to the perimeter of the hydraulically isolated activity area.
- Covers **higher than 10 feet** must have a minimum overhang of 5 feet on each side. The overhang must be measured relative to the perimeter of the hydraulically isolated activity area.

PAVEMENT

Low-risk material storage areas are not required to be paved.

High-risk material storage areas must be paved beneath the structural cover. Sizing of the paved area must adequately cover the activity area intended for storage.

DRAINAGE

Low-risk material storage areas are typically allowed in areas served by standard stormwater management systems. However, all stored erodible materials and stored materials that can contribute contaminants to stormwater runoff must be protected from rainfall.

For these materials, a structural containment barrier must be placed on at least three sides of every stockpile. The barrier must be tall enough to prevent run-on of uncontaminated stormwater into the storage area and migration of the stored materials as a result of being blown or washed away. If the area under the stockpile is paved, the barrier can be constructed of asphalt berms, concrete curbing, or retaining walls. If the area under the stockpile is unpaved, sunken retaining walls or ecology blocks can be used. The applicant must clearly identify the method of containment on the building plans.

For **high-risk** material storage areas, the paved area beneath the structural cover must be hydraulically isolated through grading, structural containment berms or walls, or perimeter drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away.

If materials are erodible or can contribute contaminants to stormwater runoff, the containment requirements described for low-risk areas, above, must be followed.

Low and high risk: Significant amounts of precipitation are not expected to accumulate in covered storage areas, and drainage facilities are not required for the contained area beneath the cover. If the applicant elects to install drainage facilities, the drainage from the hydraulically isolated area must be directed to an approved City sanitary sewer or authorized sanitary pretreatment facility. A shut-off valve must be installed if the materials have a potential effluent. BES will make this determination based on the type of material stored.

If the stored material will erode or has a potential effluent to the storm system, a sampling manhole or other suitable stormwater monitoring access point is required to monitor stormwater runoff. The monitoring location must be representative of the facility activities and located downstream of all treatment devices.

SIGNAGE

Signage must be provided at the storage area if hazardous materials or other materials of concern are stored. Signage must be located so it is plainly visible from all storage activity areas. More than one sign may be needed to accommodate large storage areas. More information is provided in [Section 4.3.5](#), and signage examples are located in [Appendix G.5, SW-511](#).

ADDITIONAL REQUIREMENTS

Storage of pesticides and fertilizers may need to comply with specific regulations outlined by DEQ. For answers to technical questions, call DEQ's Northwest Region main office at 503-229-5263.

Storage of hazardous materials in designated wellhead protection areas is subject to additional requirements, as identified in the Water Bureau's *Columbia South Shore Well Field Wellhead Protection Area Reference Manual* (June 25, 2003). The manual can be found on the Water Bureau website at <http://www.portlandonline.com/water/index.cfm?c=29602>

4.11 SOIL, STORMWATER, AND GROUNDWATER MANAGEMENT FOR DEVELOPMENT ON LAND WITH SUSPECTED OR KNOWN CONTAMINATION OR ADJACENT TO CONTAMINATED SITES

4.11.1 Overview

Special handling and management of soils, collected groundwater, and surface drainage may be necessary under federal, state, and local regulations. Sites with known or suspected contamination require a more detailed review process, and this may delay issuance of related building permits.

In addition, areas associated with construction activities are required to implement the best management practices (BMPs) outlined in the City's *Erosion Control Manual* (in the section titled "Development Activity Control BMPs"). The *Erosion Control Manual* can be found online at <http://www.portlandonline.com/shared/cfm/image.cfm?id=94539>

Applicants are advised to contact the BES Source Control Plan Review team early in the plan design process (before plan submittal) if they are aware or suspect that the site has contaminants or is adjacent to a contaminated site. It is also recommended the applicant contact the DEQ Land and Water Quality divisions before plan submittal and obtain DEQ approval before applying for City permits.

To research property-specific contaminant information, refer to DEQ's facility profiler database, which can be found at <http://deq12.deq.state.or.us/fp20/>. If records indicate that a No Further Action (NFA) or Record of Decision (ROD) exists for the site, the applicant must contact DEQ prior to pre- and post-construction activities to ensure conditions of record are not violated.

For technical questions related to site contamination and cleanup, contact DEQ's Land Quality Division. All DEQ regulatory divisions or departments referenced in this section can be reached by calling the DEQ's Northwest Region Office at 503-229-5263.

If a site is not included in the DEQ's tracking database, it does not mean that contamination may not be present.

To avoid confusion with the term "water quality pollutant" that is used throughout this manual, this section refers to pollutants as contaminants and/or contamination, unless otherwise specified.

4.11.2 Applicability

The requirements in this section apply to the following:

- Any development project that disturbs property known or suspected to contain contaminants in the soil, stormwater, or groundwater or that may exacerbate contamination by moving the contaminants onsite or offsite. This includes developments that are surrounded by or adjacent to properties suspected or found to have trace contaminants.
- Any project seeking to make a new connection to a public storm system (connections to City UIC facilities are prohibited) from a property that is known or suspected to contain contaminants in the soil or groundwater or performing work that may exacerbate contamination onsite or on an adjacent site. City Code, rules, and policy apply and must be met when a new connection is proposed.
- If contaminants have the potential to become entrained and transported through construction activities or through the post-construction design elements of the development, all requirements in this section and [Section 4.4](#) must be followed. Examples of the activities and design elements include, but are not limited to:
 - Development on land that is at risk, known, or suspected to contain contaminants in the soil or groundwater.
 - Excavation and/or stockpiling of contaminated soils (soil management).
 - Discharge or reuse facilities related to groundwater, foundation or footing drains, interior floor drains in basements or sub-grade structures, construction dewatering, long-term dewatering, and stormwater treatment and conveyance systems. The requirements for groundwater discharges and temporary stormwater discharges are in [Section 4.4](#).
 - Activities in an area of concern, including, but not limited to: City property, Portland Harbor Superfund area, area adjacent to or surrounded by contaminated sites, wildlife habitat area, areas where new development and redevelopment must meet state, federal, or local source control requirements to prevent contamination or recontamination of that specific area of concern.

4.11.3 Review

Contaminants, media, and site conditions are unique to each parcel of land. Sites at risk for contamination must therefore be reviewed on a case-by-case basis.

Stormwater and groundwater discharges from sites suspected of contamination, whether proposed as a temporary construction connection or flow or as a permanent connection to any public system, will require discharge authorization from BES. After reviewing the proposal and a characterization of the contaminants from the site, the BES Source Control Division may make one or more of the following decisions. For groundwater discharges, also refer to [Section 4.4](#).

- Deny the request to use the City conveyance system.
- Approve the discharge in accordance with City code, rules, and policy, with possible restrictions such as those described in this section or as necessary, given the nature of the discharge.
- Require the applicant to obtain an NPDES permit from DEQ for the anticipated discharge prior to connection and require a sample point that is representative of the discharge as it enters the City conveyance system.
- Require the applicant to obtain a City-issued permit or authorization and require a sample point that is representative of the discharge as it enters the City conveyance system.
- Require the applicant to become part of BES's Industrial Pretreatment Program.
- Allow an unrestricted connection to the City storm sewer and require a sample point that is representative of the discharge as it enters the City system.

4.11.4 Requirements

The following are the requirements for the different contaminated medias that exist on known or potentially contaminated properties. The City will review and assess all data as required below, and depending on the levels of contaminants and the type of the contaminated media, there may be different requirements on how stormwater, groundwater or soil is managed. In some cases, development permits may be held up until the DEQ and/or City approves of the discharge or development.

If a site is not included in the DEQ's tracking database as described in the Applicability section above, it does not mean that contamination may not be present.

If a site has a history of commercial or industrial use, a copy of the Phase I and/or Phase II Environmental Site Assessment for the site will be required for review by BES. If a Phase I or II Environmental Site Assessment was not completed, additional sampling is required, as outlined in City policies and this chapter.

SOIL MANAGEMENT

- Stockpiles of contaminated soils must be covered with temporary plastic film or sheeting to prevent stormwater from coming into contact with them. Site controls must be employed that protect drag-out into a City street from the development and, if a clean-up action site (contaminated), from the day-to-day operations.
- Stockpile perimeters must have a containment barrier on all four sides of every stockpile to prevent stormwater run-on and material runoff. Barriers can consist of concrete curbing, silt fencing, or other berming material, depending on the activity, size, and resources available.
- Areas under stockpiles of contaminated soils are not required to be paved. However, an impervious layer must be placed beneath the stockpile to protect uncontaminated areas from potential leachate. Examples of impervious layers include, but are not limited to, asphalt, concrete, or a geomembrane.

LABORATORY ANALYSIS REPORTS

Laboratory testing and associated analysis reports are required on sites that are suspected or have known contamination on site in order to identify the characteristics and levels of contamination in the soils, stormwater, and groundwater. The City in collaboration with the DEQ will coordinate the review of the data. The review will assess the different media pathways and determine the appropriate requirements for stormwater, groundwater, or soil management. The minimum testing requirements and information required is outlined in the beginning of [Chapter 4](#) in [Section 4.3.4](#).

It is highly recommended that the analytical testing of the applicable media be performed prior to submitting building permit applications and the responsible party contact the DEQ very early in the design phase to provide them the chance to review the proposal. Based upon the review of the data with the DEQ, the determination may be made that the proposal can not move forward as submitted. Therefore, communication early in the process may help catch design flaws, or perhaps move the proposal along quicker and help meet the project's desired timeline.

STORMWATER AND GROUNDWATER DISCHARGE MANAGEMENT

Stormwater and groundwater management on contaminated sites require additional review by BES Source Control. The requirements are listed below for both media types.

Temporary and Long-Term Dewatering: All temporary and long-term dewatering discharges resulting from groundwater or temporary construction-related stormwater (as defined in [Section 4.4, Applicability](#)) discharges will be evaluated for contaminants before a discharge location can be approved. See [Section 4.4](#) for dewatering requirements. On contaminated sites, dewatering may require additional oversight by the DEQ and associated permits or authorizations by that agency. The City will coordinate with the DEQ on the review process.

Post Construction Stormwater Management: [Chapter 1](#) of this manual requires vegetated infiltration facilities as the first Category of stormwater discharge. For contaminated sites, stormwater management options may be limited because of contamination onsite or on an adjacent site.

If the site or adjacent site has groundwater or soil contamination, the City will coordinate with the assigned DEQ project clean-up manager and in the case there is no assigned project clean-up manager, the City will coordinate with the DEQ manager of the Clean-up Division, Water Quality Division, or their designees.

In some cases, the stormwater management facility may be required to be lined with an impervious liner creating a flow-through facility, unless the contaminants of concern do not mobilize with stormwater or additional leachability testing and hydrology modeling has been completed to show that infiltration will not mobilize contaminants offsite or to surface waters. In the absence of good sound analytical data, the City will apply the most conservative decision, and require an imperviously lined facility.

Above-grade facilities are also an option, especially for tree landscaping requirements. Above-grade planters can be designed large enough for trees and other large plantings, or they can be designed small for portability. In some cases, additional contamination delineation must occur and; therefore, permanent facilities can not be constructed. Thus, portable above-ground planters are an option in those cases.

POST-CONSTRUCTION WATER RECLAIM OR REUSE SYSTEMS

Water reclamation or reuse systems provide innovative ways to use natural resources and save money. However, using groundwater as a resource from sites at risk of contamination may require additional source controls and trigger environmental compliance regulations, depending on the nature of the contaminants and the extent of the remediation that has been completed.

Irrigation systems may encourage transportation of contaminants, and require authorization from DEQ's Land Quality Division prior to installation.

Authorizations for all reuse systems are typically required from BDS, BES, the Oregon Water Resources Department, and DEQ. On contaminated sites, the City will coordinate with the DEQ prior to approving a groundwater reuse system.

See [Section 4.13](#) for water reclaim and reuse system requirements.

4.12 COVERED AND UNCOVERED VEHICLE PARKING AREAS

4.12.1 Applicability

The requirements in this section apply to all development with a covered or uncovered vehicle parking area.

Applicable

- New or redeveloped parking structures.

Not applicable

- Existing parking structures are not required to retrofit unless the structure is being redeveloped.
- Single-level covers (canopies, overhangs, and carports).
- Single-family and duplex residential sites.

4.12.2 Requirements

DRAINAGE

Below-Grade or Covered Parking Floor Areas

Drainage facilities on the floors of a covered vehicle parking area are not required. If the applicant elects to install drainage facilities, the drainage must be directed to an approved City sanitary sewer, per all applicable City code and policies.

Entrance trench drains located within the first few feet of the covered entrance to the parking area may discharge to the storm sewer. Trench drains located beyond the first few feet of the entrance or at the bottom of the entrance ramp must discharge to the sanitary sewer. This is evaluated on a case-by-case basis due to different ramp designs. In general, a trench drain located at 10 feet or less on a ramp that slopes and continues beyond 10 feet, can discharge to storm. On a ramp that levels out and no longer slopes beyond the 10 feet, the storm trench drain would need to be within the first 2 feet of the entrance to the ramp.

Parking Areas with Top Floor Open to Rainfall

Stormwater runoff from the top floor must be directed to a stormwater discharge point that meets all water quality requirements of this manual and any other applicable code requirements.

Adjacent, Uncovered Portions of the Site

The surrounding uncovered portions of the site must be designed so stormwater does not enter the covered parking areas. This can be accomplished through grading, berms, or drains.

4.13 WATER RECLAIM AND REUSE SYSTEMS

4.13.1 Applicability

This section applies to commercial and industrial properties only.

Water reclamation or reuse systems provide innovative ways to use natural resources and save money. Reclaim and reuse systems that will discharge to the City's sanitary sewer are subject to sanitary sewer user fees.

Utilizing groundwater or stormwater as a resource from sites at risk of contamination may require additional source controls and trigger environmental compliance regulations, depending on the nature of the contaminants and the extent of the remediation that has been completed. See [Section 4.11](#) for information on contaminated sites.

4.13.2 General Requirements

Reuse systems that use stormwater or groundwater for non-potable water use in plumbing fixtures and industrial equipment (e.g., toilets, cooling towers or boilers) are required to meet the following requirements:

- A discharge meter must be installed on the outlet of the reuse system for sewer billing purposes. Discharge meter specifications and requirements can be found in City Code Chapter 17.36 and City policy.
- Industrial equipment bleed-offs or drain valves must have discharges routed to the sanitary waste line of the facility. Discharges must meet local discharge limits, as stated in City Code, Chapter 17.34, and administrative rules.
- A permanent monitoring point is required to ensure compliance with local discharge regulations or permits. A sampling manhole, 6-inch clean-out, or flow-through vault must be installed on the discharge line of the subsurface drainage system prior to commingling with any other discharges.
- A permit or authorization for a reuse system is required from BDS and BES. The Water Resources Department (WRD) and DEQ may also require permits or authorizations for the reuse of groundwater; contact them directly for information.

Reusing Surface Drainage (Rainwater Harvesting)

Reuse systems that use only stormwater are not expected to discharge pollutants/contaminants and should not pose a threat to City infrastructure. However, non-potable uses for reclaimed/reuse water in plumbing fixtures and industrial equipment (e.g., toilets, cooling towers or boilers) must meet the requirements listed under Section 4.13.2, above.

Reusing Subsurface Drainage

Discharges may contain contaminants, and analytical data will be required and evaluated for the specific pollutants/contaminants of concern before discharge methods will be approved. Analytical submittal requirements are identified in [Section 4.3.4](#) and must be submitted as part of the permit review process.

Overflows from the reuse system, prior to use, may contain contaminants; therefore, the overflow discharge must also comply with the requirements of Section 4.13.2.

In addition to the Section 4.13.2 requirements, non-potable uses for reclaimed/reuse water in plumbing fixtures and industrial equipment (e.g., toilets, cooling towers or boilers) will require the following:

- If commercial or industrial facilities use groundwater for non-potable uses or irrigation, authorization or a permit is required from the Oregon Water Resources Department (WRD) prior to use. Minimum requirements that warrant a permit for industrial and commercial groundwater wells include, but are not limited to, irrigation of areas that are greater than ½ acre and use more than 5,000 gallons per day of water. Unique groundwater reuse systems (anything other than a standard supply well installation) will be reviewed by WRD on a case-by-case basis to determine permitting requirements (if applicable).

For assistance in obtaining authorization for the use of groundwater, contact WRD's Multnomah County Water Master at 503-722-1410. For more information on water rights and groundwater regulations, see the WRD website at www.wrd.state.or.us.

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DEFINITIONS

Note: The following definitions apply to terms used in this manual and are intended to supplement City Code Chapters 17.34, 17.36, 17.38, and 17.39.

Applicant: Any person, company, or agency that applies for a permit through the City of Portland. Includes all parties represented by the applicant.

Approved Receiving System (Discharge Point): Any system or route of conveyance approved by BES to receive stormwater runoff or other discharges. Receiving systems include, but are not limited to, groundwater; onsite, offsite, or public stormwater, sanitary, or combined sewers; and waters of the state.

Batch Discharge: A controlled discharge of a discrete and contained volume of water, stormwater, or wastewater.

BDS: Bureau of Development Services, City of Portland.

BES: Bureau of Environmental Services, City of Portland.

Best Management Practices (BMPs): Operational, maintenance and other practices that prevent or reduce environmental, health or safety impacts. BMPs include structural controls, modification of facility processes, and operating and housekeeping pollution control practices.

Bulk Fuel Terminal: Any area with its primary function dedicated to the storage and distribution of fuel to distributors (such as gas stations).

Bulk Material Transportation Route: Any path routinely used to transport bulk materials onto, off of, or within a site.

Capacity: The flow volume or rate that a specific facility (e.g., basin, pipe, pond, vault, swale, ditch, or drywell.) is designed to safely contain, receive, convey, reduce pollutants from, or infiltrate to meet a specific performance standard.

Catch Basin: A structural facility located just below the ground surface, designed to collect and convey stormwater runoff to an onsite stormwater system or offsite discharge point. A catch basin has a grated lid, a sumped bottom, and outlet pipe (with a downturned 90 degree elbow or snout) to trap coarse sediment and oil. See Appendix G for typical design.

Check Dam: A low structure or weir placed across an open channel to control water depth or velocity, or to control channel erosion.

Combined Sewers: A sewer designed to convey both sanitary sewage and stormwater.

Commercial Property: Property used in whole or part for commercial enterprises involving the sale or exchange of goods or services.

Connection: The connection of all sanitary waste and drainage disposal lines from all development on a property to the public sewer and drainage system.

Containerized: The storage of any product, byproduct, or waste that is completely held or included on all sides, within a discrete volume or area.

Containment: A structural control measure or device designed to capture and temporarily store potentially contaminated stormwater or process wastewater not appropriate for discharge to City systems without pollution, flow, or volume reduction BMPs.

Covered Vehicle Parking Areas: Vehicle parking structures used to cover parked vehicles, other than single-level covers such as canopies, overhangs, and carports.

Culvert: A hydraulically short conduit, open on both ends, generally used to convey stormwater runoff through a roadway or an embankment and typically constructed without manholes, inlets or catch basins.

CSO (Combined Sewer Overflow): A discharge of a mixture of sanitary sewage and stormwater at a point in the combination sewer system designed to relieve surcharging flows.

Department of Environmental Quality (DEQ): Oregon Department of Environmental Quality.

Design Storm: Design storms are a combination of the design storm return period (which refers to the frequency) and the storm duration (which defines the rainfall depth or intensity). A prescribed hyetograph and total precipitation amount (for a specific duration recurrence frequency) are used to estimate runoff for a hypothetical storm 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 Water Surface Elevation (Overflow Elevation): The elevation at the upper limit of the maximum depth and the lower limit of the freeboard, which corresponds to the overflow elevation. It can be considered the initial outlet elevation or over-topping elevation of the facility where an outlet is not included. Each cell of the facility may have a different design water surface elevation. The design water surface elevation can be relative to the final discharge point, a known actual elevation onsite, or can be set to zero.

Detention Facility: A facility designed to receive and hold stormwater and release it at a slower rate, usually over a number of hours. The facility may provide minimal or no volume reduction.

Detention Tank, Vault, or Oversized Pipe: A structural subsurface facility used to provide flow control for a particular drainage basin.

Development: Any human-induced change to improved or unimproved real estate, whether public or private, including but not limited to construction, installation, or expansion of a building or other structure; land division; street construction; drilling; and site alteration such as dredging, grading, paving, parking or storage facilities, excavation, filling, or clearing. Development encompasses both new development and redevelopment.

Development Footprint: The new or redeveloped area covered by buildings or other roof structures and other impervious surface areas that 1) does not allow stormwater to percolate into the ground, such as roads, parking lots, and sidewalks, or 2) is covered by pervious paving materials and systems.

Discharge Point (Disposal): The connection point or destination for a discharge leaving a site.

Discharge Rate: The rate of flow expressed in cubic feet per second (cfs).

Drainage Basin: A defined area that contributes to sanitary, stormwater or combined sewage flows to an approved connection point.

Drainageway: An open linear depression, whether constructed or natural, that functions for the collection and drainage of surface water. It may be permanently or temporarily inundated.

Driveway: The area that provides vehicular access to a site. A driveway begins at the property line and extends into the site. In parking areas, the driveway does not include vehicular parking, maneuvering, or circulation areas.

Drywell: A subsurface structure (e.g. cylinder or vault) with perforated sides and/or bottom, used to infiltrate stormwater into the ground. A drywell is a UIC by DEQ definition.

Ecoroof: A lightweight low-maintenance vegetated roof system consisting of waterproofing material, growing medium, and vegetation; used in place of or over the top of a conventional roof. Ecoroofs provide stormwater management by capturing, filtering, and evaporating rainfall.

Filter Fabric: A woven or non-woven water-permeable material, generally made of synthetic products such as polypropylene, used in stormwater management and erosion and sediment control applications to trap sediment or to prevent fine soil particles from clogging the aggregates.

Flow: The rate or volume of water moving within a natural or man-made system. Flow is often measured as a ratio, such as cubic feet per second (cfs).

Flow Control: The practice of limiting the release of peak flow rates and volumes from a site. Flow control is intended to protect downstream properties, infrastructure, and natural resources from the increased stormwater runoff peak flow rates and volumes resulting from development.

Flow Control Structure: A device used to delay or divert a calculated amount of stormwater to or from a stormwater management facility.

Freeboard: The vertical distance between the design water surface elevation (overflow elevation) and the elevation at which overtopping of the structure or facility that contains the water would occur.

Green Street: A vegetated stormwater management facility located within the planting strip or other portion of public or private rights-of-way.

Groundwater: Subsurface water that occurs in soils and geological formations that are fully saturated. Groundwater fluctuates seasonally and includes perched groundwater.

Groundwater Discharges: A discharge pumped or directed from the ground. Groundwater related discharges include, but are not limited to, subsurface water from site remediation and investigations, well development, Brownfield development, discharges from footing and foundation drains, and subsurface water associated with construction or property management dewatering activities.

Growing Medium: Soil mixture made up of sand, loam, and compost; used in stormwater facilities to support vegetation to filter runoff. Specifications described in [Appendix F.3](#).

Hazardous Substance: Any substance referenced in section 101(14) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (42 US Code §9601 et seq.), Section 502(13) of the Clean Water Act, or other substances at concentrations specified in those lists or, if no concentration is specified, at concentrations designated by the Director.

Impervious Surface: Any surface that has a runoff coefficient greater than 0.8 (as defined in the City's *Sewer and Drainage Facilities Design Manual*). Types of impervious surface include rooftops, traditional asphalt and concrete parking lots, driveways, roads, sidewalks, and pedestrian plazas. Slatted decks and gravel surfaces are considered pervious unless they cover impervious surfaces or gravels are compacted to a degree that causes their runoff coefficient to exceed 0.8.

Infiltration: The percolation of water into the ground. Infiltration is often expressed as a rate (inches per hour), which is determined through an infiltration test.

Inlet: An inlet means: 1) A structure located just below the ground surface designed to collect stormwater runoff from paved surfaces such as streets and parking lots that have no sumped sediment storage or inverted pipes to capture pollutants. See [Appendix G](#) for typical details. AND 2) The entry point, such as downspouts, piping, or curb cuts, into an onsite stormwater management system or discharge point.

Long-term Dewatering: When groundwater is drained or pumped from a subsurface or surface system for site development. Long-term is defined as dewatering that occurs 1) during the longevity of the constructed subsurface system, 2) for a period greater than three (3) years. Long-term dewatering includes, but is not limited to, groundwater remediation systems and development or construction sites.

Manufactured Stormwater Treatment Technology: A proprietary stormwater management facility structural facility or device. See [Appendix B](#) for approved Stormwater Management Treatment Technologies or [Chapter 2](#), Performance Approach for the process to request approval of project specific devices.

Maximum Depth (Storage Depth): The greatest vertical distance between the design water surface elevation (overflow elevation) and the top of the growing medium of a surface facility or the base of a subsurface facility, which creates a reservoir capable of providing safe storage capacity of stormwater.

Open Channel: A fluid passageway that allows part of the fluid to be exposed to the atmosphere.

Operations and Maintenance (O&M): The continuing activities required to keep stormwater management facilities and their components functioning in accordance with design objectives.

Outfall: A location where collected water is discharged. Outfalls can include discharge from stormwater management facilities, drainage pipe systems, and constructed open channels.

Overflow: Excess volume of stormwater or wastewater that exceeds the storage or conveyance capacity of a facility or system component and causes a release of flow to another facility, system component or the environment.

Partial Infiltration: When the total infiltration design storm (or another specified design storm as required) is unable to be completely percolated into the ground.

Parking Area: The area of a site devoted to the temporary or permanent storage, maneuvering, or circulation of motor vehicles. Parking areas do not include driveways or areas devoted exclusively to non-passenger loading.

PBOT: Portland Bureau of Transportation

Permit: An official document issued by the Director authorizing performance of a specified activity.

Pervious: Any surface determined to have a runoff coefficient less than 0.8; a surface modified in a way to encourage infiltration of water (as defined in the City's *Sewer and Drainage Facilities Design Manual*).

Pervious Pavement (aka Porous Pavement or Permeable Pavement): Alternative pavement systems that allow water to percolate into subsurface drainage systems or the ground. Examples include permeable pavers, pervious asphalt, and pervious concrete systems.

Planter: A structural facility filled with topsoil and gravel and planted with vegetation. The stormwater planter receives runoff from impervious surfaces, which is filtered and retained for a period of time. Planters may be further classified by their ability to infiltrate. An infiltration planter has an open bottom, allowing water to infiltrate into the ground. A flow-through planter has an overflow that must be directed to an acceptable discharge point. Flow-through planters may have an impervious or sealed bottom, either through a waterproof liner or a poured concrete base. Site conditions will determine appropriate facility selection.

Pollutant: An elemental or physical material that can be mobilized or dissolved by water or air and could create a negative impact to human health or the environment.

Pollution Reduction (Water Quality): The Pollution Reduction storm event is representative of 90% of the average annual rainfall and is used to size facilities for the pollution reduction stormwater management requirement. Also known as the water quality storm.

Pollutants of Concern: Constituents identified by DEQ or BES as having the potential to have a negative impact on the receiving system, including surface waters, groundwater, the wastewater collection system, or the wastewater treatment plant. Pollutants of concern can include suspended solids, metals, nutrients, bacteria and viruses, organics, volatiles, semi-volatiles, floatable debris, and increased temperatures.

Practicable: Available and capable of being done, as determined by the BES Director, after taking into consideration cost, resources, existing technology, and logistics in light of overall project purpose.

Presumptive Approach Calculator (PAC): Calculation tool used to size vegetated stormwater facilities. The PAC assumes that the 2-year, 24-hour event must be met for water quality, and the 10-year, 24-hour event must be met for flow control.

Public Facility: A street, right-of-way, sewer, drainage, stormwater management, or other facility that is either currently owned by the City or will be conveyed to the City for maintenance responsibility after construction. A new stormwater management facility that receives direct stormwater runoff from a public right-of-way becomes a public (City-maintained) facility unless the right-of-way is not part of the City's road maintenance system.

Public Improvement: An improvement of, on, over, or under property owned or controlled by the City, or property to be controlled by the City upon plat and easement recording for approved land divisions, by construction, reconstruction, remodeling, repair or replacement, when no property is intended to be assessed any portion of the improvement cost.

Public Works Project: Any project performed or conducted by local, state, or federal governments that result in the construction of a Local Improvement or a Public Improvement.

Rainwater Harvesting: The collection and use of rainwater or stormwater runoff for water use purposes such as irrigation and toilet flushing. A facility that harvests rainwater is considered a stormwater facility only if the facility has water quality or flow control benefit, as determined by BES.

Rational Method: The method used to estimate the peak rate of runoff from a drainage basin, using the formula: $Q=CiA$. Q is the peak discharge, cubic feet per second; C is the runoff coefficient; i is the rainfall intensity, inches per hour; and A is the drainage area, acres (as defined in the City's *Sewer and Drainage Facilities Design Manual*).

Redevelopment: Any development that requires demolition or complete removal of existing structures or impervious surfaces at a site and replacement with new impervious surfaces. Maintenance activities such as top-layer grinding, repaving (where all pavement is not removed), and reroofing are not considered to be redevelopment. Interior remodeling projects and tenant improvements are also not considered to be redevelopment. Utility trenches in streets is not considered to be redevelopment unless more than 50 percent of the street width is removed and repaved.

Repair: Work performed to patch, replace components, replace or rehabilitate entire facilities that serve the City's sewer and drainage system.

Reservoir: The temporarily stored volume of runoff prior to overflow. For vegetated surface facilities it is defined as the volume between the top of the growing medium, the design water surface elevation (overflow elevation), and the edges of the facility (whether sloped or vertical). In a sedimentation chamber, it is defined as the volume of runoff stored prior to discharge to the receiving system.

Retention Facility: A facility designed to receive and hold stormwater runoff so that some volume of stormwater that enters the facility is not released offsite. Retention facilities permanently retain a portion of the water onsite, where it infiltrates, evaporates, or is absorbed by surrounding vegetation.

Retrofit: Installation of a new facility or system components to manage stormwater or wastewater flows.

Roadway: Any paved surface used to carry vehicular traffic (cars/trucks, forklifts, farm machinery, or any other large machinery).

Roof Garden: A heavyweight, deep vegetated roof system of waterproofing material with a thick soil and vegetation cover.

Runoff Coefficient: A unitless number between zero and one that relates the average rate of rainfall over a homogenous area to the maximum rate of runoff, as defined in the *City's Sewer and Drainage Facilities Design Manual*.

Safety Factor: A sizing multiplier that evaluates the risks and values of specific conditions, including the failure mode of the construction material, unexpected construction deficiencies, and potential cost of system failure. The safety factor is applied to the maximum performance limit to calculate a risk-based design value used for sizing facilities. A safety factor must be used to provide reasonable assurance of acceptable long-term system performance.

Sand Filter: A structural pollution reduction or flow control facility using a layer of sand and optional vegetation to manage stormwater runoff..

Santa Barbara Urban Hydrograph (SBUH): A hydrologic method used to calculate runoff hydrographs.

Seasonally High Groundwater Level: The highest level that the permanent groundwater table or perched groundwater may reach on a seasonal basis.

Site: Any lot or parcel of land or contiguous combination where development occurs. For utility lines, trenches or other similar work, the site includes only the disturbance area directly related to the linear work activity.

Soakage Trench: A subsurface infiltration stormwater management facility that includes a perforated pipe laid in drain rock. A soakage trench is a UIC by DEQ definition.

Solid Waste Containers: Compactors, dumpsters, compost bins, grease bins, and garbage cans.

Solid Waste Storage Area: An indoor or outdoor area where solid waste containers are collectively stored. Solid wastes include both food and non-food waste or recycling.

Source Control: A structural measure required by the Stormwater Management Manual to prevent or control the release or potential release of pollutants generated by certain site characteristics and uses.

Stormwater: Water that originates as precipitation on a particular site, basin, or watershed. Also referred to as runoff.

Stormwater Facility Landscaping (Landscaping): The vegetation (plantings), topsoil, rocks, and other surface elements associated with stormwater management facility design.

Stormwater Management: Techniques used to reduce pollutants from, detain, retain, or provide a discharge point for stormwater runoff that best preserves or mimics the natural hydrologic cycle. Stormwater management reduces combined sewer overflows and basement sewer backups, and helps meet the capacity of existing infrastructure.

Stormwater Management Facility: A facility or other technique used to reduce the volume, flow rate or pollutant content of stormwater runoff. Stormwater facilities may reuse, collect, convey, detain, retain, or provide a discharge point for stormwater runoff.

Stormwater Retrofit: Installation of a new stormwater facility to treat stormwater from existing impervious area, including, but not limited to, roofs, patios, walkways, and driving or parking surfaces.

Sump: 1) A large public drywell used to infiltrate stormwater from public streets. Sumps are generally 48 inches in diameter and 30 feet deep. 2) Any volume of a facility below the point of outlet in which water or solids can accumulate.

Surcharge: 1) A flow condition when the downstream hydraulic capacity is less than the upstream inflow causing water to back up and rise above the inside crown of a pipe or facility. 2) The greatest measured distance from the water surface to the pipe crown.

Surface Infiltration Facility: A vegetated facility designed to receive and infiltrate stormwater runoff at the ground surface to meet stormwater infiltration/discharge requirements.

Temporary Dewatering: When groundwater or stormwater is temporarily drained or pumped from a subsurface or surface system. 1) For site development, temporary is defined as the duration of time during the preconstruction or construction site work. 2) For other temporary dewatering activities, temporary is less than three (3) years. Specific activities include, but are not limited to, construction dewatering, dewatering wells, trench systems or sediment control ponds.

Temporary Structure: A structure that is a separate and distinct entity from all other structures for a continuous period of three years or less. A temporary structure must be created and removed in its entirety, including impervious area associated with the structure, within three years. Paved areas such as parking lots that are developed alongside structures are not considered temporary for the purpose of this manual.

Tenant Improvements: Structural upgrades made to the interior or exterior of buildings. Tenant improvements may trigger source control requirements if they take place on sites with specified activities.

Time of Concentration (T of C or TOC): The amount of time it takes stormwater runoff to travel from the most distant point (measured by travel time) on a particular site or drainage basin to a particular point of interest.

Total Suspended Solids (TSS): Total suspended matter that either floats on the surface or is suspended in water or wastewater and that is removable by laboratory filtering in accordance with 40 CFR Table B.

Toxic Substance: Any substance listed in Oregon's water quality standards for toxic pollutants in OAR, Division 340-041-0033; the Clean Water Act effluent guidelines list or toxic pollutants at 40 CFR 401.15; or the toxic chemical release reporting specific toxic chemical listings at 40 CFR 372.65 at concentrations specified in those lists or, if no concentration is specified, at concentrations designated by the Director.

Underground Injection Control (UIC): Defined by DEQ as any system, structure, or activity that is intended to discharge fluids below the ground surface such as sumps, drywells, and soakage trenches.

Vegetated Facilities: Stormwater management facilities that rely on plantings as an integral component of their functionality.

Vegetated Filter: A gently sloping, densely vegetated area used to filter, slow, and infiltrate sheetflow stormwater.

Vegetated Infiltration Basin (Rain Garden): A vegetated facility that temporarily holds and infiltrates stormwater into the ground.

Vegetated Swale (Bioswale): A long, narrow, vegetated channel used to collect, convey and reduce pollutants from stormwater runoff. Check dams are used to slow runoff, settle sediment, and improve infiltration and pollution reduction.

Water Body: Coastal waters, rivers, sloughs, continuous and intermittent streams and seeps, ponds, lakes, aquifers, and wetlands.

Water Quality Limited: Waters identified by DEQ that do not meet water quality standards. Total Maximum Daily Load (TMDL) must be developed for these waters to satisfy Clean Water Act (CWA) requirements. The most recent EPA-approved Section 303(d) list for Oregon can be found at www.deq.state.or.us/wq/assessment/assessment.htm.

Water Table: The upper surface of an unconfined water body, the surface of which is at atmospheric pressure and fluctuates seasonally. The water table is defined by the levels at which water stands in wells that penetrate the water body (City Water Pollution Control Facility Permit).

Wellhead Protection Area: An abbreviated term usually used to refer to the Columbia South Shore Well Field Wellhead Protection Area. The Water Bureau regulates the storage, use, and transportation of hazardous/toxic materials in this groundwater resource protection area (See Wellhead Protection Area requirements at <http://www.portlandoregon.gov/water/29890>.)

Wet Pond: A vegetated basin with a permanent pool of water, used to provide pollution reduction for a particular drainage basin. The permanent pool of water provides a storage volume for pollutants to settle out and extended wet detention ponds have additional storage capacity for flow control.

Wetland: An area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include swamps, marshes, bogs, and similar areas, except those constructed as pollution reduction or flow control facilities.

Appendix A Table of Contents

Appendix A

A.1 City Code Chapter 17.38

A.2 Policy Framework and Revision Process

A.3 Private Drainage Reserve Administrative Rules

A.4 Design Guidance for Culverts and Outfalls

A.5 Stormwater Retrofits

Appendix A.1 City Code Chapter 17.38

The Auditor's Office maintains the online version of Chapter 17.38. It can be found online at:

<http://www.portlandonline.com/auditor/index.cfm?c=28865>

Appendix A.2 Policy Framework and Revision Process

The City's Stormwater Management Manual has a long history of evolving science and policy around the goals of stormwater management. The Stormwater Policy Advisory Committee (SPAC) was established in April 1996 at the direction of the City Commissioner of Public Works to develop foundational policies for requiring post-development stormwater management. SPAC members included representatives of City bureaus, the Homebuilders Association, Metro, the Oregon Department of Environmental Quality, watershed advocates, and the development community. The SPAC was charged with recommending stormwater management policies to the Bureau of Environmental Services (BES) and reported to City Council on a regular basis. In addressing stormwater issues, the SPAC also considered other City goals and policies for environmental protection, density, transportation, and economic development.

In July 1997, the SPAC submitted and City Council accepted policy recommendations for new development (*Final Recommendations: Stormwater Management Requirements for New Development*). Council then directed BES to develop a *City Stormwater Management Manual* to implement policy recommendations for post-development stormwater management. The first *Stormwater Management Manual* was adopted on July 1, 1999, by the Director of BES. The *Stormwater Management Manual* is part of BES's Administrative Rules, authorized by Portland City Code Chapter 17.38, adopted by the Director of BES following a public review process, and filed with the City Auditor as required by Portland City Code Chapter 1.07. In 2000, in conjunction with a City Code update, City Council confirmed the authority of the Director of BES to update the *Stormwater Management Manual* (Ordinance #174745).

In spring 1999, the City Council established the Stormwater Advisory Committee (SAC), whose members represent environmental, development, engineering, business, and community interests. One of the SAC's tasks was to review and make recommendations regarding changes to the manual. The SAC presented its recommendations to Council in April 2000 and again in August 2002. *Stormwater Management Manual* revisions in 1999, 2000, 2002, 2004, 2008, and 2014 included a public comment period and submitted comments were evaluated.

Update and Amendment Process

This *Stormwater Management Manual* will be reviewed and updated as necessary. The review process will include:

- consideration of changed and new technologies
- review of appeals made during the preceding interval
- review of requests for variances to standard design criteria for public and private facilities
- review of all performance-based approaches approved since the last manual revision
- review of community comments and concerns, including those of advisory bodies and professional organizations
- adjustment of internal review processes and submittal requirements for consistency with City Code and Administrative Rules

The amendment process will also include a public comment period to review amendments as identified in Portland City Code 3.13 and will produce documentation and explanation of any changes made.

Suggestions for changes and improvements can be made at any time and should be sent to:

City of Portland, BES
1120 SW 5th Ave., Room 1000
Portland, OR 97204
Attention: Stormwater Management Manual Manager

Any changes to stormwater management policies that are expressed in Chapter 17.38 and elsewhere in City Code require the approval of City Council. As provided by City Code sections 3.13.040 A and 17.38.010, any changes to the *Stormwater Management Manual* itself require the approval of the Director of BES. When changes are proposed, the Chief Engineer of BES will distribute those proposed changes to interested parties and internal staff for review. The amended manual must be approved by the Director of BES before the amendments are implemented.

APPENDIX A.3

Private Drainage Reserve Administrative Rules

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I. Program Goals and Objectives

The main goal of the drainage reserve code and associated administrative rules is to protect flow conveyance in both natural and manmade surface channels (drainageways), thereby minimizing scouring and erosion in local stream systems and protecting properties from impacts related to modifications of drainageways. Drainage reserves act as a no-build area, not an easement. Drainage reserves ensure that properties with drainage downstream and upstream of developing properties are not damaged or destabilized by ponding, flooding, or other impacts from excess flows. While reserves are implemented on a site-by site basis, the drainage reserve code and administrative rules strive to protect local waterways from cumulative impacts of development, especially in headwater areas. The code and administrative rules are intended to establish standards and appeal processes to meet the following objectives:

- A. Responsibly manage stormwater and limit site impacts. Maintain the location of stormwater discharges and flows where they naturally occur within the development area and cause least detrimental environmental impact.
- B. Limit off-site impacts. If any encroachments into the drainageway channel are proposed, identification of the upstream tributary drainage and a downstream analysis shall be required to ensure there are no substantive impacts to downstream properties. The kind of analysis required will depend on the cumulative impact of problems identified within the basin and the size of the planned project.
- C. Control runoff. Proposed construction projects and system modifications or improvements shall provide runoff controls to limit the developed condition's peak rates of runoff to the pre-development peak rates for a specific design storm frequency, based on the proposed project site's existing runoff conditions.
- D. Control erosion. All conveyance systems shall be designed and modified to prevent and reduce construction erosion and long-term, scour-related erosion within the drainageway. This includes the establishment of woody vegetation for scour protection and enhanced infiltration and water quality.
- E. Provide operation and maintenance. The private property owner is responsible for retaining the drainageway as an open system and for maintaining all drainage facilities constructed or modified by a project, unless the City has specifically agreed to City operation and maintenance (O&M) before plan approval. Owners shall also be responsible for maintaining all enrichment elements approved by the City and covered by a drainage reserve O&M plan.
- F. Maintain capacity. Because drainageways serve an important hydrologic function for small waterways, there may be a requirement to demonstrate that any encroachments into the drainageway will not affect storage or conveyance volumes of the drainageway. Mitigation may be required for any lost capacity in the drainageway resulting from encroachments.

While protection of flow conveyance is the purpose for establishing drainage reserves, the rules also include elements to meet secondary City goals such as plant diversity, water quality, habitat, and other watershed health issues such as restoring onsite hydrology, improving water quality, habitat, and biological communities.

II. Background

Throughout Portland are areas without constructed drainage facilities, where drainage flows over land through private properties and unimproved or substandard rights-of-way. Usually this overland flow of water collects into some kind of open conveyance that carries the water across the property. For the purposes of these rules, these open conveyances are collectively called drainageways. Drainageways may also fall into other City Code definitions concerning water movement, especially terms such as “streams” and “channels.” Some drainageways may be formed or controlled by structures, such as culverts, that direct or pond water. Natural seeps, springs, and wetlands may generate water, but do not convey water across property and therefore are not specifically drainageways. These rules are not intended to cover these natural water features. Drainageways must be carefully considered when properties are developed, regardless of whether the drainageways are naturally occurring or have resulted after water has been moved, shifted, or modified as part of earlier developments or actions. It is critical for watershed health and public health and safety that these private flow conveyance systems be protected and improved if receiving any development impacts. Private property owners are responsible for maintaining flow conveyance and erosion prevention within any drainageway that runs through their property.

In the mid 1970s, the City of Portland implemented provisions within the City’s land division code (known at the time as Title 34 and now known as the 600 series in Title 33) to ensure that open conveyance systems stayed open. The intent at that time was for subdivisions and planned unit developments to redesign around open conveyance channels when possible. Given the growing science of using open areas for managing drainage and for flood control, the City identified the need to establish drainage reserves over drainageways as a method of enhancing control of stormwater flows.

In 1994, the City began to rewrite its land division code. Drainage reserves were deemed a technical review item and moved into the public works code section 17.38, which is administered by the Bureau of Environmental Services (BES). Moving these regulations also reinforced that flow conveyance is a public infrastructure and public safety element, similar to other public works elements found in Title 17 of the City Code. This move also reinforced that such technical review items are distinct from more traditional subjective land use review items and that technical items are not open for appeal to the Oregon Land Use Board of Appeals (LUBA). By the time this code provision was moved in 2002, BES decided to expand the coverage of the drainageway regulations to apply to all types of development reviews (e.g., land use reviews, building permits, site development permits), not just land division reviews (one specific type of development review). This expansion to all types of development reviews enhanced City efforts to provide safe flow conveyance across the City, and the change provided equitable regulation across all forms of development.

During the 2002 code rewrite, new administrative rules were created to describe the technical review standards that were not described in the zoning code language. Those rules, which described how BES would administer drainage reserves across all forms of development review, were adopted in December 2002. (See Appendix A3-A.) The rules generally stated the technical standards and decision-making criteria that BES would use to determine whether a drainage reserve should be placed on a developing property. At that time, the City also defined drainage reserves as a condition of development approval, rather than as an easement that would be purchased or required by the City. That designation was made because no municipal facilities are involved on these private properties, and the City is not the party responsible for ongoing maintenance. Because of that decision, drainage reserves have not been shown on final plat surveys or on private property title searches. These new 2008 rules implement a procedure to record notice of conditions against a deed in order to provide some notice to property owners that a drainageway is present on their property. (See Appendix A.3-B.) These 2008 administrative rules supercede the 2002 rules.

III. Purpose of these Rules

These rules detail the criteria BES will use to establish drainage reserves and to review for drainage reserve encroachments related to development. Applicants are encouraged to either meet these rules outright or request an appeal to review site-specific conditions that could influence the establishment of a drainage reserve or the approval for encroachments. All appeals shall be prepared to address the intent of the standards and criteria outlined in this document. Appeals shall be processed as described in Section XII.

BES staff experience over the five years of implementing the 2002 drainageway rules has identified the need to have greater flexibility for encroachment. While the City code grants general authorities, it does not specifically describe how a development proposal will be reviewed and evaluated for the need to place a drainage reserve. These rules achieve the following:

- Clearly identify BES's obligations for ensuring appropriate protections of stormwater flows.
- Clarify BES's administrative review, submittal requirements, and evaluation standards for requiring drainage reserves.
- Detail the responsibilities for protecting drainage reserves from other site development.
- Explicitly describe the approval standards and process for modifications made within a designated reserve area.
- Reflect the differences between building permit review and land division review, especially the ability to redesign at a late stage of City review in the building permit process.
- Detail the issues of concern and the submittals required to approve encroachments into the reserve area versus into the drainageway channel.
- Identify the methods for an applicant to appeal and for site-specific consideration.
- Clarify the inspection and enforcement roles and responsibilities of all City parties.

- Identify the ongoing responsibilities of a property owner in protecting, using, and maintaining a drainageway and drainage reserve area.
- Create a new notice of condition recording process to ensure that property owners are aware that a drainage reserve is present on their property and that there are maintenance and encroachment review responsibilities.

In the last five years, the City has made substantial progress in identifying multiple watershed health objectives that should be met by all City activities. While **these rules are foremost for flow conveyance protection**, they also often result in improved vegetated facilities that meet multiple watershed health objectives. These other benefits are secondary; open flow conveyance is the primary objective of these rules. There may be site needs that result in a determination to pipe a drainageway for land stability or other safety issues. In these cases, public health and safety needs will be prioritized over other vegetative/habitat-related watershed benefits.

IV. Regulatory Authority

City Code Chapter 17.38.030 gives BES the authority to require drainage reserves as part of development review. The code states:

1. Authority. The Director may require drainage reserves or tracts over seeps, springs and drainageways as necessary to preserve the functioning of these areas and to limit flooding impacts from natural and man made channels, ditches, seeps, springs, intermittent flow channels and other open linear depressions. Standards and criteria for imposing drainage reserves or tract requirements shall be adopted by administrative rule. Placement and/or sizing of drainage reserves do not relieve property owners of their responsibility to manage stormwater in a manner that complies with the duties of property owners under applicable law. Drainage reserve or tract requirements may be imposed during land use reviews, building permit review or other development process that require Bureau of Environmental Services (BES) review.
2. Required management of the drainage reserve: Drainage reserves or tracts shall remain in natural topographic condition. No private structures, culverts, excavations or fills shall be constructed within drainage reserves or tracts unless authorized by the BES Chief Engineer. All changes must also comply with zoning regulations as described in Title 33, and grading and floodplain regulations as described in title 24.

While drainage reserves are routinely required at the building permit stage of development, BES staff will evaluate, identify, and propose conditions of approval at the land division stage of development to help enhance the ability of developers to design around reserve areas.

These rules do not specifically address existing development that has previously been built in areas that would meet the drainageway definitions found in this document. However, any new expansion of structures that encroach in the drainage reserve and trigger a building permit must comply with these rules.

V. Relationship of Drainage Reserve Code to Other Regulations

The City has multiple regulations that require management of open surface flow conveyance systems. Below are other regulations that may need to be addressed instead of or in addition to these drainage reserve regulations. The program descriptions identify differences among regulations and note any processes that coordinate review of drainage reserves with other reviews.

Land Division Tracts

BES participates in land division review processes to ensure the adequacy of sanitary services, onsite stormwater management, and drainageway protection. The main objective is to ensure that the property has sufficient space reserved for flow conveyances and post-development stormwater management facilities. Given the variety of regulatory mechanisms in the land division code (seep/spring tracts, stormwater management tracts, environmental tracts, and drainage reserves), Bureau of Development Services (BDS) and BES review staff coordinate closely to determine which regulatory mechanism is the most appropriate for protection of the drainageway. In many cases, drainageways are protected by the placement of a land division tract to ensure protection from future development.

Stormwater Management Manual (SWMM) Requirements

BES also administers regulations to control post-development stormwater flows for both water quality and quantity issues. The SWMM regulates new flows generated by new impervious surfaces in developments, while the drainageway regulations control the *existing* conveyance system for flows that cross an applicant's property. The onsite drainageway is often the ultimate approved disposal point for onsite structural facilities required by the SWMM.

Environmental Zones (E-zones)

Chapter 33.430 of the City's zoning code regulates impacts to the identified natural resources within the City's jurisdiction. These natural resources have been identified as providing benefits to the public, including fish and wildlife habitat, stream stability, and stormwater flow control. Development proposed within an environmental overlay zone (E-zone) must be sensitive to the site's protected resources and specifically provide protection to surface vegetation and land features, in addition to stream protection.

There are two kinds of environmental overlay zone: the Environmental Conservation overlay zone and the Environmental Protection overlay zone. BES's current practice is to establish drainage reserves in the Environmental Conservation overlay zone as necessary because development is allowed within that zone. Establishing drainage reserves in the Environmental Protection overlay zone is not necessary because allowed development is limited.

BES and BDS coordinate review when drainageways are identified within an E-zone. When an environmental review is required, BES provides drainage reserve comments on the development proposal along with its other environmental review comments related to the development proposal.

Drainageway-related regulations are BES's responsibility and are required as a separate review in any of the following situations:

- The development proposal requires an environmental plan check and there is a drainageway on the site that is not identified on the map of streams and waterbodies.
- The development proposal requires an environmental plan check.
- The development proposal is exempt from E-zone regulations.
- The drainageway is outside of the E-zone.

Geotechnical Issues

Section 24.70 of the City's building regulations specifies City regulations regarding clearing, grading, and erosion control (as does Title 10). BDS reviews all development proposals to determine whether any clearing, grading, or geologic condition on private property is or may become a hazard to life and limb; endanger property; cause erosion; adversely affect drainage; or adversely affect the safety, use, or stability of a public right-of-way or drainage channel. BES and BDS coordinate review of any development or mitigation proposed within a drainage reserve.

Floodplain Regulations

If the drainageway is located in a floodway mapped by the Federal Emergency Management Area (FEMA), a specific drainage reserve is not required, since the floodplain regulations of Title 24 and Title 33 are sufficient to protect flow conveyance. Drainageways may also be classified as unidentified watercourse flood zones, even if they are not identified in a federal insurance study, and may be subject to further regulations as provided for in the flood hazard chapter (Section 24.50.050.I) of the City Code.

VI. Definitions

Pursuant to City Code Title 17.38 and these administrative rules, the following definitions apply to these administrative rules. They are not necessarily the same as dictionary or zoning code definitions:

- A. *Channel*. For the purposes of these rules, a channel is the portion of the drainageway that demonstrates evidence of the passage of water. It is the depression between the banks worn by the regular and usual flow of the water. The channel need not contain water year-round.
- B. *Drainage*. Drainage is a general term for waters generated at or conveyed through a particular site. Drainage is predominantly surface runoff generated from rainfall. Surface groundwater shall be considered drainage.
- C. *Drainageway*. A drainageway is an open linear depression, whether constructed or natural, that functions for the collection and drainage of surface water across a property. It may be permanently or temporarily inundated, act as a headwater or tributary to a larger drainage system, and may be present as a distinct channel tributary. Natural seeps, springs, or wetlands where subsurface waters come to the surface are not considered drainageways unless they are part of a conveyance carrying waters across a property.
- D. *Drainage Reserve*. A drainage reserve is a portion of property set aside to protect the functional flow values of the drainageway. This reserve is placed during the development review process and is legally reserved as a no-build area on the building permit or application. Previous rules and City Code called this a drainageway easement.
- E. *Headwaters*. Headwaters are the source of a stream or river (e.g., a spring). [Department of State Lands definition OAR 141-085-0010 (93)]. They are an area where groundwater surfaces and forms an open drainage channel.
- F. *Outfall*. An outfall (as specified in the *BES Sewer Design Manual*) is a location where collected and concentrated water is discharged. An outfall can occur at the end of a pipe system, from a structural facility, or from an open drainage channel.

VII. Identifying Drainageways on Properties

BES review staff will evaluate mapped stream layers, site development plans, aerials, and other information to ascertain whether a drainageway may be present on a property that is in for development or building permit review. City review or inspection staff (usually from BES or BDS) will usually make a site visit to collect information on site conditions. BES staff will make a final determination of the existence of a drainageway area, based on both topographic and infrastructure indicators on and near the site and on any evidence of concentrated flow and/or ponding. Factors may be present in wet or dry seasons or both. The determination of an onsite drainageway does not depend on water being present, only on factors that demonstrate the presence of water during a previous wet season. In making a determination, staff will evaluate

the factors listed below. Placement of a drainage reserve may be based on any combination of these factors; not all of the factors must be present.

A. Year-round Factors

1. Topography.
2. Infrastructure type, size, and location (e.g., culverts, right-of-way ditches, outfalls).
3. Soil type.
4. Erosion/incision.
5. Channel substrate.
6. Evidence of drift lines, waterborne sediment deposits, or sorting.
7. Soil saturation within 18 inches of the surface.
8. Characteristic vegetation
9. Visual topographic or vegetative connection to nearby wetlands, streams, seeps/springs, and sensitive natural areas identified by other regulatory agencies.
10. Maps, photographs, and historical records.
11. Identification of any municipally owned stormwater control structures or management facilities along the drainageway or at its outlet.

B. Additional Wet Season Factors

1. Visible flowing or ponding water.
2. Volume and velocity of existing drainage on, upstream of, and downstream of the site (including groundwater flows). The amount of upland development will be coarsely evaluated to help identify the quantity of presumed flow.

VIII. Placing and Protecting Drainage Reserves

BES will place a drainage reserve over any portion of a property with flow conveyance features that meet the drainageway definitions and are not already protected by environmental stream mapping or land division tracts (described earlier). If the environmental overlay zones or land division tracts are insufficiently sized to cover the presumed 30-foot-wide reserve width, drainage reserves may be placed on top of these other protection methods to ensure full protection of the full desired width for flow conveyance. The drainage reserve shall be considered a no-disturbance area for the purposes of the proposed site development. Proposed developments that wish to encroach into the designated reserve area must meet the standards and submittals of Section IX (Drainage Reserve Encroachment Standards and Review). In essence, the drainage reserve can be thought of as a buffer, protecting the flowing water from development. The standard buffer is 15 feet from the centerline of the flowing water on both sides of the flowing water. Like a setback, these generally are areas that should stay clear of structures, but can be approved for use by specific types of development.

A. Sizing

Drainage reserves shall be sized to ensure that the current flow rate and pattern of the drainage continues to be adequately conveyed through the site. Current flow volumes and/or drainageway capacities may be determined through reviewing a number of sources, including but not limited to:

1. Drainage basin hydrology and hydrologic records.
2. Delineation of the drainage catchment, including any impacts of adjacent open and piped drainage systems on the catchment of concern.
3. Modeling information, including volume and velocity, using a continuous simulation model to be approved by BES.
4. Historical data.
5. High-water marks.
6. Soil inundation records.
7. Photographs of past flooding limits.
8. Placement. Drainage reserves are typically 30 feet in width and placed on a site in one of the following manners:
 - a. 15 feet from the centerline of the identified channel on both sides, or
 - b. Within the boundary of designated environmental zones (if the zone is less than a total 30-foot zone), or
 - c. For full coverage of the channel, plus 15 feet from top of bank, if the 30-foot width will not fully protect the channel width on larger drainageways.

BES staff retains the authority to modify or remove drainage reserves if the drainageway poses or may pose a landslide, flooding, or other public health and safety concern. In those instances, BES may allow drainageways to be moved, modified, or piped to protect public health and safety, in compliance with Title 24 and 33 regulations.

B. Long-term Protection

Drainage reserves shall be protected during the course of any proposed or future development to ensure the continuation of flow conveyance and other benefits. Drainage reserves shall be protected and maintained to meet the following standards:

1. The limits of the drainage reserve shall remain in natural topographic condition to the maximum extent practicable, as determined by BES.
2. No new vegetation proposed within the drainage reserve limits shall be on Portland's lists of nuisance plants or prohibited plants. Preference shall be given to native vegetation, especially for erosion control and water quality purposes.

C. Recording Notice of Conditions against the Property Deed

To help ensure long-term protection of drainage reserve areas, BES will require the applicant to record notice of condition against the property deed. This notice of condition is to notify future property owners of the presence of a drainage reserve onsite and the requirements to maintain it as an open, functional flow conveyance feature. (See Appendix A.3-B for a sample notice of condition form.)

D. Protection during Site Development

Development proposals shall meet all of the following minimum standards to ensure drainageway protection.

1. All proposed disturbances on the site, including but not limited to structures, pipes, culverts, excavations, and fills, shall be located away from the existing drainageway and drainage reserve limits to the maximum extent practicable, as determined by BES review staff. Small facility outfalls are exempted. (See Section 3-B, below).
2. Temporary and permanent erosion control measures shall meet the requirements in the City's *Erosion Control Manual* (City Code Title 10.30.020). Additional erosion control measures (e.g., reinforced silt fence, bio-filter bags, or erosion blankets) may be required to ensure adequate protection of the drainageway during construction and during the establishment of vegetation within the drainage reserve.
3. During site construction, water shall be safely conveyed around or through the drainageway. The channel shall not be obstructed, with the exception of properly employed erosion control measures (such as bio-filter bags) when necessary. Seasonal limitations on development in or near the reserve may be placed if there are special site conditions such as those defined in Title 10.
4. No heavy machinery that produces ground compaction shall be allowed within the drainage reserve limits during construction. Low ground-pressure vehicles (such as spider hoes) may be allowed if the applicant can show adequate soil and vegetation protection.

E. Development Plan Submittal Requirements

To assess proper protection of drainage reserves during development review, the following information must be included for BES review:

1. Land Use Reviews (other than land division and environmental overlay related reviews). In addition to standard plan sets that show topography, general development layout, and large trees, BES will review for the following information, which should be located on a separate plan sheet or on an existing erosion control plan sheet:
 - a. Location of drainageways, both natural and manmade. The limits of the identified drainageway shall be clearly delineated.

- b. Location of proposed drainage reserve. The standard 30-foot reserve shall be used, or alternatively a smaller reserve proposal shall be made. (See Section 3 below for supporting documentation requirements.) Describe the tools to be used to demarcate the drainageway on the development property for staff review during onsite visits (flags, tape, fencing, etc). Provide construction plan notes to ensure proper installation, inspection, and maintenance of construction protection devices (orange construction fence, sediment fence, etc.) for issues such as sediment removal, inspection for undercutting, and bank sloughing.
 - c. Location and type of proposed encroachment or modification into the required drainage reserve area or into the drainageway itself.
2. Building Permit Reviews. *In addition to the information above*, development-type permits must also include:
- a. A **site plan** of the entire property, including all items below, shall be submitted as part of the building permit or site development permit submittals. Submittals shall ensure that all of the following elements are included:
 - i. Property lines and dimensions.
 - ii. Location of the proposed development activity, disturbance area, and staging and/or stockpiling areas.
 - iii. Location of existing trees 6 inches or greater dbh (diameter at breast height) and all proposed vegetation.
 - iv. Location and dimensions of existing and proposed roads, driveways, utilities, parking areas, and building footprints.
 - v. Existing and proposed topographic contour lines for site grading.
 - b. An **erosion control plan** shall be submitted to identify how drainageways on the site will be protected during construction (including exclusionary fencing to prevent encroachment and protect drainageways from soil stockpiles, backfill, construction debris, construction equipment, etc.) and how disturbed soil will be permanently stabilized. For proposals that include construction activity within or adjacent to the limits of a drainage reserve, the erosion control fencing that protects the drainage reserve shall be reinforced. Refer to Section IX-B below for reserve encroachment review submittal requirements.
 - c. A **development schedule** shall be submitted that notes any seasonal development limitations for drainageway protection.

BES reviewers will evaluate the development submittals to determine if the proposed development adequately meets the standards for protection of drainageways identified above.

3. Requests for Smaller Reserves. An applicant may make a request for a smaller reserve area to BES. Any such request shall be sent to the appeals recipient described in Section XII of these rules and shall include an engineer's design report, as detailed in Section X: Channel Encroachment Standards and Review. BES will review and determine whether a smaller reserve sufficiently meets the drainage reserve goals

outlined in this section. Smaller drainage reserve areas shall be noted on all deed notice of conditions.

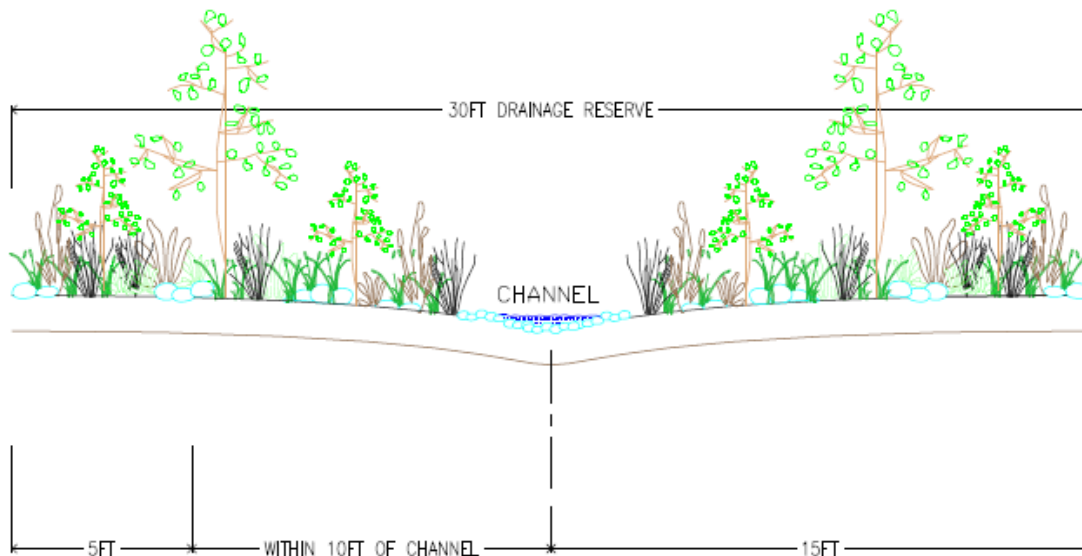
IX. Drainage Reserve Encroachment Standards and Review

Proposed encroachments into the drainage reserve will require additional review by City staff. Encroachments into a drainage reserve are evaluated based on the encroachment feature's proximity to an actual channel of the drainageway. In-channel structures can cause flow diversion, flow capacity, and bank stabilization issues. Encroachments into the reserve can cause floodplain impingements for high-flow conditions. The amount of encroachment can have negative impacts resulting from the cumulative loss of floodplain space. For ease of review, BES has separated encroachment into two types:

- Channel encroachment – within 10 feet of the channel centerline or for encroachments that remove more than 10 percent of the entire reserve area on the development-related side of the drainage channel.
- Reserve encroachment – usually within only the outside 5-foot edge of a reserve.

Exhibit A.3-1 shows this distinction. This section specifies the standards and submittal requirements for all reserve encroachments. Section X identifies additional standards and submittals required for channel encroachments. Appendix A.3-C summarizes development and submittal requirements for drainage reserve and channel encroachments.

Exhibit A.3-1: Cross-Section View of Drainage Reserve



- A. Reserve Encroachment Standards. The proposal will be approved if the applicant has clearly demonstrated that ALL of the following standards can be met:
1. The encroachment shall be minimized to the maximum extent possible.

2. The encroachment shall occur in the most environmentally sensitive manner, considering seasonality, slope, soil, geologic, and erosion control issues to limit disturbance impact to flow capacity and channel stability.
 3. All mitigation for disturbances within the drainage reserve limits shall be located on the project site. Proposed mitigation shall equal or exceed any loss in conveyance volume, flow rate control, and vegetation density within the drainage reserve limits.
 4. All structures, mitigation plantings, and drainageway improvements shall be maintained in accordance with the submitted O&M plan.
 5. Proper temporary and permanent erosion control and exclusionary fencing measures, including but not limited to those found in the *Erosion Control Manual* (City Code Title 10.30.020), shall be employed to ensure adequate protection of the drainageway during construction and during the establishment of vegetation within the drainage reserve limits.
 6. Flows shall be conveyed around the encroachment area during construction.
- B. Reserve Encroachment Review Submittal Requirements. In addition to the general review submittals required in section VIII-B, the applicant shall provide information specific to encroachment, including but not limited to:
1. Type of encroachment/improvement structure.
 2. Boundary of disturbance (both permanent and temporary) to the reserve caused by the encroachment. Type and size of any proposed encroachments. (Refer to Section IX-B for reserve encroachment review submittal requirements).
 3. Estimate of flow impacts to the drainageway, including decreases in cross-sectional flow volume, flow path alteration, or any structure that could cause flow ponding.
 4. Number or density and type of vegetation to be removed within the reserve boundaries.
 5. A **mitigation plan** that clearly identifies existing and proposed conditions (included in the building plans). The mitigation plan shall include calculations and channel cross-sections to demonstrate where lost flow conveyance capacity will be restored within the project site. The plan shall include a revegetation plan that shows how proposed areas of disturbance within the drainage reserve limits will be protected from erosion by replanting with native plants that are similar types and sizes, or equivalent basal area, as those removed. Because plantings are used for long-term erosion control purposes, all plantings must be within the drainageway and drainage reserve area.
 6. An **operations and maintenance plan** for the actual structure that is encroaching and for the mitigation plan elements, submitted in accordance with Section XII: Operations and Maintenance Requirements.

X. Channel Encroachment Standards and Review

The following additional requirements apply to encroachments within 10 feet of a drainage channel or for encroachments that remove more than 10 percent of the entire reserve area on the

development-related side of the drainage channel. Modifications to channels shall be considered facilities and shall require ongoing maintenance by the property owner.

- A. Channel Encroachment Exemptions. Single, small-gauge outfalls from stormwater management facilities, regardless of location, are allowed to encroach outright if they meet the standards that govern outfalls in the City's environmental zoning code (Chapter 33.430). These standards address many environmental sensitivity issues and are being used as a guide for the approval of all small outfalls, both within and outside of environmental overlay zones, that reach a drainageway. Outfalls that meet these E-zone standards are exempt from channel encroachment review and submittal requirements. All other outfalls that do not meet these standards shall be processed by the review standards and submittals detailed below.
- B. Channel Encroachment Standards. The proposal will be approved if the applicant has clearly demonstrated that ALL of the following standards can be met:
 - 1. The encroachment shall not worsen any existing drainageway conditions, such as channel erosion or water impoundment.
 - 2. Construction activities shall not occur during the wet-weather season (October 1 through April 30) or outside of designated work season windows for Oregon Department of Fish and Wildlife designated streams.
 - 3. The channel encroachment shall be mitigated by modifying the channel to retain its original capacity or by enhancing storage and conveyance volumes.
 - 4. Flows resulting from the encroaching facility shall leave the site in a location and manner that maximizes the watershed benefits of the drainageway. Flow rates and outlet locations may be altered to improve watershed function. Hydrologic modeling may be required, depending on site conditions and the extent of encroachment.
 - 5. Additional erosion control measures, independent of those required on the building permit, shall be used to ensure protection and functionality of the existing stormwater conveyance system during construction of the improved/modified drainageway.
- C. Channel Encroachment Review Submittals Requirements. Modifications to existing drainageway channels shall be done under a BDS building permit, either for drainageway work specifically or combined with a property-wide building permit. The site drainageway protections and structures encroaching into a drainage reserve shall be inspected as part of overall site erosion control inspections. Reserve protections shall be in place by the time of the preconstruction erosion control inspections. Drainageway encroachments must meet all elements of area floodway and floodplain regulations, if applicable. The permit submittal shall include all of the submittals required in the reserve encroachment section, plus the following information:
 - 1. Engineering design report. This report, stamped by a licensed engineer, shall include technical evaluation of all site and drainageway concerns and all of the following information:
 - a. A hydrologic modeling analysis of the upstream tributary drainage area and a downstream analysis shall be conducted. The analysis must extend downstream of the proposed project location to a point in the public drainage system where the proposed project site constitutes less than 15 percent of the total tributary drainage

area. This point shall not be less than 1,500 feet downstream of the site. The level of analysis required will depend on the problems identified within the basin by the design engineer, in consultation with the City, and the size of the project being planned.

- b. Cross-sectional data for the new and existing channel shall be incorporated into the hydrologic modeling analysis. The report shall include cross-sectional data at various points along the existing and proposed sections of open channel. These cross-sectional data shall be provided at:
 - i. Locations several feet from the beginning and the end of the open channel.
 - ii. Points of significant change in configuration (e.g., grade, size, or shape of channel). The following data shall be provided for each cross-section:
 - Width, depth, shape, and invert elevation.
 - Roughness coefficient/condition of the open channel (e.g., rocky, dense vegetation, large woody debris).
 - c. For proposed pipes, cross-sectional data shall include:
 - i. Diameter, length, slope, and invert elevations at beginning and end of pipe.
 - ii. Pipe material.
2. Construction management plan. This plan shall be submitted to show the limits of all disturbance areas for the entire site, including the area within the drainage reserve that will be disturbed during construction. It may be submitted as a separate sheet or combined with the erosion control plan, and shall describe:
- a. The nature of the disturbance, including construction access roads and areas where materials and equipment will be stored/stockpiled.
 - b. Areas where equipment will be maneuvered, staging areas, and the limits of grading. The plan shall identify how undisturbed and tree protection areas will be protected.
 - c. A schedule of activities. A narrative description of the type, sequence, and timing of all major construction activities shall be written on or attached to the construction management plan.

XI. Relationship to Public Drainage Improvements

Public improvements in drainageways are reviewed and administered through the City public works process, usually administered through a BES public works permit. Most of the guidelines for encroachment described above are implemented via BES public works permits, based on technical review by the BES Chief Engineer. It is the City's practice to avoid drainageway impacts where practicable. Appropriate road-crossing methodology shall be dictated by site-specific drainageway flow characteristics. All designs shall meet the evaluation criteria of the City Code Title 17.38 drainageway code and the following general standards:

- A. The applicant has demonstrated that it is possible to construct street improvements within the right-of-way that will meet all of the following standards:
 1. The proposed street improvements shall not impede or restrict flows within the drainageway.
 2. The street improvements shall provide minimal impact to the slope, width, and depth of the stream channel, spring, or seep.
 3. The street improvements shall not impede fish passage in a drainageway that has been identified by the Oregon Department of Fish and Wildlife as fish bearing.
 4. Exposed soil shall be replanted with native seed mix and plants from the Portland Plant List, with preference give to native plants.

XII. Appeals

If the applicant does not agree with the BES staff determination of the location, size, or delineation of the existing drainageway or with the sizing of the drainage reserve, the applicant may appeal the BES determination. ***Appeals must be made through the BES administrative appeals process.*** Drainageway appeals are not allowed to be resolved through a building code appeals process. Drainage reserves that are either less than or greater than 30 feet may be placed over a drainageway, either at the discretion of BES staff based on evaluation of the criteria listed in Section VIII or at the request of the applicant through the appeals process. The applicant shall submit a written appeal and shall submit a land survey from a licensed land surveyor that includes, at minimum, the following information:

- A. Property lines with dimensions.
- B. Delineation and extent of the drainageway.
- C. Distance from all points of intersection of the drainageway with the property lines, to the property corners.
- D. Elevation of the drainageway at all points of intersection with property lines.
- E. Modeling support information from Section X: Channel Encroachment Standards and Review.
- F. A plan set showing the existing and proposed configurations.
- G. A fee of \$100.

Appeals will be reviewed by the Stormwater Early Assistance Team manager and routed to appropriate engineering staff for calculation and cross-section review. Reviews should take approximately 4 to 6 weeks. Appeals shall be sent to:

Stormwater Early Assistance Team Manager
City of Portland - Bureau of Environmental Services
1120 SW 5th Ave, RM 1000
Portland, OR 97204-1972

XIII. Inspections

In general, drainageways on private property will be inspected for protection and encroachment measures during the building permit process. All plan sets shall clearly demark the drainage reserve and appropriate protection measures (fencing, etc.). Any applicable maintenance measures, such as removal of collected sediment, shall also be noted on plan sets. BDS will verify that drainageway protections and encroachments shown on the site plan are in place. They will consult with BES staff on any concerns regarding adequacy of permittee efforts. Violations or failure to comply with drainage reserve protection requirements will be referred to BES staff for investigation and enforcement.

XIV. Operations and Maintenance Requirements

An Operations and Maintenance (O&M) plan is required if there is a permitted improvement or encroachment to the drainage reserve. For encroachments into the drainage reserve area, the O&M plan shall be kept on file with BES and attached to TRACS for public access. For encroachments into the active channel area, O&M plans shall be recorded with an O&M Form (Form 3) in the county of the subject property. See SWMM Appendix D for O&M Form instructions. The applicant may elect to use the O&M plan in A.3-D or may create a different one, which must be approved by BES. The drainage reserve and any mitigation must remain in their permitted condition.

- A. Minimum Maintenance. The following minimum maintenance activities shall occur on all structures, channel enhancements, and mitigation sites approved for encroachment.
 - 1. Mitigation plants that die shall be replaced with the same species, same size, and in the same location. BES must approve proposals to relocate or substitute plants.
 - 2. Any structure that impedes flow (e.g., a fallen tree, illegally dumped garbage, sediment deposition) shall be removed, and the channel shall be restored to the natural or approved designed cross-section. Fallen trees, landslides, or other debris that blocks part of the channel conveyance shall be removed as quickly as practical. All repairs shall be made using handheld equipment, unless otherwise preapproved by BES staff.
 - a. Structures or debris shall be removed within 30 days of their discovery.
 - b. Any disturbance that has occurred to the drainageway or reserve shall be replanted or reinforced. If erosion occurs, the eroded area shall be reinforced with rocks, plantings, etc.
 - c. Replanting/reinforcing shall occur within 15 days after the impediment is removed during the dry months or within 7 days during the wet months.
- B. Log Sheets. The following information, at a minimum, shall be recorded on a log sheet on an annual basis for 5 years after mitigation is completed:
 - 1. Condition of mitigation plants and any replacement that has occurred.
 - 2. Soil erosion within the drainage reserve.
 - 3. Channel erosion or sedimentation.
 - 4. Condition and functionality of any flow control structures, such as culverts.

XV. Enforcement

Any unauthorized encroachment or other harm made within the drainage reserve or failure to obey the site-specific drainage reserve O&M plan shall be considered a violation of Title 17.38 and these rules. BES staff in the Spill Protection/Citizen Response (SP/CR) section shall respond to, investigate, and resolve all drainage reserve violation cases and shall respond to any complaints or referrals in a timely manner.

- A. Staff may use education and technical assistance to remediate any discovered violations, especially with parties who are unlikely to have knowledge of regulatory requirements or knowledge of the reserve placement on their property. Timely remediation of any site issues such as vegetation removal that exposes bare ground, drainageway diversions, or blockages of the drainageway shall be priorities. Staff may work with property owners to establish an agreeable schedule for the remedy, but BES reserves the right to remediate any violations posing an imminent threat to public safety or water quality.
- B. Enforcement to gain compliance with the standards of these rules and City Code shall generally follow the escalating steps of enforcement called out in the stormwater administrative rules (under separate cover). Measures such as stop work orders (especially for violations resulting from construction activities), administrative reviews, formal voluntary compliance agreements, financial penalties and/or criminal charges are available enforcement tools. Appeal to the City Code hearings officer is available, pursuant to City Code Section 22.10.

V. Protection of Drainageway Areas

III.B.1. c Easements/ Drainage Reserves. *Are there easements or drainage reserves already present that would influence site design? Other than pipe easement described in (4) above, applications may be required to obtain a drainageway reserve. (From Sewer Design Manual and Technical Review Standards above)*

- (1) **Definition.** Drainageway is an open linear depression, whether constructed or natural, which functions for the collection and drainage of surface water. It may be permanently or temporarily inundated.
- (2) **Drainageway Reserves.** A drainageway reserve shall be placed to assure adequate and environmentally beneficial conveyance of stormwater across a developing site. Because of the unpredictable nature of storm events and great variation in potential flows, the sizing of drainageway reserves does not guarantee prevention of damages in all situations. Requirements imposed by the Bureau of Environmental Services are designed to address typical flows and do not relieve property owners of their responsibility to manage stormwater in a manner that complies with the duties of property owners under applicable law. Reserves shall be placed on a proposed development site in one of the following manners:
 - (a) 15 feet from the centerline of the channel; or
 - (b) 15 feet from the delineated edge of a designated water feature (i.e. seep, spring, wetland); or
 - (c) Within the boundary of a designated environmental zone; or
 - (d) Over a designated seep, spring and stream tract.

Exemptions: Drainage reserves shall not be required for drainageways located within a FEMA designated and mapped area.

- (3) **Sizing of Drainageway Reserves.** Drainage reserves shall be sized to assure that the current flow rate and pattern of the drainageway continues to be adequately conveyed through the development site. Current flow volumes and/or drainageway capacities will be determined by:
 - (a) Reviewing existing data, which may include available hydrologic records, drainage basin hydrology, historical data, high water marks, soil inundation records, photographs of past flooding, and other similar information.
- (4) **Improvements within Drainageway Reserves.** Improvements within the drainageway reserve shall only be approved when all of the following conditions exist:
 - (a) Where the modification will not impede or reduce flows within the drainageway; and
 - (b) Where the improvement will enhance the surface flow capacity and habitat values of the drainageway; and
 - (c) Where the improvement shall provide additional safety to public or privately held properties or facilities; and

* Adopted as part of the Title 17 Land Division Related Administrative Rules package

- (d) Where the improvement is constructed with minimal hard surface armoring of the drainageway.
- (5) **Improvement Development Standards:** All improvements shall meet one of the following development standards:
 - (a) All improvements shall comply with City codes and standards that apply to the improvement being proposed (i.e. erosion control manual, street design standards, and *Sewer Design Manual*); or
 - (b) Other design guidelines may be used, but only if approved by the BES Chief Engineer.

Appendix A.3-B: Notice of Condition Form for Recording Against Property Deed

After Recording Return Copy to:
LAND USE REVIEW DIVISION
BUREAU OF DEVELOPMENT SERVICES
1900 SW Fourth Avenue, Suite 4500
Portland, OR 97201

This Space Reserved For Recorder's Use:

PORTLAND BUREAU OF ENVIRONMENTAL SERVICES (BES)
1900 SW Fourth Avenue, Suite 5000
Portland, OR 97201

Notice of Condition of Development Permit Approval Conditions

_____ is the declarant of lot or parcel with Legal Description # _____ located at Site Address _____ Multnomah County Records. Approval of the development permit for this parcel is based on the Portland City Code Title 17.38. Section 17.38.030 requires that drainage flows from above to below this property be conveyed in an open drainageway, which can appear as a channel or depression that conveys flows across a site. To assure continued operation and maintenance of this drainageway in an open, naturalized condition, the City's Bureau of Environmental Services (BES) has placed a drainage reserve on this property. The reserve is a 30 foot buffer, centered on the centerline of a drainageway, with 15 feet of reserve area on each side of the centerline. This buffer overlay where development encroachment, flow path alteration, or vegetation disturbance is prohibited without BES review and approval. Parcel or Lot owners and future parcel/lot owners should verify the constraints on their lots in the applicable land use and building permit decisions and conditions of approval, and with BES land use review staff.

Name and title of declaring

By: _____

The forgoing instrument was acknowledged before me on this _____ day of _____, _____ by declarant, the developer of the lot or parcel with R number _____.

Appendix A.3-C: Summary of Development and Submittal Requirements for Drainage Reserve and Channel Encroachments

Requirement	Location		
	In Drainage Reserve: <ul style="list-style-type: none"> • At least 10 feet away from channel AND • Less than (<)10% total of the reserve area on the development side of the channel 	In Drainage Reserve: <ul style="list-style-type: none"> • Within 10 feet of the channel OR • More than (>)10% total of the reserve area on the development side of the channel 	In Drainageway Channel
Site Plan	Required	Required	Required
Erosion Control Plan	Required	Required	Required
Mitigation Plan	Required	Required	Required
Construction Management Plan		Required	Required
Work Period	Any	Dry Weather Only	Dry Weather Only
Engineering Design Report			Required
Hydrologic Modeling		May be Required	Required
Cross-Sectional Data			Required
O&M Plan	Office Copy	Office Copy	Recorded with County
Notice of Condition Against Deed	Recorded with County	Recorded with County	Recorded with County

Appendix A.3-D: Drainage Reserve Operations and Maintenance Plan

<p>Private drainage channels, which have been modified through a City permit process, must be inspected and maintained in order to ensure proper function and prevent property damage. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event (defined as ½" in 24 hours). The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. This log must be available to City inspector upon request. The following items shall be inspected and maintained as stated:</p>
<p>Inlet (culvert/outfall) shall maintain an unimpeded and controlled flow of water entering the drainageway.</p> <ul style="list-style-type: none">• Source of erosion shall be identified and controlled when native soil is exposed or erosion channels are forming.• Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4" thick or so thick as to damage or kill vegetation.• Inlet shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.• Rock splash pads shall be replenished to prevent erosion.
<p>Banks/Side Slopes shall be maintained to prevent erosion that introduces sediment into the drainageway.</p> <ul style="list-style-type: none">• Slopes shall be stabilized and planted using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
<p>Drainageway Outlet shall maintain sheet flow of water exiting drainageway unless a collection drain is used. Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.</p> <ul style="list-style-type: none">• Outlets such as drains and overland flow paths shall be cleared when 50% of the conveyance capacity is plugged.• Sources of sediment and debris shall be identified and corrected.
<p>Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion. Mulch shall be replenished as needed to ensure survival of vegetation.</p> <ul style="list-style-type: none">• Vegetation, large shrubs or trees that impedes flow within the drainageway channel shall be pruned.• Fallen leaves and debris from deciduous plant foliage shall be removed.• Nuisance and prohibited vegetation from the Portland Plant List (such as Himalayan blackberries and English Ivy) shall be removed when discovered. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.• Dead vegetation and woody material shall be removed to maintain less than 10% of area coverage or when drainageway flow is impeded. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.
<p>Spill Prevention measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.</p>
<p>Training and/or written guidance information for operating and maintaining modified drainage channels shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.</p>
<p>Access to the drainageway shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.</p> <ul style="list-style-type: none">• Obstacles preventing maintenance personnel and/or equipment access to the drainageway shall be removed.• Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
<p><i>If used at this site, the following will be applicable:</i></p>
<p>Check Dams shall control and distribute flow.</p> <ul style="list-style-type: none">• Causes for altered water flow shall be identified, and obstructions cleared upon discovery.• Causes for channelization shall be identified and repaired.

Appendix A.4 Design Guidance for Culverts and Outfalls¹

Open Bottom Culverts and Outfalls

The inclusion of the detailed information regarding the design and construction of stormwater outfalls in the SWMM, is a focused effort by the City of Portland to provide options for stormwater management that are functional and minimize impacts to watersheds. The guidance documents are intended to provide guidance to designing stormwater outfalls and culverts. The guidance documents are also intended to provide flexibility to the engineer for designing a system, and to the reviewer examining the designed system. Staff recognizes the uniqueness of each site and potential stormwater management system.

Natural, open channel systems are formed and maintained by key watershed processes including flood flows, base flows, the erosion, transport and accumulation of sediments and woody debris, and the interaction of surface water and groundwater. When these processes are in equilibrium, they support a broad range of biological and ecological functions, including: fish spawning, rearing and migration; wildlife passage; habitat connectivity; and other ecological attributes that contribute to high biological productivity. In addition to ecological benefits, natural, open channel streams provide additional beneficial functions such as flood attenuation and water quality treatment.

Open Bottom / Natural-Bed Box Culverts Description

Culverts and bridges at road crossings and other constructed obstructions along these channels can disrupt watershed processes by altering or interrupting the transport of woody debris and sediments, and changing groundwater/surface water interactions. Poorly designed or failing road crossings can also block fish passage, preventing fish from migrating to spawning and rearing habitats. Over time, this can result in degradation of the biological productivity of the stream system and a net reduction in the ecological benefits it produces. Culverts can also restrict or block wildlife passage. In worst case situations, poorly designed culverts and bridges can induce major channel and bank erosion that threatens to undermine the roadway, and/or impede flood flow conveyance that in turn causes flooding of the roadway.

¹ The information included in this section is from a guidance document compiled by Herrera Environmental Consultants for the City of Portland *Concept Designs and Technical Guidance –Stormwater Outfalls* (April 2007) has been edited by City staff to eliminate duplicative information that is already contained in the SWMM, the SDFDM, and other references.

Ideally, road crossings over open channels should be designed to minimize the negative effects on watershed processes and ecological functions while adequately conveying flood flows downstream. To the extent possible, culverts beneath roadways should be designed to provide the following functions of a natural, open channel stream:

- Stream bed material transport,
- Woody debris transport,
- Natural flood attenuation,
- Biological productivity,
- Water quality benefits,
- Fish migration.
- Wildlife passage (other than fish),
- Surface water/ground water hydraulic connectivity.

These functions can be largely maintained by simulating a natural channel bed through the bottom of a culvert. Stream simulation methodology (ODFW 2004, WDFW 2003) can be used to design an open-bottom or natural-bed box culvert. An open-bottom culvert typically consists of a pipe arch or bottomless concrete structure (typically called a three-sided box) supported on footings, spanning a streambed for the entire length of the roadway crossing. Alternatively, a box-shaped culvert structure can be placed in a deeper excavation and partially filled with substrate materials to simulate a natural streambed. Typical culvert configurations are shown in [Exhibit SW-530](#). If properly designed, these types of culverts can mimic the substrate and flow conditions in the natural channel upstream and downstream of the culvert, thereby reducing the impacts of the road crossing structure on natural channel functions. While these culverts typically cannot reproduce all conditions of a natural streambed (e.g., floodplains, undercut banks, etc.) it can vastly reduce the impacts relative to traditional round, small diameter culvert installations.

Applicability

The selection factors for open-bottom and natural-bed box culverts are listed in [Exhibit A.4-1](#). As indicated in [Exhibit A.4-1](#), open-bottom and natural-bed box culverts are recommended for a variety of scenarios.

When native migratory fish are currently present or were historically present in the system, the culvert must provide fish passage pursuant to Oregon Department of Fish and Wildlife (ODFW) requirements. Current state law and ODFW fish passage criteria require consideration of fish passage requirements prior to installation or replacement of culverts in waters where native migratory fish are currently or were historically present.

In most cases, fish passage should be accommodated with the culvert design. The process for satisfying fish passage requirements includes native migratory fish determination, defining the fish passage criteria, and obtaining plan approval from all of the required federal, state, and local agencies.

Wildlife passage is also an important consideration for culvert design. Culvert width can be increased to contain an artificial ledge inside the culvert on one or both sides to enable connectivity for terrestrial species.

For specific guidance on additional measures that can be incorporated into culvert or bridge design to maximize wildlife passage, the wildlife crossings toolkit has various resources: www.wildlifecrossings.info/beta2.htm. For project-specific information, contact Oregon Department of Fish and Wildlife: www.dfw.state.or.us.

Bridges

Many of the concerns related to culverts at road crossings can be alleviated by constructing a bridge rather than a culvert. Bridges are the most appropriate choice to maintain the integrity of many of Portland's urban stream systems, particularly those systems with wide active channels (greater than 20 feet).

Bridges do not have the dimensional limitations of culverts and can be large enough that the structure does not significantly affect the flood hydraulic profile. A bridge, rather than a culvert crossing, should be considered when:

- The active channel width is greater than 20 feet.
- The channel gradient is greater than 6 percent.
- Movement of large woody debris occurs frequently.
- There is a high risk associated with flooding.
- The channel is actively meandering.
- There are large animals such as coyote or deer present and there is limited local wildlife passage.
- It is difficult to achieve hydraulic objectives (i.e., flood flow capacity, stream power continuity, subcritical flow regime, debris flows, and fish passage depth and velocity criteria, if applicable).

Exhibit A.4-1: Selection considerations for open bottom and box culverts

Selection Factors	Open Bottom or Box Culvert		Consider Bridge	Additional or Alternate Measures	Natural Stream Function of Culvert
	Required by ODFW	Recommended			
Fish Passage					
Native migratory fish currently or historically present (Unless waiver or exemption obtained from ODFW)	X				Provide fish passage and habitat
Wildlife Passage (non migratory fish)					
Resident fish, amphibians, small animals present		X			Provide wildlife passage and habitat
Large animals (coyote, deer) present with limited upland passage			X		
Downstream Fish Presence					
Tributary to fish-bearing stream		X			Maintain biological productivity (invertebrate habitat) and water quality functions
Woody Debris Transport					
Woody debris in channel, high potential for recruitment (well vegetated riparian corridor)		X	X	Consider upstream trapping with engineered log jam or collection and relocation of large wood to prevent blockage	Provide woody debris transport, lowering likelihood of culvert blockage
Hydrologic Conditions					
High variability in flow, "flashy" flow regime (typical for highly developed, urban, snowmelt and rain on snow systems)		X		Sufficient embedded depth to allow for vertical fluctuations in bed elevation	Enable sediment transport through culvert during episodes of bed scour and deposition (typical of flashy systems)
Flooding Concerns					
Flooding could endanger human health and safety, result in extensive property damage, or impact the environment significantly		X	X		Reduce likelihood of inlet blockage with debris or aggraded sediment that could result in capacity reduction and flooding. Channel provides natural flood control.
Channel Gradient					
Gradient greater than 6% and vulnerable to debris flow (headwaters include channels >20%)		X	X		Provide some capacity for debris flow
Up- and down-stream gradients differ or culvert bed slope differs from channel gradient		X	X	Sufficient embedded depth to allow for vertical fluctuations in bed elevation/consider grade control structures	Allow for some vertical fluctuations in bed elevation due to grade change
Channel Width					
Channel width greater than 20 feet			X		

Selection Factors	Open Bottom or Box Culvert		Consider Bridge	Additional or Alternate Measures	Natural Stream Function of Culvert
	Required by ODFW	Recommended			
Channel Stability					
Vertically aggrading or incising-evidence of historical fluctuations in channel bed elevation (e.g., headcuts, near-vertical channel banks, channel avulsion, gravel-splay deposits in floodplain)		X		Grade control structures recommended	Provides sediment transport / Allows for some vertical fluctuations in bed elevation
Actively meandering		X	X	Large wing walls or upstream bank stabilization	Provides sediment transport / Allows for more horizontal fluctuations in channel alignment than traditional round culverts
Confined channel-if confined due to historical incision		X		Grade control structures recommended	Provides sediment transport / Allows for some vertical fluctuations in bed elevation
High sediment flux		X		Sufficient embedded depth to allow for vertical fluctuations in bed elevation	Provides sediment transport / Allows for some vertical fluctuations in bed elevation
Maintenance					
Maintenance required		X		Consider grates in road bed to provide access for sediment removal	Larger culvert easier to access to remove debris and accumulated sediment

Summary of Analysis and Design Methods

This section provides a brief description of hydrologic analysis and design methodologies for open-bottom and natural-bed box culverts. Detailed design requirements and procedures are not included here, but can be found in reference documents listed below and cited in this section.

- Hydrologic analysis requirements for culverts in the City of Portland public drainage system are provided in chapter six of the Portland Sewer and Drainage Facilities Design Manual (BES 2006).
- Culvert design requirements and procedures are detailed in Chapter 8, Appendix A and Appendix J of the Portland Sewer and Drainage Facilities Design Manual (BES 2006).
- Culvert design guidance for fish passage is provided in the Oregon Department of Fish and Wildlife Fish Passage Criteria (ODFW 2004) and related statutes, the Oregon Road/Stream Crossing Restoration Guide (ODFW 1999), and the Washington Department

of Fish and Wildlife Design of Road Culverts for Fish Passage (WDFW 2003).

- Permits from the US Army Corps of Engineers and the Oregon Division of State Lands may be required.

Design Storm

Typically, culverts must be designed to convey the 25-year storm flow (SDFDM Appendix J page 13 says 100 year) through a roadway fill without surcharging the inlet (i.e., water depth shall not exceed the inside height of the culvert crown). If the risk associated with culvert failure is high, a more conservative standard may be required. In addition, if the culvert is not oversized to convey the 100-year peak flow, a route must be established to safely convey any flow exceeding the 25-year storm without damage to property, endangering human life or public health, or causing significant environmental impact.

Hydrologic Analysis

The peak flow values used for culvert design should be estimated using single-event hydrologic methods. The Rational Method is recommended for culverts conveying runoff from a drainage basin less than 50 acres in size. Modeling peak flows based using the HEC-HMS (U.S. Army Corps of Engineers Hydrologic Engineering Center - Hydrologic Modeling System) or EPA SWMM (U.S. Environmental Protection Agency Stormwater Management Model) program, or a comparable alternative, is recommended for culverts conveying runoff from a drainage basin equal to or greater than 50 acres in size. The selected hydrologic analysis method for culverts conveying flow from these larger drainage areas requires approval from the City of Portland. Drainage area characteristics (e.g., area, land use, ground surface cover characteristics, time of concentration, runoff coefficients, runoff curve numbers, and infiltration rates) must be estimated to represent the future build-out condition as defined in the Comprehensive Plan.

Rainfall depths and an Intensity-Duration-Frequency Curve have been developed for the City of Portland. These are provided in the Portland Sewer and Drainage Facilities Design Manual.

Design Procedures

The culvert shape, dimensions, slope and bed roughness must be designed to provide flood conveyance capacity. To maintain natural stream function, it is also

recommended that stream power (described below) is preserved through the culvert and that a subcritical flow regime (described below) is maintained. These three goals (conveyance capacity, stream power continuity, and subcritical flow regime) can be achieved by performing iterations using the following equations. The conditions during a 100-year event should also be evaluated.

Conveyance Capacity for Design Storm

The culvert shape, dimensions, slope and bed roughness should be designed to convey the peak design flow at build-out land use conditions in the upstream drainage area. Manning's Equation can be used to evaluate open channel flow (when the pipe is not surcharged) through the culvert barrel. Using English measurement units, the equation is as follows:

$$Q=1.49/n (A*R^{2/3}*S^{1/2})$$

Where, Q = flow rate (cubic feet per second)

n = roughness coefficient (dimensionless)

A = flow cross section area (square feet)

R = hydraulic radius = flow cross section area / wetted perimeter (feet)

S = friction slope (feet/foot)

note: for uniform flow, S equals the slope of the channel bed.

Chapter 8 of the Portland Sewer and Drainage Facilities Design Manual (BES 2006) provides a discussion about the application of this equation for calculating capacity and velocity for pipes and channels.

For calculations using Manning's Equation, a Manning's roughness value ("n") of 0.013 must be used for the culvert regardless of culvert material type. BES has selected this constant value, while recognizing that it can vary as a function of pipe material, flow depth and pipe size. Approval must be obtained to use an alternative roughness factor. A typical roughness value for streambed gravel is 0.03.

When assuming open-channel flow, it is important to confirm that the tailwater (water surface elevation at the downstream end of the culvert) is not significantly greater than the culvert invert due to downstream controls. If tailwater conditions prevail at the downstream end of the culvert, the analysis must address "outlet control." Methods of analysis for culverts flowing under outlet control can be found in the Federal Highway Administration publication entitled Hydraulic Design of Highway Culverts (FHWA 2001a) as well as in many other hydraulic engineering publications.

Sediment Transport Capacity

Sediment transport capacity is directly related to stream power (Simons and Sentürk 1992). Stream power is not a quantitative measure unto itself (i.e., there is not an optimal range of stream power values that can be applied between watersheds).

Rather, it can be used as a relative measure of sediment transport capacity between adjacent stream and culvert reaches. Thus, the power of adjacent reaches can be compared to identify areas which may exhibit sediment aggradation in the channel (a reach with a low stream power value relative to the adjacent upstream reach) or channel bed degradation (a reach with a high stream power relative to the adjacent upstream reach). Stream power (Ω) can be calculated according to Simons and Sentürk (1992) as follows:

$$\Omega = v \cdot \tau_o = v \cdot \gamma \cdot R \cdot S_b$$

Where, v = velocity (feet per second)

τ_o = shear stress (shear force per unit wetted area, in pounds per square foot)

γ = specific weight of water (62.4 pounds per cubic foot at a water temperature of 50°F)

R = hydraulic radius = flow cross section area / wetted perimeter (feet)

S_b = channel bed slope (feet/foot).

The stream power for the upstream reach, within the culvert barrel, and for the downstream reach can be compared at low and high flows (e.g., 2- and 25-year events) to assess the ability of the culvert to move sediment through the system.

Flow Regime

It should be confirmed that a subcritical flow regime is maintained through the culvert (i.e., the Froude number (F) is less than unity).

$$F = v / (g \cdot y_h)^{1/2}$$

Where, v = velocity (feet per second)

g = acceleration due to gravity (32.2 ft/s²)

y_h = hydraulic depth.

Fish Passage Criteria

When fish passage is required, additional criteria, such as maximum velocity and minimum depths during fish passage flows must be met. Fish passage criteria vary as a function of fish species, age, and the time of migration among other factors. These requirements are detailed in Oregon Department of Fish and Wildlife guidance.

Surcharged Flow

Headwater depth under higher flow conditions (100-year peak flow) should be evaluated. Nomographs for culvert conveyance under inlet and outlet control conditions are provided in the Washington State Department of Transportation Highway Runoff Manual (WSDOT 2006).

Culvert Design Considerations

Considerations for the design of open-bottom and natural-bed box culverts are discussed below. For detailed design discussions refer to Oregon and Washington Department of Fish and Wildlife guidance documents (ODFW 1999, 2004; WDFW 2003).

In general, stream simulation culverts are designed to mimic the substrate and flow conditions in the natural streambed above and below the culvert. To accomplish this, the culvert alignment, culvert bed grade, and channel bed material should generally be as similar as possible to the adjacent natural streambed.

Horizontal Alignment

Culvert alignment should be established to make the culvert as short as possible while minimizing the skew of the culvert relative to the existing stream channel alignment. Skew between the upstream channel orientation and the culvert inlet increases inlet contraction resulting in turbulence at high flows and a reduction of flood conveyance capacity and sediment transport. In-channel deposition and bank scour often occur upstream of culverts with excess skew. When the culvert is skewed relative to the downstream channel alignment, there is an increased risk of bank erosion near the culvert outlet. When conditions make the ideal alignment impractical, the designer should consider relocation of a portion of the channel or small angle bends with bank stabilization.

Culvert Length

The culvert length should be minimized to reduce channel disturbance. This consideration should be balanced with the need to minimize the skew of the culvert alignment relative to the stream channel as described above.

The maximum culvert length that can provide conveyance capacity, stream power continuity, subcritical flow regime, and fish passage (if required) for any given channel are is dependent on stream hydrology and geomorphology (e.g., slope, sediment transport conditions). Culvert length can be minimized by adding headwalls to each end of the culvert, by narrowing the road or by steepening the fill embankments.

Culvert Size

The culvert span, rise and slope will be determined iteratively to meet capacity, stream power and Froude number requirements. Additional considerations regarding culvert span and rise are provided below.

The culvert span should be no less than the active channel width. According to ODFW (2004), the width of the active stream channel is the stream width that occurs annually at ordinary high water. This width can be determined by measuring the stream's cross-sectional distance between the ordinary high water line (OHWL) on both banks of the stream.

To more closely simulate stream functions, it has been suggested that the minimum culvert bed width be calculated as 1.2 times the active stream channel plus two feet (WDFW 2003).

Usually a span of at least 6 feet is necessary to enable channel bed construction within a culvert. For construction and maintenance of the culvert, a minimum effective rise (from the culvert bed to the height of the culvert crown) of 4 feet is recommended.

Culvert Bed Slope

Culvert bed slope should be set as close as possible to the natural channel gradient extending upstream and downstream of the culvert. For new installations, this is the slope of the existing channel. For replacement culverts this is the slope of the channel upstream and downstream of the roadway crossing (beyond the extents of any channel scour or bed aggradation created by the culvert that is being replaced).

Installing the culvert bed at a slope significantly lower (flatter) than the natural gradient may result in a reduction of stream power and resultant sediment aggradation that reduces conveyance capacity and hinders other natural functions. Installing the culvert bed at a slope significantly higher (steeper) than the natural gradient may induce instability of the culvert bed material during higher flows. It has been suggested that the ratio of the culvert bed slope to the natural channel slope should not exceed 1.25 (WDFW 2003).

It is recommended that the culvert design process include a comparison of stream power in the culvert barrel to the up-and downstream reaches of the stream to confirm continuity in sediment transport capacity.

The culvert pipe/structure itself may be installed flat or on a slope, depending upon the culvert length and bed slope. For box culverts, the slope of the culvert should be minimized to decrease shear stress between the culvert bottom and the bed material. The depth of channel bed material can vary through the length of a bottomless/open-bottom culvert that is laid flat to create the desired bed slope through the culvert. This typically requires a taller culvert pipe/structure so that the hydraulic opening on the upstream side meets the design criteria. Longer culverts will require some slope in order to maintain embedded depths and inlet capacity.

Culvert Bed Material

For Stream Simulation culverts, ODFW recommends the following mix of fill/bed material to provide the best streambed function:

- 30 percent fines (dirt or silt; this allows the new bed to “seal” and water to remain in the channel rather than flow sub-surface).
- 30 percent small rock ($\frac{1}{2}$ to 6 inch diameter).
- 30 percent large rock (6 inch - D_{100} diameter).
- 10 percent “shadow” rock (D_{150} to D_{200} ; these simulate undercut banks, large wood, and boulders and should remain in place during flood events).

D_{100} rock is the size (diameter) of the largest rock found naturally in the stream. D_{150} to D_{200} rock is 50 to 100 percent larger than the largest rock found naturally in the stream. Shadow rock should protrude 30 to 50 percent above the final streambed elevation. During construction, the small rock, large rock, and fines should be mixed before placing. The final bed surface should be washed gently with water to allow the fines to work into interstitial spaces and provide a good seal, and to demonstrate that this seal has occurred.

Another approach is to select the bed material size based on the adjacent natural stream channel (WDFW 2003). In the “reference reach approach” the maximum particle size and appropriate distribution can be determined by examining reaches directly upstream from the culvert. If the culvert is designed to maintain stream power and subcritical flow, this material will move as the bed material in the adjacent channel, (so it will be replenished if it degrades). If the sediment transport capacity in the culvert will be higher, the size of the native channel substrate materials should be increased by a factor of safety to ensure bed stability.

Embedded Depth

The minimum embedded depth (depth of the bed material in the bottom of the culvert) is 12 inches, or 20 percent of the culvert rise, whichever is greater. The bottom of a box culvert or round arch culvert must be buried at sufficient depth in the channel bed to prevent exposure by scour. Scour calculations are therefore an important component of the design analysis, particularly if the culvert will constrict the flow of the upstream channel cross-section. Methods of scour analysis applicable to culvert installations can be found in FHWA (2006, 2001b, 2001c).

Baseflow Channel

The recommended cross-sectional dimensions for the baseflow channel (1 foot wide x 6 inches deep) are based on confining the summer baseflow. The baseflow channel helps to maintain stream power on the bottom leg of the hydrograph, hence transporting the fine-grained materials through the culvert. In addition, the baseflow channel confines low flows and helps to maintain sufficient depths for fish passage during low flow periods.

Woody Debris Transport

Culverts can be designed to provide some transport of woody debris. The size of material to pass through a culvert can be selected based on woody material present in the system (considering root-wad diameter for larger pieces) and culvert size constraints. The water depth required to pass (i.e., float the material) can be calculated. The culvert rise can be designed so that sufficient water depth and freeboard occurs during a storm in which the material would be mobile.

If it is not feasible to design for wood passage, and frequent accumulations of wood can reasonably be expected in the channel system upstream, the culvert may be vulnerable to blockage with wood mobilized in higher flow events. In these situations, consideration should be given to installing wood trapping measures in the upstream channel. For example, one or more engineered logjams could be installed in the channel upstream of the culvert to trap wood at a targeted location. If the culvert is not sized to effectively convey woody debris, long-term maintenance may be required to periodically remove collected debris in the channel upstream of the culvert and place it downstream of the culvert.

When frequent transport of large woody debris must be provided, a bridge should be considered. While there is no easy way to quantitatively evaluate the frequency of wood transport, considerations should be made for the downstream transport of woody debris when woody debris accumulations are observed in the channel, there is history

of culvert plugging in the system, and/or there is a potential for recruitment of wood from a well-vegetated riparian corridor.

Inlet/Outlet Treatment

If the culvert width is less than the upstream or downstream channel width or the skew of the culvert inlet or outlet relative to the stream alignment is significant (not recommended, but sometimes may be necessary), structural protection of the inlet and/or outlet will be necessary. Depending on the size of the channel and the peak flow rates that the culvert will convey, this protection can range from concrete wingwalls to rock armoring or woody debris embedded in a tapered section of the channel bank approaching the upstream culvert entrance.

If the channel is actively meandering, large wing walls and/or upstream bank stabilization is strongly recommended.

Grade Control

If the stream channel bed is aggrading (rising) or degrading (incising), grade control structures are recommended. Such instability is indicated by evidence of historical fluctuations in channel bed elevation (e.g., headcuts, channel avulsion, gravel-splay deposits in floodplain). If instability is observed downstream of the road crossing, grade control should be installed below the culvert to prevent the upstream migration of headcuts that could undermine the structure and damage the roadway. If instability is observed upstream of the road crossing, grade control can help to stabilize the reach. Grade control structures can also be used to re-grade an adjacent channel to a steeper gradient.

If fish passage requirements are applicable, the grade control structures must meet ODFW elevation drop criteria.

Materials

There are several options for open-bottom and natural-bed box culvert material. Selection of the optimal material for a particular site is typically based on cost, considerations for onsite assembly as relates to desired construction duration, and site accessibility for material delivery. Material options for most applications include the following:

- Pre-cast concrete,
- Cast-in-place concrete,
- Metal arch pipe.

Cast-in-place concrete is the most expensive of these options, and results in the most construction impacts. However, it allows for a structure that conforms to the exact project and site constraints. Metal arch pipe is least expensive and due to its lighter weight, typically less complex construction than concrete. However, in certain soil and moisture conditions, metal pipe can be subject to corrosion, limiting its design life. For a detailed discussion of corrosion, including soil pH and resistivity values that may warrant protective coatings, see Section 5.7 of the Oregon Department of Transportation Hydraulics Manual (ODOT 2006). The ODOT Hydraulics Manual also provides information on the design life of different pipe materials (design lives summarized in Table 5-3 are applicable, provided that the requirements from Section 5.4 are met for the pipe material).

Minimum Cover Requirements

Open bottom culverts made of metal require soil cover between the top of the culvert barrel and the overlying ground surface or roadway pavement section. The depth of cover over the culvert may vary depending upon the weight of traffic loads or other land use that can be expected atop the culvert. Typically a minimum 2 feet of soil or crushed rock cover is needed above the culvert barrel to protect the culvert from deformation under heavy traffic loading. If a three-sided concrete box is proposed for the open bottom culvert, the top slab of the structure may be specified with a thickness that can greatly reduce or eliminate soil cover requirements. A structural engineer should be consulted for site-specific recommendations for cover depth when an open bottom culvert is planned.

Natural-bed box culverts are usually made of reinforced concrete, including a thick top slab, or elliptical metal pipe arches. As with open bottom culverts made of reinforced concrete, the top slabs on reinforced concrete boxes can be specified to a thickness that is capable of supporting heavy traffic loads. In some light traffic areas the top of the concrete box culvert can serve as the roadway driving surface. Cover depth over a natural-bed box culvert can typically be minimal if desired by specifying a stronger culvert material. The designer should evaluate the tradeoff of a taller and stronger box structure (at greater material cost) that requires less cover versus a lesser structure height (at lower material cost) covered with onsite soil from the culvert excavation.

Construction Considerations

Construction of open bottom and natural-bed box culverts requires fairly intrusive excavation and local modification of channel conditions at each end of the culvert. As such, there are many considerations that must be addressed for timely completion of construction and prevention of adverse environmental impacts during construction.

Erosion Control

Temporary erosion control measures should be implemented during construction to minimize erosion and prevent sediment from impacting site runoff. Permanent stabilization measures should be implemented to protect stream water quality and rehabilitate vegetation in the stream corridor. Details on appropriate erosion and sediment control measures are provided in the Erosion Control Manual (City of Portland, 2008).

Replanting

ODFW recommends that all disturbed areas be protected from erosion within 7 calendar days of completion of the project using vegetation or other means, and that the stream banks should be re-vegetated within 1 year with native or other approved woody plant species.

Stream Dewatering/Diversions

Culvert and related channel improvements should be constructed “in the dry” whenever possible to prevent or minimize water quality impacts on streams and biological communities. Construction in relatively dry site conditions typically enables faster completion of the construction work, avoids potential conflicts with sensitive fish species that may be present in the stream at the time of construction, and minimizes potential for mobilization of soil and sediments into the stream.

Bed Material Placement

Culvert fill material can be loaded into the pipe from either end using hand equipment for smaller projects, and with a small Bobcat® style front-end loader, a small bulldozer, a gravel conveyor belt or a rail-mounted cart for larger projects where hand placement is not practical. Alternatively, the bed material can be pushed into the culvert with a log or stiff board manipulated by an excavator (WDFW 2004). For culverts that are assembled in the field (in the excavation) in sections, stream bed material can be placed from the top before installing the top section of the culvert.

Care should be taken in the method in which the bed material is placed. According to WDFW (2004):

In order to achieve stream simulation, fill materials must be arranged to mimic channel conditions. Avoid grid patterns or flat, paved beds made of the largest rocks. A low-flow channel and secondary high-flow bench on either side should be created in the culvert. A step-pool profile generally occurs in the 3 to 10 percent slope range. The spacing of steps is somewhat variable, but one to four channel widths with a maximum 0.8-foot drop between successive crests is recommended. This type of channel ensures that stream energy is dissipated in pool turbulence, creating better fish passage and more stable channels. Segregating a portion of the coarsest fraction into bands can encourage this pattern. Do not exceed 0.8 feet of drop between successive steps. The steepest channels (greater than 10 percent grade) are cascades with large roughness elements protruding into the channel. The same material comprises the whole depth of fill. Stratification, such as placing spawning gravel over a boulder fill in a steep channel, is not appropriate.

If the culvert bed material will be laid on a relatively steep slope or subjected to high velocity flows that could mobilize the channel bed material, baffles or other sill materials will be needed at intervals through the culvert length to hold the smaller bed materials in place. Sometimes it is sufficient to place boulder clusters within the culvert to prevent significant mobilization of bed material while not compromising high flow conveyance capacity. The designer should refer to ODFW (1999) and WDFW (2003) for details on options and design guidance for bed material retention.

Schedule

The time and duration of culvert construction should be carefully considered to minimize stream sedimentation, flow interruption, and disturbance of fish during sensitive periods. Generally, construction should be performed during low flow conditions in mid to late summer. If fish are present, construction must not coincide with fish migrations, spawning, and egg incubation periods. If in-water excavation is anticipated, timing must conform to state guidelines.

Foundation

If a box culvert structure is used, the only foundation typically required is crushed rock bedding material beneath the structure to create a smooth, even surface upon which the structure is laid. However, a geotechnical engineer should always be consulted to determine the adequacy of the underlying soil to support the weight of the structure, adjacent backfill, and the overlying roadway or other overlying land use. Site-specific techniques may be needed in some instances to provide a stable foundation for a box culvert. The geotechnical engineer's recommendations should be followed to achieve

sufficient structural support for long-term success. A civil engineer also needs to be consulted to look at proposed and future loadings on the culvert as well as the basin dynamics.

If an open bottom culvert structure is used, the culvert will need to be laid on a foundation to prevent differential settlement over time that could compromise culvert functions and/or cause damage to the overlying roadway. Parallel foundation support is needed for each side of the culvert through the length of the culvert. Again, a geotechnical engineer should be consulted to determine the most appropriate foundation design for site-specific conditions. The basic options for open bottom culvert foundations include the following:

- Footing pads
- Continuous spread footings
- Pilings.

Minimizing Disturbance of Streambed and Banks

Disturbance of the bed and banks should be limited to that necessary to place the structure, embankment protection, and any required channel modification associated with the installation. This will expedite completion of construction and minimize potential for adverse water quality impacts. All disturbed areas associated with culvert construction should be replanted with native vegetation to help stabilize soils and slopes.

Outfalls

Outfall Description

This section provides guidance for designing and constructing drainage system outfalls to open channels or upland areas in such a manner as to prevent and reduce erosive conditions to protect the stability of shorelines, channel grades, ravine slopes, and channel banks. Three types of outfalls are addressed below. These are described in a preferred sequence for use; the first priority is for an open channel outfall, the second priority is for upland dispersion, and the third priority is for a piped outfall.

- **Open channel outfalls** – The location where stormwater is discharged via an open channel (typically a ditch) to a stream, drainage way, or another open channel. The longitudinal slope (in the direction of flow) of the outfall channel must be less than 20 percent.

- **Upland Dispersion** – A method used to spread out concentrated discharge of stormwater over an area outside the riparian zone and higher in elevation than the receiving stream, drainageway, or open channel. Where soil conditions are appropriate, this method enables stormwater to be used to support habitat functions while also adding attenuation benefits through uptake by vegetation, decreased flow velocities, and allowing infiltration. Upland dispersion is recommended only for low flows (100-year flow less than 2 cfs) and where site conditions are appropriate. Level spreading is another term that may be used for upland dispersion.

- **Piped outfalls** – The location where stormwater is discharged from a piped conduit (typically made of concrete, metal, or plastic) to a stream, drainageway, or open channel, as indicated above. This is often the end or terminus of a storm sewer pipe network.

Applicability

This section can be used as guidance for outfalls that are smaller than 36 inches in diameter/width. Abiding by the guidelines listed does not preclude submittal of additional engineering information when required by the City of Portland or other jurisdictions. See the City of Portland 2006 Sewer and Drainage Facilities Design Manual (SDFDM), Chapters 6 and 8 and Appendices A and J, for more detailed design information.

This section is *not* intended to cover outfalls governed by the City's municipal NPDES permit (National Pollutant Discharge Elimination System permit for separate storm sewer systems) with the Oregon Department of Environmental Quality (i.e., the larger municipal storm drain outfalls discharging to receiving water bodies throughout the City).

Open Channel Outfalls

Open channel outfalls are good options for sites with existing concentrated surface discharge (ditches or channels). For use of an open channel outfall to be acceptable, the following conditions must be met:

- The soils through which the outfall channel is constructed must be stable.
- The longitudinal slope (in the direction of flow) of the outfall channel must be less than 20 percent.
- Adequate space must be available to meet the design criteria for an open channel, such as side slopes and freeboard, as described in Section 8.5.1 of the 2006 SDFDM.
- The open channel will not pose safety risks at design flow depth.

Upland Dispersion

Dispersion of stormwater flows is often a good choice for sites with limited development where stormwater currently infiltrates, particularly if there are steep slopes, ravines, riparian areas, and/or other natural areas downstream where erosion could readily occur if stormwater is concentrated in an open channel outfall. For upland dispersion to be feasible, the following conditions must be met:

- The slope(s) onto which the runoff will be dispersed must be stable.
- The slope(s) onto which runoff will be dispersed must have a gradient of 20 percent or less.
- There must be no existing concentrated surface discharge (channels or ditches) on the site.
- No drinking water wells, septic systems, or springs used for drinking water may lie within 100 feet of the proposed dispersion site.
- A vegetated flow path of at least 50 feet must be accommodated from the proposed dispersion location to the nearest property line,

structure, environmental zone, or steep slope (greater than 40 percent).

- It is imperative to determine and document potential downstream effects and conflicts associated prior to permitting and construction.

Piped Outfalls

Piped outfalls should be used if the soil, slope, or space requirements of an open channel or upland dispersion outfall cannot be met.

- Hand trenching should be provided where runoff will pass over erodible soils in a slope area that is higher than 20 feet with a gradient of 15 percent or steeper.
- For slopes steeper than 40 percent, it is recommended that the pipe be installed on the ground surface to minimize disturbance to what could be an unstable slope.

Outfall Design

Before initiating the design process, it is imperative that an assessment of the site be made to determine its existing characteristics, such as the type and condition of soil, vegetation, and habitat. Many outfalls have failed or otherwise caused significant environmental damage, such as major erosion, because the outfall design did not fully consider potential adverse consequences.

In most settings, the impacts of outfall design should be considered with the design storm event in mind. Under design event conditions, discharge velocities are greatest and have the most potential to damage slopes and receiving waterways. However, in settings where fish passage is an issue, low flow periods may require special consideration.

All outfalls should be designed to accommodate the peak flow during the pertinent recurrence interval design storm specified in SWMM [Chapter 1](#) and Section 6.4 of the SDFDM. The design should also minimize flow velocities and dissipate energy at the outfall to the extent possible, thereby decreasing the potential for erosion and scour in the flow path to the adjacent stream, drainageway, or open channel. In general, stormwater conveyance systems should be designed to reduce flow velocity throughout the length of the network, not just at the outfall.

Open Channel Outfalls

Open channel outfalls may be appropriate for sites with concentrated surface discharge under undeveloped conditions, as long as the slope, soil stability and space requirements indicated in the *Applicability* section of this document can be met.

Hydrologic Analysis and Hydraulic Design

- Design Storm Recurrence Interval: 25 years (see Section 6.4.1 of the SDFDM)
- As set forth in Section 8.5.3 of the SDFDM, there are separate velocity limitations identified for specific channel lining materials and for the vegetation within the channel. See the SDFDM for listed values. Please note, rock outfalls with native tree stakes is another type of vegetative channel lining that can accommodate slope up to 10% and a maximum velocity of 4 fps.

Channel Depth and Width

The primary concerns where an open channel outfall merges with a wider and deeper channel is prevention of erosion at the confluence of the outfall channel and the receiving channel, and stabilization of the outfall channel. The bottom (invert) of the open channel outfall should be at the same elevation as the bottom of the receiving channel, to avoid spilling of water down the bank of the receiving channel that can cause erosion of the bank or bed of the receiving channel. As recommended in the SDFDM, there should be 6 to 12 inches of freeboard depth above the design storm water surface elevation in an open drainage channel.

Erosion and Scour Control

The outfall and receiving waterway must be protected against erosion and scour. Erosion and scour can result when the shear stress of the flowing water exceeds the shear stress at which the soil lining the outfall channel or receiving waterway is stable (the critical shear stress). The maximum shear stress in the channel at any particular flow depth should be used as a basis for design to ensure the design is conservative. Maximum shear stress can be calculated as follows:

$$\tau_d = \gamma d S$$

τ_d = maximum shear stress, lb/ft²

γ = unit weight of water, 62.4 lb/ft³

d = depth of flow, ft

S = average channel slope, ft/ft

For more information on shear stress refer to Section 8.5.5 of the SDFDM.

Protection from erosion can be provided by these techniques:

- rock lining (large riprap or smaller quarry spalls, or streambed boulders),
- geotextile fabric lining (PDOT 2007, Section 00350),
- low-rise check dams spanning the outfall channel,
- plantings on the channel banks, and/or
- woody structures installed in the drainageway channel bank.

Each technique has specific design requirements listed in Chapter 8 of the SDFDM. As a rule of thumb, if check dams are used to slow velocities in the open channel outfall, a minimum of three check dams should be used with dam heights and spacing as indicated in the check dams [Exhibit SW-520](#). They should be made of wood or rock, and must be keyed into the open channel bed and banks to prevent the dam from being displaced during high flows. Where rock is used, the rock must be placed by hand or mechanically, rather than dumped from a truck. Check dams are a good choice for steep outfall channels if channel lining is impracticable. Check dams are not usually necessary in low-gradient (less than 1 percent channel slope) reaches.

Angle of Discharge at Confluence with Drainageway Channel

The open channel outfall should be oriented at no less than a 30 degree angle from a perpendicular alignment with the receiving channel, with the confluence of flow oriented in the downstream direction ([see Exhibit SW-521](#)).

Plantings

Whenever possible, native vegetation should be incorporated into the design of an open channel outfall. In most cases involving planting, the use of an erosion control blanket over the bare soil is recommended until the vegetation is fully established. For guidance on plantings, refer to Section 8.5.6 of the SDFDM and SWMM [Appendix F](#).

Grade Control

To minimize erosion and scour, the outfall should be designed to minimize the elevation difference between the bottom of the open channel and the bottom of the receiving waterway. Where the outfall channel slope drops steeply to meet the receiving drainageway channel, one or more grade control structures (larger than typical check dams) are required to create a step-pool sequence within the open channel outfall. Short drops of less than a foot will not typically require grade control, unless the outfall channel bed material is highly erodible. But steep (greater than 20 percent slope) elevation drops of greater than 1 foot should be avoided through use of properly designed and installed grade controls, particularly if upstream fish passage is a consideration. Appropriate grade control measures depend upon the outfall channel, the receiving waterway, the site characteristics, and fish passage considerations.

If the receiving drainageway channel is deeply incised near the outfall, grade control structures may be needed within the drainageway channel for a reasonable distance downstream of the outfall point to prevent the outfall discharges from worsening the incision problem. If a project site appears to need grade control structures for channel stability, a stream restoration design professional should be consulted early in the project design. If fish passage considerations apply to the site, ODFW fish passage design criteria for the elevation drop across a grade control structure must be adhered to (WDFW 2004).

Options for grade control include log sills, plank sills, and boulder controls. Design guidelines may be obtained from Chapter 7 of the Washington Department of Fish and Wildlife document entitled Design of Road Culverts for Fish Passage (WDFW 2003).

Upland Dispersion

Dispersion of concentrated stormwater flows is often a good choice for discharges to long slopes, ravines, riparian areas, and other natural areas where erosion could readily occur otherwise. Effective dispersion occurs when concentrated flows are converted to sheet flow. The primary concerns for effective dispersion design are stable slopes, a suitably-sized vegetated flowpath downslope of the dispersal location, prevention of erosion caused by the dispersed flow, and selection of plantings that are suited to the hydrologic regime that will be created by the flow dispersion.

Vegetated Area Requirements

A vegetated flowpath of at least 50 feet, and preferably greater, should be maintained between the dispersal point and any property line, structure, steep slope (greater than 40 percent), or Environmental Zone.

Dispersion Model

One method used to disperse concentrated stormwater flow in hilly terrain is through a flow dispersal trench (see [Exhibit SW-524](#)), where direct discharge from a storm drain or culvert infiltrates or percolates through a wide gravel-filled trench before it spreads out and continues onto existing soil and vegetation. It is recommended that this method not be used where hill slopes are greater than 20 percent. The discharge point shall not be placed on or above slopes greater than 20 percent or above identified erosion hazard areas without evaluation by a geotechnical engineer or qualified geologist and approval by the City of Portland Bureau of Development Services. The guidance below pertains to sites that meet these slope considerations.

The following guidance for dispersion trench design is taken from the Washington State Department of Transportation Highway Runoff Manual (WSDOT 2006). Discharge points with up to 0.2 cfs discharge for the peak 100-year flow may use rock pads or dispersion trenches to disperse flows. Piped discharge points with between 0.2 and 0.5

cfs discharge for the 100-year peak flow must use only dispersion trenches to disperse flows. Dispersion trenches must be a minimum of 2 feet wide by 2 feet deep in section, 50 feet in length; filled with $\frac{3}{4}$ - $1\frac{1}{2}$ inch washed drain rock; and provided with a level notched grade board (see [Exhibit SW-160](#)). Manifolds may be used to split flows up to 2 cfs discharge for the 100-year peak flow between four trenches (maximum). Multiple dispersion trenches must have a minimum spacing of 50 feet. If the 100-year peak flow at the outfall is greater than 2 cfs, dispersion is not an option for the site.

Erosion Control

Both the areas where stormwater enters and is dispersed must be protected against erosion. Erosion can result when the dispersed flow passes over sparsely vegetated ground or bare soil. If the dispersion area must be planted to provide the desired vegetation cover, a natural-fiber erosion control blanket (such as jute, coir, or excelsior) is recommended to provide soil stabilization while the vegetation matures, see City of Portland 2008 Erosion Control Manual. Native vegetation should be incorporated into an upland dispersion area, if not already present. Thick vegetation cover is critical to effective dispersion and infiltration of stormwater.

Piped Outfalls

On very steep or sensitive slopes, it may be difficult or impossible to route stormwater through an open channel or disperse upland without causing severe erosion. In such situations, it may be appropriate to use a piped outfall system (see [Exhibit SW-522](#)). All outfalls shall be located above the downstream mean low water level. Where the outfall may impact the receiving stream, especially fish bearing streams, consultation and approval by an ODFW authority may be required. The angle of discharge at the confluence with a drainageway channel is discussed later in this section.

Energy Dissipation

High velocity flows have significant kinetic energy, which can cause extensive erosion and scour at an outfall and/or receiving waterway. Every attempt should be made to decrease this kinetic energy throughout the conveyance network. However, when flow velocity is high at an outfall, the energy must be dissipated and erosion protection must be in place to protect against scour. This applies to all outfall scenarios regardless of outfall type. The design of an energy dissipation device is unique to the site; both the engineer designing the system and the reviewer of the design should consider that the device may not match these specifications. However, as long as it can be proven to both dissipate energy and protect against erosion and scour, it can be considered acceptable.

Techniques available:

- Rock outfalls with vegetation incorporated;
- Pipe Tee diffusion structures (see [Exhibit A.4-2](#));
- Non-rock dissipaters that are shaped with soils, vegetation, berms, and woody debris are encouraged;
- *Energy dissipation structures (stilling basins, drop pools, hydraulic jump basins, baffled aprons, bucket aprons should be engineered) are required where velocities are greater than 20 feet per second.

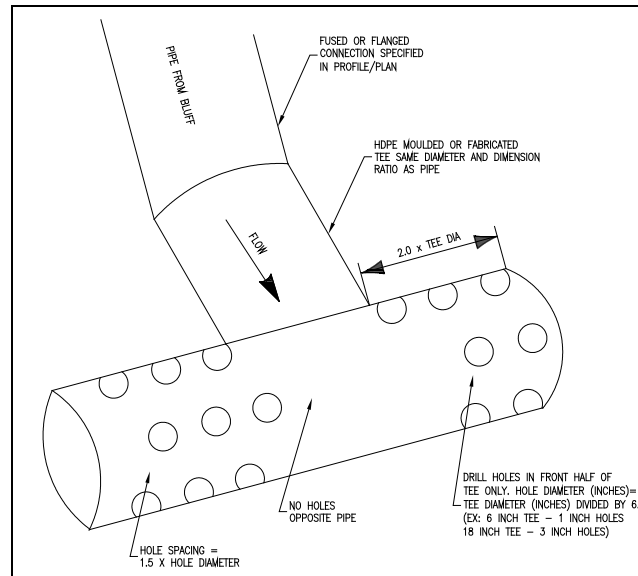


Exhibit A.4-2: Pipe Tee Diffuser

**These shall be designed by a professional engineer using published references such as Hydraulic Design of Energy Dissipaters for Culverts and Channels (U.S. Department of Transportation, Federal Highway Administration) and other references. The construction plan submittal shall identify the design reference.*

In general, rock protection of outfalls is most common. With the use of the proper size and gradation, rocks provide energy dissipation as well as protection against soil erosion. Depending on the flow velocity and existing site conditions, loose rocks such as riprap or quarry spalls can be used. [Exhibit A.4-3](#) has information on rock sizing based on outfall diameter and velocities. [Exhibit SW-523](#) and [Exhibit A.4-4](#) show two options for outfall energy dissipaters made of rock. All rock protection areas shall be inter-planted with willow stakes or other approved plantings, every two feet on center, to increase stability, reduce erosion, provide shading, and improve aesthetics.

The outfall should be oriented at no less than a 30 degree angle from a perpendicular alignment with the receiving channel; with the confluence of flow oriented in the downstream direction (same as described for open channel outfalls, see [Exhibit SW-521](#)).

Outfalls shall be located above the downstream mean low water level, except as approved by the City. Concrete endwalls will be required for all exposed outfall pipes greater than 12 inches in diameter (see [Exhibit SW-524](#)). Publicly accessible outfalls greater than 18 inches in diameter shall include grated protection in accordance with [Exhibit SW-525](#).

Outfalls to drainageways and rivers are often located in Environmental Zones. Environmental Review may be required pursuant to City Code Title 33.

Drainageways and rivers may have steep slopes or banks and may have unstable landforms (i.e. slump). Geotechnical investigation to determine the stability of the stream or river bank, as reviewed and approved by BES or BDS, may be required for approval.

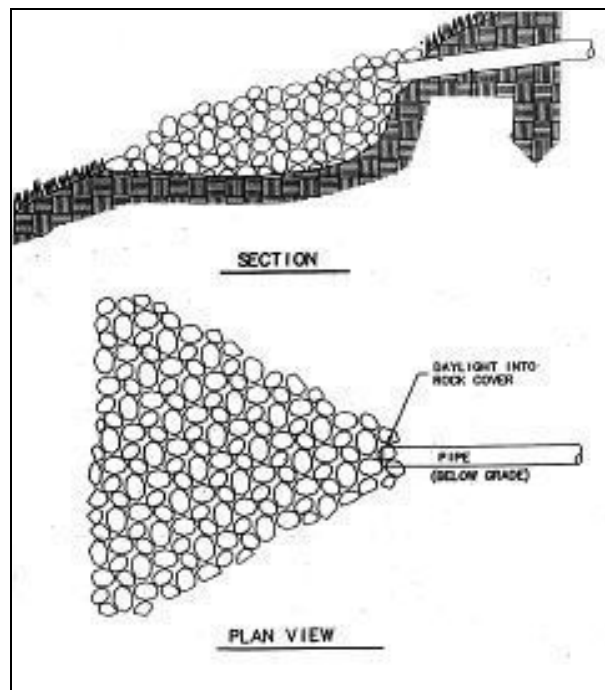


Exhibit A.4-3: On-Site Storm Outfall

Exhibit A.4.4: Rock Protection at Outfalls for Pipes

Outfall Diameter	Discharge Velocity at Design Flow	Type	Depth	Width	Length	Height
2 inch		Average stone size 1 inch	2 inch	12 inch	24 inch	
4 inch		Average stone size 2 inch	4 inch	24 inch	36 inch	
6 inch		Average stone size 4 inch	6 inch	36 inch	48 inch	
>6 inch	0 - 5 fps	Riprap ^a	2 x max. stone size	Diameter + 6 feet	As calculated ^b	Crown + 1 foot
	6 - 10 fps	Riprap ^a	2 x max. stone size	Greater of: (diameter + 6 feet) or (3 x diameter)	As calculated ^b	Crown + 1 foot
	11 - 20 fps	Gabion or riprap ^a	2 x max. stone size	Greater of: (diameter + 6 feet) or (4 x diameter)	As calculated ^b	Crown + 1 foot
	Over 20 fps		Engineered energy dissipater required			

^a Riprap size shall be determined using the following formulae and the *City of Portland Standard Construction Specifications* (PDOT 2007), Section 00390.11 Riprap.
 Riprap size $ds=0.25*Do*Fo$ (6" minimum).
 Depth= $2*ds$ (1 foot minimum).

^bApron length (ft) = $Do(8+17*Log Fo)$. $Fo = V/(g*Do)0.5$ $g = 32.2 \text{ ft/s}^2$.
 $V =$ Average velocity (ft/s). $ds =$ Riprap diameter (ft).
 $Do =$ Pipe diameter (ft). $\text{depth} =$ Thickness (ft).

Construction Techniques for Both Open Channel and Piped Outfalls

To the extent possible, heavy equipment and machinery should be kept out of the receiving waterway and off the banks. Channel beds and banks are typically in a delicate state of equilibrium and can easily be damaged by the action and forces of large earth-moving machinery. Equipment operations within the waterway can cause the release of sediment and disrupt the natural layering and armoring of particles on the channel bed. Out of the waterway, excessive compaction of native soils can slow or limit the propagation of beneficial vegetation.

For open channel outfalls, it is required that the new channel excavation be completed and stabilized to the extent practicable before making the connection to the receiving

drainageway. This will minimize the amount of time that disturbance occurs in the receiving drainageway while also enabling the downstream end of the excavated area to serve as a temporary sediment trap for downstream water quality protection. A plug of native soil should be retained between the outfall channel excavation and the receiving drainageway until the connection is ready to be made.

Construction in and adjacent to streams that provide habitat for fish must adhere to prescribed periods for in-water work, as defined in the Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources (ODFW 2000). As defined currently, the preferred in-water work period for Willamette River tributaries within city limits is July 1 to October 15. Project applicants should check the in-water work dates prior to proceeding with in-water work.

If runoff or other discharge will occur in the area where a new energy dissipater or open channel outfall is to be constructed, flow bypass or other forms of dewatering must be accomplished to enable construction in relatively dry conditions.

APPENDIX A.5 STORMWATER RETROFITS

This appendix identifies the regulations in the City's *Stormwater Management Manual* that apply to stormwater retrofits on private property. A stormwater retrofit is the installation of a new stormwater facility to treat stormwater from existing impervious area, including, but not limited to, roofs, patios, walkways, and driving or parking surfaces.

Stormwater retrofits are installed for a variety of reasons, including:

- land use, building, zoning, or other development proposals that may trigger compliance with *Stormwater Management Manual* requirements
- property owners motivated to increase their onsite stormwater management to provide multiple watershed health benefits, including reducing stormwater flow to combined sewer systems, reducing basement flooding, and providing groundwater recharge
- property owners wanting to install ecologically sensitive landscapes to reduce overall ecological footprint
- ratepayers wanting to reduce or eliminate onsite stormwater utility charges

Each retrofit site is unique and has specific site conditions. These conditions include location of existing structures and other impervious areas, zoning considerations, soils, slopes, current and historic site use and source control concerns, required uses (e.g., number of parking spaces, accessibility), desired uses (e.g., play or other common areas, gardens, visual amenities), and the existing stormwater discharge point (onsite, offsite to public system, or offsite to natural feature or drainageway).

There are two types of stormwater management retrofits:

1. **Mandated retrofits**, which result from a land use or redevelopment requirement. Mandated retrofits help the City control stormwater discharges by requiring the site to comply with the applicable elements of the *Stormwater Management Manual* as a condition of development.
2. **Voluntary retrofits**, which help the City incrementally provide management of stormwater from existing impervious surfaces.

Permits are determined by site use and stormwater facility characteristics. If a site has multifamily, commercial, industrial or institutional uses, a permit will be needed for stormwater retrofits; a permit *may* be needed for specific stormwater facilities at residential sites.

Stormwater retrofits must meet *Stormwater Management Manual* requirements as follows:

- Retrofits required as part of land use, zoning, building permits, or other conditions of developments must meet the *Stormwater Management Manual* requirements in full.
- If new offsite connections are created as a part of a stormwater retrofit, the infiltration, discharge, flow control, and pollution prevention requirements of the *Stormwater Management Manual* apply in order to meet the requirements of the stormwater hierarchy.
- For installation of new Underground Injection Control (UIC) facilities to treat existing development, all *Stormwater Management Manual* requirements regarding water quality, source control, and depth to groundwater apply in full. The property owner, applicant, or site manager (as appropriate) is responsible for registering or rule authorizing new UICs with the Department of Environmental Quality.

Voluntary retrofits must meet the following *Stormwater Management Manual* requirements when a City permit is necessary:

- Facility design and landscaping, as described in [Chapter 2](#).
- Sizing methodology and permit submittals for appropriately selected stormwater facilities, as described in [Exhibit 2-5](#) in [Chapter 2](#).
- Recorded operations and maintenance plans and activities, as described in [Chapter 3](#).
- Source control requirements if the project site has characteristics or activities that would classify it as high risk, as described in [Chapter 4](#).

For voluntary stormwater retrofits, there is flexibility in the facility sizing and site discharge location criteria. The City would rather encourage voluntary retrofits where the facilities are some portion of the required *Stormwater Management Manual* sizing than disallow facilities that do not meet full sizing criteria. These smaller facilities can still collectively add up to significant management of runoff from existing impervious surfaces. The following facility sizing and discharge criteria apply:

- Voluntary retrofits are encouraged to size facilities through the Simplified Approach for project areas of less than 10,000 square feet. If site characteristics make Simplified sizing difficult to achieve, voluntary retrofits are allowed to request the use of smaller facilities. Applicants must use the Presumptive Approach to get approval for smaller facilities. In general, the City will not approve facilities that are not sized to at least manage the water quality design storm. Applicants should clearly note on project submittals and any permit applications that the project is a voluntary retrofit and that water quality storm sizing is being used.
- Voluntary retrofits are encouraged to meet the stormwater hierarchy by fully infiltrating onsite whenever practicable. Infiltration testing (as described in [Appendix F.2](#)) is recommended in all situations and will be required for certain sizing approaches or stormwater facility options. If total onsite infiltration is not practicable, voluntary stormwater retrofits are allowed to use existing discharge systems and do not need to meet the stormwater hierarchy for discharge criteria. At sites where the Simplified sizing approach is appropriate and possible and total onsite infiltration is not expected to be practicable, infiltration testing is not required, and the site can use the existing discharge point. Examples of existing discharge points include, but are not limited to, onsite catch basins connected to offsite public systems or existing onsite infiltration facilities. Applicants should clearly note on project submittals and any permit applications that the project is a voluntary retrofit, that the existing discharge point will be used, and how and where the proposed stormwater management facility will connect to the existing discharge point.

Additional Resources

The Bureau of Environmental Services (BES) encourages retrofits by providing technical assistance, competitive funding opportunities, and partnerships. For choosing and designing stormwater facilities to manage runoff from existing impervious area, see BES's *Site Assessment Guide*, which is available on BES's website: <http://www.portlandonline.com/bes>.

The most common residential stormwater management retrofits are downspout disconnection, rain gardens, and soakage trenches. These can often be used in a comprehensive stormwater management system for a site and can most likely be constructed by property owners. Brochures about these residential retrofit stormwater management systems can be found on the BES website.

Maintenance guidance is available for a variety of stormwater management systems. Most residential stormwater systems include conveyance methods (such as downspouts, curb cuts, and piping), soil, and vegetation. A brochure titled *Maintaining Home Stormwater Systems* and other maintenance guidance is available on the BES website.

Appendix B

MANUFACTURED STORMWATER TREATMENT TECHNOLOGIES

SUBMITTAL GUIDELINES



ENVIRONMENTAL SERVICES
CITY OF PORTLAND

working for clean rivers

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List of Approved Manufactured Stormwater Treatment Technologies

BES maintains the list of approved manufactured stormwater treatment technologies on the BES website. For the most current list, please visit:
<http://www.portlandoregon.gov/bes/swmm/>

Submittal Guidance

Applicability

Manufacturers of stormwater management treatment technologies must apply and follow the submittal guidelines to be considered for general use within the City of Portland. The approval process evaluates the manufactured stormwater management treatment technology for its effectiveness in meeting the pollution reduction requirements of the *Stormwater Management Manual* and Portland City Code 17.38. The City of Portland maintains a list of approved manufactured stormwater treatment technologies for use under the *Stormwater Management Manual* Presumptive Approach.

Manufactured stormwater treatment technologies not on the approved list (such as those that provide flow or volume control) may use the *Stormwater Management Manual* Performance Approach for a specific site development or improvement proposal.

Introduction

The City of Portland's *Stormwater Management Manual* requires post-development stormwater pollution reduction and provides guidance for implementing City regulations. The Bureau of Environmental Services (BES) specifies design criteria, such as pollution reduction storm intensity and volume, and facility performance goals. Manufactured stormwater treatment technologies must satisfy those criteria as stand-alone systems or as part of a treatment train approach.

The Washington State Department of Ecology (DOE) *Technology Assessment Protocol* (TAPE) has become a standard method by which many Northwest municipalities evaluate and approve manufactured stormwater treatment technologies for use in their communities. BES requires that all manufacturers requesting approval for general use of manufactured stormwater treatment technologies in the City of Portland must have current approval for general use level designation (GULD) by Washington State DOE under TAPE. BES has decision-making authority to approve, deny or revoke the use of manufactured stormwater treatment technologies within the City of Portland at any time, regardless of previous certification by DOE or prior approval by BES.

Performance Criteria

Applicants should ensure that the performance goal(s) achieved by the manufactured stormwater treatment technology under TAPE GULD certification meet Portland's pollution reduction requirements. The *Stormwater Management Manual* includes the following pollution reduction requirements:

Total Suspended Solids:

The pollution reduction performance goal for the City is 70 percent removal of total suspended solids (TSS) from 90 percent of the average annual runoff. Because the influent concentration of TSS can greatly influence the ability of a manufactured stormwater treatment technology to remove 70 percent of TSS, the performance tests must specify the influent limits used. The manufactured stormwater treatment technology must achieve an effluent goal of no more than 20 mg/L TSS for low influent concentrations (< 70 mg/l). Influent concentrations of greater than 70 mg/L must remove 70% of TSS.

Total Maximum Daily Load and 303(d) Listed Parameters:

Certain watersheds within the City of Portland have established Total Maximum Daily Loads (TMDLs). The TMDLs apply specific pollution control requirements to designated pollutants of concern. To ensure that new development does not contribute pollutants of concern to a TMDL watershed, pollution reduction facilities are required to demonstrate specific removal rates for those specific pollutants. See Exhibit 1-5 in Section 1.3.3 of *the Stormwater Management Manual* for a current list of TMDL watersheds with corresponding pollutant parameters.

TSS may be used as a surrogate for aldrin, chlordane, DDE, DDT, dieldrin, dioxin, and PCBs.

Application Process

Applicants¹ seeking BES approval of manufactured stormwater treatment technologies must submit an application form, all required documentation, and an application fee. The review process consists of a public presentation about the manufactured stormwater treatment technology, a technical interview, third-party review of the documentation.

¹ Applicants include manufacturers, product vendors, consultants, or any other person promoting the manufactured stormwater treatment technology.

Manufactured stormwater treatment technologies on the 2005 list of BES-approved devices that have achieved TAPE GULD certification will not have to reapply for BES approval (date of approval will be date of SWMM adoption). Any manufactured stormwater treatment technology that does not have TAPE GULD certification must apply under these submission requirements regardless of prior BES approval.

All documents must be in the following formats: two hard copies and one set of digital files. The applicant must deliver all required hard copy submittals to the following address:

City of Portland, BES
1120 SW 5th Ave. Room 1000
Portland, OR 97204
Attention: Engineering Services Standards and Materials Program Manager

All data and documentation necessary to verify performance must be included in the application. The following pages outline the minimum requirements that must be submitted at the time of application in order for the application to be considered complete. BES may request additional documentation and data during the review process.

BES will provide a single point of contact for applicants that will facilitate and track the application process. All correspondence and communication with the City of Portland regarding the application must be through the single point of contact. BES will also convene a Review Committee that will attend the public presentation and the technical interview, review the application and the third-party review evaluation, and maintain the list of approved manufactured stormwater treatment technologies. Following submission of a complete application, BES will provide the Applicant with a list of Review Committee members and single point of contact for any questions or coordination needs.

Required Submittals

Applicants must submit all of the following documents. Submitting an application does not guarantee that BES will approve a manufactured stormwater treatment technology for general use. BES will accept for review only manufactured stormwater treatment technologies that have achieved TAPE GULD certification.

Application Form

Applicants must submit a Manufactured Stormwater Treatment Technology Application Form, found online with the *Stormwater Management Manual* on the BES website. Applicants must complete the form in full.

Application Fee

Applicant must pay the Application Fee at the time of application submission. Checks must be made out to the City of Portland. The Application Fee for the current fiscal year is listed with the Sewer and Drainage Rates and Charges, available on the BES website. The fee will cover costs of the third-party evaluation as well as City staff time to process, coordinate, and review the application.

Cover Letter

The cover letter must be a single page and include the following:

- The name of the device with a short description of its intended application within the City of Portland.
- A summary of the TAPE history for the device, including the date of achieving GULD certification.
- A summary of the treatment performance goals, specific land uses, and targeted pollutants for which the device received TAPE certification.
- The signature of a company representative authorized to submit the application.

TAPE Documentation

All documentation used to achieve TAPE GULD certification from Washington State DOE.

Applicant must submit documents in both hard copy and digital formats. This includes:

- Technology Evaluation Report (TER), including Appendices.
- Third-party review memorandums, if any third-party was utilized.
- Quality Assurance Project Plan
- Copies of the General Use Level Designation

All information provided to the City shall be public record and subject to public disclosure pursuant to Oregon public record laws (ORS 192.410 to 192.505). Any portion of an application that the Applicant claims as exempt from disclosure must meet the requirements of ORS

192.501(2) and ORS 192.502(4) and/or ORS 646.461 et seq. In order for such information to be considered exempt from public disclosure, the applicant must certify that the information is unique to the design and construction of the technology, or release to the public or to a competitor would adversely affect the competitive position of the proponent. All monitoring data including, but not limited to, laboratory results and field measurements, QA/QC data, data qualifiers, and monitoring site information cannot be considered confidential.

The applicant must mark only those pages that contain information exempt from public disclosure with the word “confidential” and provide a letter of explanation as to why these pages are exempt from public disclosure. The fact that an Applicant marks information as exempt from disclosure does not mean that the information is necessarily exempt. Review of information exempt from public disclosure will be limited to the Review Committee and the Third Party Review.

BES Requirements

No additional testing or performance goals beyond the scope of TAPE requirements are necessary.

BES Evaluation Process

After BES deems an application complete, the presentation and interview should be scheduled within 30 business days. Following the presentation, the third-party review should be complete within 90 business days. BES will make a final decision of approval or denial within 30 business days following completion of a third-party review. BES has decision-making authority for approval of manufactured stormwater treatment technologies for use within the City of Portland and may place conditions of approval to provide consistency with local zoning or land use requirements, or to meet watershed-specific water quality requirements. Conditions may include, but are not limited to, maximum flow rates, limitations on drainage basin size, or installation locations.

BES may at any time suspend or revoke approval of a manufactured stormwater treatment technology if the performance of the technology does not meet the approval performance criteria, or if the performance criteria changes due to local, state, or federal pollution reduction requirements.

Applicant Presentation and Interview

BES will work with the applicant, the Review Committee, and third-party reviewers to arrange a public presentation of the proposed manufactured stormwater treatment technology. At the conclusion of the presentation, there will be a technical interview of the applicant about the proposed manufactured stormwater treatment technology. The interview will not be open to the public and will consist only of the Review Committee, third-party reviewers, and the Applicant.

BES staff will make reasoned decisions about manufactured stormwater treatment technologies and their application in the Portland metro area based on “best professional judgment” of the evidence provided. The TER, submitted as part of the TAPE process, will be critical to understanding the applications and characteristics of the technology and how it will be used in Portland, Oregon. The applicant should be prepared to respond to each of the key sections of the TER as they are applicable to the Portland area. Applicants should also be prepared to discuss or provide local or regional examples of operation and maintenance of systems by public agencies and/or private entities.

Third-Party Review

For all submittals, BES will engage a consultant or academic institution to evaluate the manufactured stormwater treatment technology for use within the City of Portland. The third-party review will compare the data used to achieve GULD certification against the pollution reduction requirements for the City of Portland as identified in City Code 17.38 and the *Stormwater Management Manual*. The third-party review will evaluate whether the manufactured stormwater treatment technology meets Portland’s requirements. The third-party review will evaluate water quality data and storm event intensity.

Appeals Process

If the applicant does not agree with the outcome or conditions of the evaluation process, the applicant may appeal. The appeal process is described in Appendix D.7 of the *Stormwater Management Manual*.

Approval Renewal and Changes to Technologies

Manufactured stormwater treatment technologies will be approved for 36 months from the date of approval. If no changes to the manufactured stormwater treatment technology have occurred (such as, but not limited to, dimensional changes to the physical device, changes to the filtration media, changes

to maintenance requirements, or changes in expected performance or device design criteria), the approval can be renewed. At the end of the approval period, the applicant may notify BES of their intent to renew their approval for a subsequent 36 months. If any changes, updates or revisions, have occurred to the manufactured stormwater treatment technology, the applicant must obtain TAPE GULD certification and re-apply following the submission guidelines in effect at the time of application, including fee payment.

To renew approval of a manufactured stormwater treatment technology, the applicant must submit an application form noting the intent to renew an existing approved manufactured stormwater treatment technology. There is no cost to renew an existing approval. The renewal will begin on the date that BES determines the renewal form is complete.

If an applicant submits a renewal request and the pollution reduction requirements or the evaluation criteria have changed since the original approval, BES may require the applicant to re-apply.

References and Resources

Washington State Department of Ecology, Technology Assessment Protocol (TAPE):

<http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html>

City of Portland Environmental Services, Sewer and Drainage Rates and Charges:

<http://www.portlandoregon.gov/bes/55059>

City of Portland Environmental Services, Stormwater Management Manual:

www.portlandoregon.gov/bes/swmm



CITY OF PORTLAND
Stormwater
Management
Manual

FORM B

MANUFACTURED STORMWATER TREATMENT TECHNOLOGY APPLICATION FORM

Applicants applying for approval of manufactured stormwater treatment technologies must meet the submission guidelines and evaluation requirements in Appendix B of the *Stormwater Management Manual*. BES requires that a manufactured stormwater treatment technology has a general use level designation through the Washington State Department of Ecology Technology Assessment Program.

Applicants requesting review of a **new application** must submit all of the required application materials in order for their application to be considered complete. Applicants must submit two (2) hard copies and one set of digital files of all required items and data.

Applicants requesting **renewal of an existing approval** should complete this form and submit to BES, but do not need to re-submit materials or the application fee.

(for Environmental Services use only)

Evaluation milestones

Date Received: _____

Date of Presentation: _____

Date Delivered to TPR: _____

Date Due to BES: _____

Tracking Number: _____

Date of Request: _____

APPLICANT INFORMATION

Contact Name: _____

Company Name: _____

Address: _____

Phone: _____

Email: _____

Website: _____

TECHNOLOGY INFORMATION

Name of Technology: _____

Manufacturer: _____

Brief Description:

THIS APPLICATION IS A:

- New application
- Renewal of an existing approval

REQUIRED APPLICATION MATERIALS

- Application Fee
- Cover Letter
- TAPE Documentation, including:
 - Technology Evaluation Report, including Appendices
 - Third-party memorandums, if utilized
 - Quality Assurance Project Plan
 - General Use Level Designation

All applications and payments should be submitted to:

ATTN: Engineering Services Support Manager
Bureau of Environmental Services
City of Portland
1120 SW 5th Ave., Room 1000
Portland, OR 97204-1972



ENVIRONMENTAL SERVICES
CITY OF PORTLAND

working for clean rivers

Approved Manufactured Stormwater Treatment Technologies

The City of Portland approved the following manufactured stormwater treatment technologies under the submission and review requirements of Appendix B in the *Stormwater Management Manual* (2014). Project designers may use technologies from the approved list under the *Stormwater Management Manual* (SWMM) Presumptive Approach.

The following technologies have achieved General Use Level Designation (GULD) through the Technology Assessment Protocol (TAPE)¹ from the Washington State Department of Ecology (DOE) and have been reviewed and approved by the City of Portland. The City of Portland has included any conditions of approval with each device, such as configuration specification or use category.

DOE TAPE categorizes each technology by treatment type², which describes its effectiveness at removing specific pollutants. The treatment types are defined below:

Basic Treatment: Intended to achieve a goal of 80% removal of total suspended solids for an influent concentration range of 100 mg/L to 200 mg/L. For influent concentrations less than 100 mg/L, the effluent goal is 20 mg/L total suspended solids. For influent concentrations greater than 200 mg/L, a higher treatment goal is intended.

Phosphorous Treatment: Intended to achieve a goal of 50% total phosphorus removal for an influent concentration range of 0.1 to 0.5 mg/L as well as achieving basic treatment.

Enhanced Treatment: Intended to achieve a higher level of treatment than basic treatment. Enhanced treatment is targeted at removing dissolved metals.

Pretreatment: Intended to achieve 50% removal of fine (50 micron-mean size) and 80% removal of coarse (125-micron-mean size) total suspended solids for influent concentrations greater than 100 mg/L, but less than 200 mg/L. For influent concentrations less than 100 mg/L, the facilities are intended to achieve effluent goals of 50 mg/L of fine and 20 mg/L of coarse total suspended solids.

Oil Treatment: Intended to achieve the goals of no ongoing or recurring visible sheen and a daily average total petroleum hydrocarbon concentration no greater than 10 mg/L with a maximum of 15 mg/L for discrete (grab) samples.

Only technologies certified for Basic, Enhanced or Phosphorous Treatment meet the City of Portland's standards for TSS reduction. A technology that is on the City of Portland's approved list may not meet Portland's standards for pollution reduction with a single standalone installation and other stormwater management options may be necessary, such as a treatment train. Project designers should determine which technology best fits their site conditions, project goals, and long-term maintenance requirements. Not all technologies will be appropriate for every site or project.

¹ <http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html>

² <https://fortress.wa.gov/ecy/publications/publications/1110061.pdf>

City of Portland
Approved Manufactured Stormwater Treatment Technologies

Manufacturer	Device Name	Treatment Type	Approval Expiration	Conditions
CONTECH Engineered Solutions, LLC	Stormfilter using ZPG Media	Basic Treatment	1/2/2017	<p><i>The following configurations are approved for standalone use in the <u>public right-of-way</u> at 15 gallons per minute (gpm) treatment flow per cartridge:</i></p> <ul style="list-style-type: none"> • Vault-type with multiple filter cartridges • Precast 48" manhole with 2 filter cartridges • Precast 60" manhole with 3 filter cartridges <p><i>The following configurations are approved for standalone use on <u>private property</u> at 15 gpm treatment flow per cartridge:</i></p> <ul style="list-style-type: none"> • Vault-type with multiple filter cartridges • Precast 48" or 60" manhole designs • Catch basin model
CONTECH Engineered Solutions, LLC	CDS™ Stormwater Treatment System	Pretreatment	1/2/2017	Pretreatment only. Treatment train approach or other stormwater management options likely required.
CONTECH Engineered Solutions, LLC	Vortechs System	Pretreatment	1/2/2017	Pretreatment only. Treatment train approach or other stormwater management options likely required.
Hydro International	Downstream Defender	Pretreatment	1/2/2017	Pretreatment only. Treatment train approach or other stormwater management options likely required.
Imbrium Systems	Stormceptor	Pretreatment	1/2/2017	Pretreatment only. Treatment train approach or other stormwater management options likely required.

Appendix C.1: Santa Barbara Urban Hydrograph Method

INTRODUCTION

The Santa Barbara Urban Hydrograph (SBUH) method was developed by the Santa Barbara County Flood Control and Water Conservation District to determine a runoff hydrograph for an urbanized area. It is a simpler method than some other approaches, as it computes a hydrograph directly without going through intermediate steps (i.e., a unit hydrograph) to determine the runoff hydrograph.

The SBUH method is a popular method for calculating runoff, since it can be done with a spreadsheet or by hand relatively easily. The SBUH method is the method approved by the Bureau of Environmental Services (BES) for determining runoff when doing flow control calculations.

ELEMENTS OF THE SBUH METHOD

The SBUH method depends on several variables:

- Pervious (A_p) and impervious (A_{imp}) land areas
- Time of concentration (T_c) calculations
- Runoff curve numbers (CN) applicable to the site
- Design storm

These elements shall all be presented as part of the submittal process for review by BES staff. In addition, maps showing the pre-development and post-development conditions shall be presented to BES to help in the review.

Land Area

The total area, including the pervious and impervious areas within a drainage basin, shall be quantified in order to evaluate critical contributing areas and the resulting site runoff. Each area within a basin shall be analyzed separately and their hydrographs combined to determine the total basin hydrograph. Areas shall be selected to represent homogenous land use/development units.

Time of Concentration

Time of concentration, T_c , is the time for a theoretical drop of water to travel from the furthest point in the drainage basin to the facility being designed. (In this case, T_c is derived by calculating the overland flow time of concentration and the channelized flow time of concentration.) T_c depends on several factors, including ground slope, ground roughness, and distance of flow. The following formula for determining T_c is found in BES's *Sewer Design Manual*.

Formulas

$$T_c = T_{t1} + T_{c2} + T_{c3} + \dots + T_{cn}$$

$$T_t = L/60V \quad (\text{Conversion of velocity to travel time})$$

$$T_t = \frac{0.42 (nL)^{0.8}}{1.58(s)^{0.4}} \quad (\text{Manning's kinematic solution for sheet flow less than 300 feet})$$

(Shallow concentrated flow for slopes less than 0.005 ft/ft. For steeper slopes, consult BES's Sewer Design Manual):

$$V = 16.1345(s)^{0.5} \quad (\text{Unpaved surfaces})$$

$$V = 20.3282(s)^{0.5} \quad (\text{Paved surfaces})$$

Where,

T_t = travel time, minutes

T_c = total time of concentration, minutes (minimum $T_c = 5$ minutes)

L = flow length, feet

V = average velocity of flow, feet per second

n = Manning's roughness coefficient for various surfaces (see Chart 10 of the 1991 Sewer Design Manual)

s = slope of the hydraulic grade line (land or watercourse slope), feet per foot

When calculating T_c , the following limitations apply:

- Overland sheet flow (flow across flat areas that does not form into channels or rivulets) shall not extend for more than 300 feet.
- For flow paths through closed conveyance facilities such as pipes and culverts, standard hydraulic formulas shall be used for establishing velocity and travel time. (See the *Sewer Design Manual* for more data on pipe flow rates and velocities.)
- Flow paths through lakes or wetlands may be assumed to be zero (i.e. $T_c = 0$).

Runoff Curve Numbers

Runoff curve numbers were developed by the Natural Resources Conservation Service (NRCS) after studying the runoff characteristics of various types of land. Curve numbers (CN) were developed to reduce diverse characteristics such as soil type, land usage, and vegetation into a single variable for doing runoff calculations. The runoff curve numbers approved by BES for water quantity/quality calculations are included as Table C-2 of this appendix.

The curve numbers presented in Table C-2 are for *wet* antecedent moisture conditions. Wet conditions assume previous rainstorms have reduced the capacity of soil to absorb water. Given the frequency of rainstorms in the Portland area, wet conditions are most likely, and give conservative hydrographic values.

Design Storm

The SBUH method also requires a design storm to perform the runoff calculations. For flow control calculations, BES uses a NRCS Type 1A 24-hour storm distribution. This storm is shown in Figure C-1 and Table C-4. The depth of rainfall for the 2 through 100-year storm events is shown below in Table C-1.

Table C-1
24-HOUR RAINFALL DEPTHS AT PORTLAND AIRPORT

Recurrence Interval, Years	2	5	10	25	100
24-Hour Depths, Inches	2.4	2.9	3.4	3.9	4.4

**Table C-2
RUNOFF CURVE NUMBERS**

Runoff curve numbers for urban areas*

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area	A	B	C	D
Open space (lawns, parks, golf courses, cemeteries, etc.):					
Poor condition (grass cover <50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82

Runoff curve numbers for other agricultural lands*

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range-continuous forage for grazing					
<50% ground cover or heavily grazed with no mulch	Poor	68	79	86	89
50 to 75% ground cover and not heavily grazed	Fair	49	69	79	84
>75% ground cover and lightly or only occasionally grazed	Good	39	61	74	80
Meadow-continuous grass, protected from grazing and generally mowed for hay	-	30	58	71	78
Brush--weed-grass mixture with brush as the major element					
<50% ground cover	Poor	48	67	77	83
50 to 75% ground cover	Fair	35	56	70	77
>75% ground cover	Good	30	48	65	73
Woods-grass combination (orchard or tree farm)					
	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79

Runoff curve numbers for other agricultural lands*

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Woods					
Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.	Poor	45	66	77	83
Woods are grazed but not burned, and some forest litter covers the soil.	Fair	36	60	73	79
Woods are protected from grazing, and litter and brush adequately cover the soil.	Good	30	55	70	77

Runoff curve numbers for Simplified Approaches**

Cover description		Curve numbers for hydrologic soil group			
Simplified Approaches	Hydrologic condition	A	B	C	D
Eco-roof	Good	n/a	61	n/a	n/a
Roof Garden	Good	n/a	48	n/a	n/a
Contained Planter Box	Good	n/a	48	n/a	n/a
Infiltration & Flow-Through Planter Box	Good	n/a	48	n/a	n/a
Pervious Pavement	-	76	85	89	n/a
Trees					
New and/or Existing Evergreen	-	36	60	73	79
New and/or Existing Deciduous	-	36	60	73	79

n/a - Does not apply, as design criteria for the relevant mitigation measures do not include the use of this soil type.

*Soil Conservation Service, *Urban Hydrology for Small Watersheds*, Technical Release 55, pp. 2.5-2.8, June 1986.

**CNs of various cover types were assigned to the Proposed Simplified Approaches with similar cover types as follows:

Eco-roof – assumed grass in good condition with soil type B.

Roof Garden – assumed brush-weed-grass mixture with >75% ground cover and soil type B.

Contained Planter Box – assumed brush-weed-grass mixture with >75% ground cover and soil type B.

Infiltration & Flow-Through Planter Box – assumed brush-weed-grass mixture with >75% ground cover and soil type B.

Pervious Pavement – assumed gravel.

Trees – assumed woods with fair hydrologic conditions.

Note: To determine hydrologic soil type, consult local USDA Soil Conservation Service Soil Survey.

TABLE C-3
NRCS HYDROLOGIC SOIL GROUP DESCRIPTIONS

<u>NRCS Hydrologic Soil Group</u>	<u>Description</u>
Group A	Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.
Group B	Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
Group C	Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.
Group D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a fragipan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Figure C-1 - NRCS 24-Hour Type 1A Hyetograph

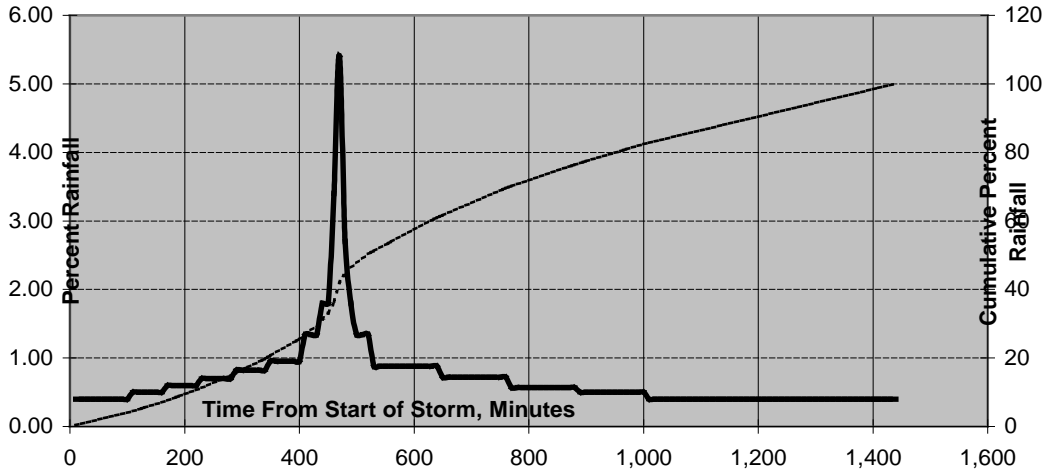


Table C-3 - NRCS Type 1A Hyetographic Distribution - For Use In Water Quality/Quantity Design

Time From Start of Storm, Minutes	Cumulative % Rainfall	Time From Start of Storm, Minutes	Cumulative % Rainfall	Time From Start of Storm, Minutes	Cumulative % Rainfall	Time From Start of Storm, Minutes	Cumulative % Rainfall
0 - 10	0.40	360 - 370	0.95	720 - 730	0.72	1080 - 1090	0.40
10 - 20	0.40	370 - 380	0.95	730 - 740	0.72	1090 - 1100	0.40
20 - 30	0.40	380 - 390	0.95	740 - 750	0.72	1100 - 1110	0.40
30 - 40	0.40	390 - 400	0.95	750 - 760	0.72	1110 - 1120	0.40
40 - 50	0.40	400 - 410	1.34	760 - 770	0.57	1120 - 1130	0.40
50 - 60	0.40	410 - 420	1.34	770 - 780	0.57	1130 - 1140	0.40
60 - 70	0.40	420 - 430	1.34	780 - 790	0.57	1140 - 1150	0.40
70 - 80	0.40	430 - 440	1.80	790 - 800	0.57	1150 - 1160	0.40
80 - 90	0.40	440 - 450	1.80	800 - 810	0.57	1160 - 1170	0.40
90 - 100	0.40	450 - 460	3.40	810 - 820	0.57	1170 - 1180	0.40
100 - 110	0.50	460 - 470	5.40	820 - 830	0.57	1180 - 1190	0.40
110 - 120	0.50	470 - 480	2.70	830 - 840	0.57	1190 - 1200	0.40
120 - 130	0.50	480 - 490	1.80	840 - 850	0.57	1200 - 1210	0.40
130 - 140	0.50	490 - 500	1.34	850 - 860	0.57	1210 - 1220	0.40
140 - 150	0.50	500 - 510	1.34	860 - 870	0.57	1220 - 1230	0.40
150 - 160	0.50	510 - 520	1.34	870 - 880	0.57	1230 - 1240	0.40
160 - 170	0.60	520 - 530	0.88	880 - 890	0.50	1240 - 1250	0.40
170 - 180	0.60	530 - 540	0.88	890 - 900	0.50	1250 - 1260	0.40
180 - 190	0.60	540 - 550	0.88	900 - 910	0.50	1260 - 1270	0.40
190 - 200	0.60	550 - 560	0.88	910 - 920	0.50	1270 - 1280	0.40
200 - 210	0.60	560 - 570	0.88	920 - 930	0.50	1280 - 1290	0.40
210 - 220	0.60	570 - 580	0.88	930 - 940	0.50	1290 - 1300	0.40
220 - 230	0.70	580 - 590	0.88	940 - 950	0.50	1300 - 1310	0.40
230 - 240	0.70	590 - 600	0.88	950 - 960	0.50	1310 - 1320	0.40
240 - 250	0.70	600 - 610	0.88	960 - 970	0.50	1320 - 1330	0.40
250 - 260	0.70	610 - 620	0.88	970 - 980	0.50	1330 - 1340	0.40
260 - 270	0.70	620 - 630	0.88	980 - 990	0.50	1340 - 1350	0.40
270 - 280	0.70	630 - 640	0.88	990 - 1000	0.50	1350 - 1360	0.40
280 - 290	0.82	640 - 650	0.72	1000 - 1010	0.40	1360 - 1370	0.40
290 - 300	0.82	650 - 660	0.72	1010 - 1020	0.40	1370 - 1380	0.40
300 - 310	0.82	660 - 670	0.72	1020 - 1030	0.40	1380 - 1390	0.40
310 - 320	0.82	670 - 680	0.72	1030 - 1040	0.40	1390 - 1400	0.40
320 - 330	0.82	680 - 690	0.72	1040 - 1050	0.40	1400 - 1410	0.40
330 - 340	0.82	690 - 700	0.72	1050 - 1060	0.40	1410 - 1420	0.40
340 - 350	0.95	700 - 710	0.72	1060 - 1070	0.40	1420 - 1430	0.40
350 - 360	0.95	710 - 720	0.72	1070 - 1080	0.40	1430 - 1440	0.40

Appendix C.2: Simplified Approach Sizing Calculations

BES staff conducted a technical process to determine facility designs and sizes that would be appropriate for small development sites. The process included a review of technical literature, review of BES monitoring data, calculations, and theoretical analysis. The sizing factors on the **Simplified Form** were developed as a simple site planning tool for small projects and to accelerate permit review and approval. Generalized assumptions were used and are documented in the Simplified Sizing requirements in **Section 2.3**. Facilities sized through this approach assume that there is an overflow to an approved discharge point. Facilities built to the standards of Simplified Sizing are assumed to meet pollution reduction and flow control requirements but not infiltration and discharge requirements. Applicants have the option to use the sizing factors provided on the Simplified Approach Form or to follow the Presumptive or Performance Approach and submit an alternative facility size, along with supporting engineering or PAC calculations for BES review and consideration.

The spreadsheet columns are described below:

Column (1)	Time in Minutes
Column (2)	Inflow (cfs) Note: Contributing Impervious Area = 1 acre Note: 10-Year Storm Event (3.4"/24 hours)
Column (3)	Inflow Volume (cf) = Inflow (cfs) x 60 (sec/min) x 10 (min)
Column (4)	Cumulative Volume (cf) = Inflow Volume(cf) + Cumulative Inflow (cf) of previous step
Column (5)	Infiltration (cfs) = If(Inflow < Max Infiltration, Inflow, Maximum Infiltration)
Column (6)	Maximum Infiltration (cfs) = Infiltration Area (sf) x Infiltration Rate (ft/s) Note: Infiltration rate is assumed to be 2.0"/hr in this case.
Column (7)	Incremental Storage (cf) = [Inflow (cfs) – Infiltration (cfs)] x 60 (sec/min) x 10 (min)
Column (8)	Cumulative Storage (cf)
Column (9)	Percent Storage Capacity = Cumulative Storage / Facility Storage x 100 Planter Facility Storage = Facility Bottom Area (sf) x Storage Depth (ft) For this example: Bottom Area = 2,825 sf Storage Depth = 1 ft Note that the storage capacity does not exceed 100% which would result in an overflow condition. The maximum depth of 12 inches is not exceeded. Resulting planter square-footage is 2,825 sf, which when divided by the 43,560 square-foot impervious surface equals a 0.065 sizing factor.

(1) Time (minutes)	(2) Inflow (cfs)	(3) Inflow Volume (cf)	(4) Cumulative Volume (cf)	(5) Infiltration (cfs)	(6) Max. Infiltration (cfs)	(7) Incremental Storage (cf)	(8) Cumulative Storage Volume (cf)	(9) % Storage Capacity (%)
0	0.0000	0.00	0.00	0.0000	0.1308	-78.47	0.00	0%
10	0.0000	0.00	0.00	0.0000	0.1308	-78.47	0.00	0%
20	0.0000	0.00	0.00	0.0000	0.1308	-78.47	0.00	0%
30	0.0000	0.00	0.00	0.0000	0.1308	-78.47	0.00	0%
40	0.0026	1.54	1.54	0.0026	0.1308	-76.93	0.00	0%
50	0.0097	5.80	7.34	0.0097	0.1308	-72.67	0.00	0%
60	0.0180	10.79	18.13	0.0180	0.1308	-67.68	0.00	0%
70	0.0249	14.97	33.10	0.0249	0.1308	-63.50	0.00	0%
80	0.0308	18.50	51.60	0.0308	0.1308	-59.97	0.00	0%
90	0.0359	21.52	73.12	0.0359	0.1308	-56.95	0.00	0%
100	0.0402	24.11	97.24	0.0402	0.1308	-54.36	0.00	0%
110	0.0499	29.94	127.17	0.0499	0.1308	-48.54	0.00	0%
120	0.0599	35.94	163.11	0.0599	0.1308	-42.53	0.00	0%
130	0.0642	38.51	201.62	0.0642	0.1308	-39.96	0.00	0%
140	0.0679	40.71	242.33	0.0679	0.1308	-37.76	0.00	0%
150	0.0710	42.61	284.95	0.0710	0.1308	-35.86	0.00	0%
160	0.0738	44.27	329.22	0.0738	0.1308	-34.20	0.00	0%
170	0.0841	50.43	379.65	0.0841	0.1308	-28.04	0.00	0%
180	0.0944	56.66	436.31	0.0944	0.1308	-21.81	0.00	0%
190	0.0971	58.24	494.55	0.0971	0.1308	-20.24	0.00	0%
200	0.0993	59.60	554.15	0.0993	0.1308	-18.87	0.00	0%
210	0.1013	60.80	614.95	0.1013	0.1308	-17.67	0.00	0%
220	0.1031	61.85	676.81	0.1031	0.1308	-16.62	0.00	0%
230	0.1135	68.10	744.90	0.1135	0.1308	-10.38	0.00	0%
240	0.1239	74.37	819.27	0.1239	0.1308	-4.11	0.00	0%
250	0.1256	75.35	894.62	0.1256	0.1308	-3.12	0.00	0%
260	0.1270	76.22	970.83	0.1270	0.1308	-2.26	0.00	0%
270	0.1283	76.99	1047.82	0.1283	0.1308	-1.49	0.00	0%
280	0.1294	77.67	1125.49	0.1294	0.1308	-0.80	0.00	0%
290	0.1417	85.04	1210.53	0.1308	0.1308	6.57	6.57	0%
300	0.1541	92.45	1302.98	0.1308	0.1308	13.98	20.55	1%
310	0.1552	93.11	1396.09	0.1308	0.1308	14.64	35.19	1%
320	0.1562	93.70	1489.79	0.1308	0.1308	15.23	50.42	2%
330	0.1571	94.23	1584.03	0.1308	0.1308	15.76	66.18	2%
340	0.1578	94.71	1678.73	0.1308	0.1308	16.23	82.41	3%
350	0.1712	102.71	1781.44	0.1308	0.1308	24.24	106.65	4%
360	0.1845	110.73	1892.17	0.1308	0.1308	32.26	138.90	5%
370	0.1853	111.19	2003.36	0.1308	0.1308	32.72	171.62	6%
380	0.1860	111.60	2114.96	0.1308	0.1308	33.13	204.75	7%
390	0.1866	111.98	2226.94	0.1308	0.1308	33.50	238.26	8%
400	0.1872	112.31	2339.25	0.1308	0.1308	33.84	272.10	10%
410	0.2263	135.80	2475.06	0.1308	0.1308	57.33	329.43	12%
420	0.2657	159.39	2634.45	0.1308	0.1308	80.92	410.35	15%
430	0.2664	159.87	2794.32	0.1308	0.1308	81.40	491.75	17%
440	0.3131	187.88	2982.20	0.1308	0.1308	109.41	601.16	21%
450	0.3600	215.98	3198.18	0.1308	0.1308	137.51	738.66	26%
460	0.5219	313.11	3511.29	0.1308	0.1308	234.64	973.31	34%
470	0.8866	531.96	4043.26	0.1308	0.1308	453.49	1426.80	51%
480	0.8183	491.00	4534.26	0.1308	0.1308	412.53	1839.32	65%

(1) Time (minutes)	(2) Inflow (cfs)	(3) Inflow Volume (cf)	(4) Cumulative Volume (cf)	(5) Infiltration (cfs)	(6) Max. Infiltration (cfs)	(7) Incremental Storage (cf)	(8) Cumulative Storage Volume (cf)	(9) % Storage Capacity (%)
490	0.4558	273.50	4807.76	0.1308	0.1308	195.03	2034.35	72%
500	0.3185	191.07	4998.83	0.1308	0.1308	112.60	2146.95	76%
510	0.2720	163.22	5162.05	0.1308	0.1308	84.75	2231.70	79%
520	0.2722	163.32	5325.38	0.1308	0.1308	84.85	2316.55	82%
530	0.2256	135.36	5460.73	0.1308	0.1308	56.89	2373.44	84%
540	0.1789	107.36	5568.10	0.1308	0.1308	28.89	2402.33	85%
550	0.1790	107.40	5675.50	0.1308	0.1308	28.93	2431.26	86%
560	0.1791	107.44	5782.94	0.1308	0.1308	28.97	2460.23	87%
570	0.1791	107.47	5890.41	0.1308	0.1308	29.00	2489.23	88%
580	0.1792	107.51	5997.92	0.1308	0.1308	29.03	2518.26	89%
590	0.1792	107.54	6105.46	0.1308	0.1308	29.07	2547.33	90%
600	0.1793	107.57	6213.02	0.1308	0.1308	29.10	2576.42	91%
610	0.1793	107.60	6320.62	0.1308	0.1308	29.13	2605.55	92%
620	0.1794	107.63	6428.25	0.1308	0.1308	29.15	2634.70	93%
630	0.1794	107.65	6535.90	0.1308	0.1308	29.18	2663.88	94%
640	0.1795	107.68	6643.58	0.1308	0.1308	29.21	2693.09	95%
650	0.1632	97.91	6741.49	0.1308	0.1308	19.44	2712.53	96%
660	0.1469	88.14	6829.63	0.1308	0.1308	9.66	2722.19	96%
670	0.1469	88.15	6917.78	0.1308	0.1308	9.68	2731.87	97%
680	0.1469	88.17	7005.95	0.1308	0.1308	9.70	2741.57	97%
690	0.1470	88.18	7094.13	0.1308	0.1308	9.71	2751.28	97%
700	0.1470	88.20	7182.33	0.1308	0.1308	9.72	2761.00	98%
710	0.1470	88.21	7270.54	0.1308	0.1308	9.74	2770.74	98%
720	0.1470	88.22	7358.76	0.1308	0.1308	9.75	2780.49	98%
730	0.1471	88.24	7446.99	0.1308	0.1308	9.76	2790.26	99%
740	0.1471	88.25	7535.24	0.1308	0.1308	9.78	2800.03	99%
750	0.1471	88.26	7623.50	0.1308	0.1308	9.79	2809.82	99%
760	0.1471	88.27	7711.77	0.1308	0.1308	9.80	2819.62	100%
770	0.1318	79.09	7790.86	0.1308	0.1308	0.61	2820.23	100%
780	0.1165	69.90	7860.76	0.1165	0.1308	-8.57	2811.66	100%
790	0.1165	69.90	7930.66	0.1165	0.1308	-8.57	2803.09	99%
800	0.1165	69.91	8000.57	0.1165	0.1308	-8.56	2794.53	99%
810	0.1165	69.92	8070.49	0.1165	0.1308	-8.55	2785.98	99%
820	0.1165	69.92	8140.42	0.1165	0.1308	-8.55	2777.43	98%
830	0.1166	69.93	8210.35	0.1166	0.1308	-8.54	2768.89	98%
840	0.1166	69.94	8280.28	0.1166	0.1308	-8.54	2760.35	98%
850	0.1166	69.94	8350.23	0.1166	0.1308	-8.53	2751.82	97%
860	0.1166	69.95	8420.17	0.1166	0.1308	-8.52	2743.30	97%
870	0.1166	69.95	8490.13	0.1166	0.1308	-8.52	2734.78	97%
880	0.1166	69.96	8560.09	0.1166	0.1308	-8.51	2726.27	97%
890	0.1094	65.67	8625.76	0.1094	0.1308	-12.80	2713.46	96%
900	0.1023	61.38	8687.13	0.1023	0.1308	-17.10	2696.37	95%
910	0.1023	61.38	8748.51	0.1023	0.1308	-17.09	2679.28	95%
920	0.1023	61.38	8809.90	0.1023	0.1308	-17.09	2662.19	94%
930	0.1023	61.39	8871.29	0.1023	0.1308	-17.08	2645.10	94%
940	0.1023	61.39	8932.68	0.1023	0.1308	-17.08	2628.03	93%
950	0.1023	61.40	8994.08	0.1023	0.1308	-17.08	2610.95	92%
960	0.1023	61.40	9055.48	0.1023	0.1308	-17.07	2593.88	92%
970	0.1023	61.40	9116.88	0.1023	0.1308	-17.07	2576.81	91%

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Time	Inflow	Inflow	Cummulative	Infiltration	Max.	Incremental	Cummulative	%
(minutes)	(cfs)	Volume	Volume	(cfs)	Infiltration	Storage	Storage	Storage
		(cf)	(cf)		(cfs)	(cf)	Volume	Capacity
							(cf)	(%)
980	0.1023	61.41	9178.29	0.1023	0.1308	-17.06	2559.74	91%
990	0.1024	61.41	9239.70	0.1024	0.1308	-17.06	2542.68	90%
1000	0.1024	61.41	9301.11	0.1024	0.1308	-17.06	2525.62	89%
1010	0.0921	55.28	9356.39	0.0921	0.1308	-23.20	2502.43	89%
1020	0.0819	49.14	9405.53	0.0819	0.1308	-29.34	2473.09	88%
1030	0.0819	49.14	9454.66	0.0819	0.1308	-29.33	2443.76	87%
1040	0.0819	49.14	9503.80	0.0819	0.1308	-29.33	2414.43	85%
1050	0.0819	49.14	9552.95	0.0819	0.1308	-29.33	2385.10	84%
1060	0.0819	49.14	9602.09	0.0819	0.1308	-29.33	2355.77	83%
1070	0.0819	49.15	9651.24	0.0819	0.1308	-29.33	2326.44	82%
1080	0.0819	49.15	9700.39	0.0819	0.1308	-29.32	2297.12	81%
1090	0.0819	49.15	9749.54	0.0819	0.1308	-29.32	2267.80	80%
1100	0.0819	49.15	9798.69	0.0819	0.1308	-29.32	2238.48	79%
1110	0.0819	49.15	9847.84	0.0819	0.1308	-29.32	2209.16	78%
1120	0.0819	49.16	9897.00	0.0819	0.1308	-29.32	2179.84	77%
1130	0.0819	49.16	9946.16	0.0819	0.1308	-29.31	2150.53	76%
1140	0.0819	49.16	9995.32	0.0819	0.1308	-29.31	2121.22	75%
1150	0.0819	49.16	10044.48	0.0819	0.1308	-29.31	2091.91	74%
1160	0.0819	49.16	10093.64	0.0819	0.1308	-29.31	2062.60	73%
1170	0.0819	49.16	10142.81	0.0819	0.1308	-29.31	2033.29	72%
1180	0.0819	49.17	10191.97	0.0819	0.1308	-29.31	2003.98	71%
1190	0.0819	49.17	10241.14	0.0819	0.1308	-29.30	1974.68	70%
1200	0.0820	49.17	10290.31	0.0820	0.1308	-29.30	1945.38	69%
1210	0.0820	49.17	10339.48	0.0820	0.1308	-29.30	1916.08	68%
1220	0.0820	49.17	10388.66	0.0820	0.1308	-29.30	1886.78	67%
1230	0.0820	49.18	10437.83	0.0820	0.1308	-29.30	1857.48	66%
1240	0.0820	49.18	10487.01	0.0820	0.1308	-29.30	1828.19	65%
1250	0.0820	49.18	10536.19	0.0820	0.1308	-29.29	1798.89	64%
1260	0.0820	49.18	10585.37	0.0820	0.1308	-29.29	1769.60	63%
1270	0.0820	49.18	10634.55	0.0820	0.1308	-29.29	1740.31	62%
1280	0.0820	49.18	10683.73	0.0820	0.1308	-29.29	1711.02	61%
1290	0.0820	49.18	10732.91	0.0820	0.1308	-29.29	1681.73	60%
1300	0.0820	49.19	10782.10	0.0820	0.1308	-29.29	1652.44	58%
1310	0.0820	49.19	10831.29	0.0820	0.1308	-29.28	1623.16	57%
1320	0.0820	49.19	10880.48	0.0820	0.1308	-29.28	1593.88	56%
1330	0.0820	49.19	10929.67	0.0820	0.1308	-29.28	1564.59	55%
1340	0.0820	49.19	10978.86	0.0820	0.1308	-29.28	1535.31	54%
1350	0.0820	49.19	11028.05	0.0820	0.1308	-29.28	1506.03	53%
1360	0.0820	49.19	11077.24	0.0820	0.1308	-29.28	1476.76	52%
1370	0.0820	49.20	11126.44	0.0820	0.1308	-29.28	1447.48	51%
1380	0.0820	49.20	11175.64	0.0820	0.1308	-29.28	1418.20	50%
1390	0.0820	49.20	11224.84	0.0820	0.1308	-29.27	1388.93	49%
1400	0.0820	49.20	11274.04	0.0820	0.1308	-29.27	1359.66	48%
1410	0.0820	49.20	11323.24	0.0820	0.1308	-29.27	1330.39	47%
1420	0.0820	49.20	11372.44	0.0820	0.1308	-29.27	1301.12	46%
1430	0.0820	49.20	11421.64	0.0820	0.1308	-29.27	1271.85	45%
1440	0.0820	49.20	11470.85	0.0820	0.1308	-29.27	1242.58	44%
1450	0.0410	24.60	11495.45	0.0410	0.1308	-53.87	1188.71	42%

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APPENDIX D.1 LANDSCAPE SUBMITTAL GUIDE

Landscape specifications and plans are required (as described in [Section 2.3.2](#)) with all permits that include at least one vegetated stormwater facility. The only exception is where a contract with the Bureau of Environmental Services Watershed Revegetation Program is confirmed.

Landscape specifications and plans must address all elements that ensure plant survival and overall stormwater facility functional success. At a minimum, landscape specifications and plans must include:

- A planting plan that indicates existing vegetation to be preserved, the location of all landscape elements, and the size, species and location of all proposed plantings. The plant species should be selected and placed in accordance with proper delineation of Zone A (wet zone) and Zone B (moderate to dry zone), where appropriate.
- A plant list or table, including botanic and common names, size at time of planting, quantity, spacing, type of container, evergreen or deciduous, and other information related to the facility-specific planting, in accordance with landscape industry standards.
- A soil analysis for the stormwater facility growing medium (required for all public facilities and may be required for private facilities). A soil analysis is not required for single-family residential sites. The source of the growing medium must be provided. The location of all stockpiles must be indicated on plans, including erosion protection measures per the City's *Erosion Control Manual*.
- The method of irrigation to be used for the establishment period and for the permanent long-term. Public stormwater management facilities must be designed so permanent long-term irrigation systems are not needed.

See facility specifications in [Section 2.3.3](#) for plant density and size requirements. See [Appendix G.2](#) for example planting templates appropriate for public and private streets.

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APPENDIX D.2 LAND USE REVIEW SUBMITTAL GUIDE

Land use review applications must include a conceptual Stormwater Management Plan that indicates stormwater pollution reduction, flow and volume control, and discharge methods in accordance with the stormwater hierarchy (See [Section 1.3.1](#)). To meet zoning code requirements (Title 33 of the City Code) and use the available land most efficiently, the applicant must determine the proposed stormwater management facilities and illustrate them on a site plan. The size and location of the proposed facilities will be assessed during the review process to ensure that adequate space is available with required setbacks. The facilities must also be located for proper overflow or access to an approved discharge point.

The Bureau of Environmental Services (BES) and the Bureau of Development Services (BDS) work cooperatively to review proposed plans during land use review to ensure stormwater management requirements are met. BES assesses the Stormwater Management Plan to determine if it meets the *Stormwater Management Manual* and *Sewer and Drainage Facilities Design Manual* requirements. BES provides the technical assessment information to BDS to determine if the land use review application meets zoning code approval criteria.

It is the applicant's responsibility to demonstrate that the stormwater hierarchy requirements are met. Some land use applications require more detailed information and more thorough planning and coordination with BES than others prior to land use approval. The determining factors are related to the type of land use review, the complexity of the proposed project, and the existing site conditions.

Land use applications that must address stormwater management can *generally* be divided into the following two categories:

1. those that verify adequacy of services, such as land divisions, planned developments, zone changes, and conditional uses
2. those that verify the available area for stormwater management and in some cases the impact of the stormwater management system, such as environmental reviews; greenway reviews; design reviews; and adjustments to regulations such as setbacks, building coverage, and paved area

Completing and documenting the first six steps presented in [Section 2.1.2](#) will meet most, if not all, of the submittal requirements for the Stormwater Management Report (see [Appendix D.4](#)) and the BES land use review process.

The applicant must determine the anticipated stormwater management design approach (Simplified, Presumptive, or Performance) that will be used. When the

Presumptive or Performance Approach is used, the applicant must complete and submit the project overview and description, methodology, analysis, and engineering conclusions (described in and the Stormwater Management Report Outline in [Appendix D.4](#)) with submittal of the application.

To determine which category of the stormwater hierarchy (see [Section 1.3.1](#)) the project will meet, the applicant must establish if, and to what degree, onsite infiltration is feasible (see [Appendix F.2](#) for infiltration testing requirements). In addition to providing the justification necessary to select a category of the stormwater hierarchy, the results of the infiltration testing will contribute to decisions regarding type, size, and location of stormwater facilities.

Other Design Considerations:

- Perimeter landscaping requirements, limited available area meeting setback requirements, and the need for impermeable liners or watertight planter boxes may make stormwater facilities impractical along property lines.
- Elevation and topographic constraints must be evaluated to ensure that gravity flow is possible and plumbing code depth of cover requirements for pipes can be met.
- Coordination between the project engineer, architect, and landscape designer may be necessary to ensure that potential conflicts with construction methods and materials (geogrids, drains, footings, foundations, limitations on rooting depth imposed by planter box dimensions, impervious liners, etc.) are considered during the selection of trees and landscaping plantings.
- The landscape design should minimize potential impacts of plan and tree roots on stormwater facilities and utilities, including under drains, storm sewer, and rain drains.
- Tree preservation and tree planting must account for not only initial construction, but also the need for future maintenance of stormwater facilities and utilities.
- Arborist reports should address all stormwater facilities and utilities proposed to encroach in the root protection zones of trees required to be preserved.

When stormwater management is required, the applicant must provide adequate information to show that the proposed development can meet the stormwater requirements at the time of development. In general, this includes:

- A plant list or table, including botanic and common names, size at time of planting, quantity, spacing, type of container, evergreen or deciduous, and other information related to the facility-specific planting, in accordance with landscape industry standards.

- A site utility plan that includes stormwater management facilities and a proposed discharge point.
- If public street improvements will be required as a condition of land use approval, a plan for managing stormwater from the street and identification of required right-of-way dedications (that include space for stormwater management facilities).
- A Stormwater Management Report (see [Appendix D.4](#)) that describes how the proposal complies with the stormwater hierarchy, including supporting documentation such as infiltration testing (see [Appendix F.2](#)) and calculations, per the requirements of the appropriate design approach (see detailed requirements of the Simplified, Presumptive, and Performance approaches in Appendices D.3, D.4, and D.5).
- Other requirements, depending on the site and complexity of the project. Examples include a grading plan, geotechnical report, and groundwater level testing (see [Appendix F.1](#)).

The use of the Presumptive and Performance Approach (required for larger and/or complex projects) require the stormwater submittal to be prepared by a qualified professional, as outlined in [Section 2.2](#). The submittal must include Presumptive Approach Calculator (PAC) printouts that demonstrate the stormwater facility engineering.

Issues that Frequently Delay Land Use Review Applications

Land use applications that cannot be fully processed or approved often have the following deficiencies related to stormwater management:

- It is not clear whether infiltration is feasible on the site.
- It is not clear which category of the stormwater hierarchy is being met.
- A category of the stormwater hierarchy is chosen without proper justification.
- Access to an offsite stormwater discharge point (drainageway, storm sewer, or combined sewer) is not clearly shown.
- Site plan information is inaccurate or inadequate.
- The amount of land required to accommodate stormwater facilities is not accurately shown.

- Conflicts between stormwater facilities and property line or foundation setbacks are shown.
- Disturbance areas are undefined or inaccurate.
- Proposed and existing impervious areas are undefined or inaccurate.

To ensure a timely review, the land use review applicant is strongly encouraged to address these issues before submitting the land use application by following steps 1 through 5 in [Section 2.1.2](#). This information should be included in the Stormwater Management Report and submitted with the land use application.

APPENDIX D.3 SIMPLIFIED APPROACH SUBMITTAL GUIDE

The Simplified Approach Form is designed to be used for private stormwater management facilities with development proposals having less than 10,000 square feet of overall impervious area. Each individual tax lot is required to manage the stormwater it generates on the same lot to the maximum extent practicable and within accordance of the *Stormwater Management Manual*. Site conditions may require additional geotechnical or geological evaluation, which may require the Bureau of Environmental Services (BES) to prohibit the use of this simplified approach and require the applicant to utilize the Presumptive or Performance approach.

If total impervious area for the submitted development proposal is equal to or greater than 10,000 square feet or includes public or private street improvements, the Presumptive or Performance approach must be used, and a Stormwater Management Report will be required. For more information, refer to the current *Stormwater Management Manual* Sections 2.2.2 and 2.2.3, respectively.

If the proposal is unable to meet the requirements of the *Stormwater Management Manual*, the applicant must submit a Special Circumstances request; refer to the *Stormwater Management Manual* Section 1.7 for more information.

Submittal Form Instructions

1. **Project, Designer, and Applicant Information** – If the site information, calculations, and final design data are provided by the owner or another third party, the owner must sign this acknowledging and accepting responsibility for the information provided on the form.
2. **Site Information**
 - a. Soil classification information can be found at the following website:
<http://www.portlandmaps.com>

To locate the data pertaining to the development site, select the <Environmental> information for the property, then select the <Stormwater Management> tab and locate the soil classification data.

- b. Required Infiltration Testing Instructions - See **Appendix F.2 for Simplified Approach Infiltration Test** procedures.
 - If the test pit infiltration rate is greater than, or equal to, 2 inches per hour, then onsite infiltration is required. Applicants may choose either a surface infiltration facility with overflow to a drywell or soakage trench or a surface infiltration facility with an overflow to an approved discharge point. If the tested infiltration rate is below 2 inches per hour, then a flow-through or

partial infiltration facility is required with an overflow to an approved discharge point.

Projects that infiltrate roof runoff with private soakage trenches or drywells are not required to provide pollution reduction prior to infiltration. This exemption does not apply to projects that discharge stormwater offsite. Single-family residential (up to three units) roofs and footing drains are excluded from underground injection control (UIC) registration. Refer to Section 1.4 for specific pollution reduction requirements for UICs.

- Waiving testing requirements: The applicant must provide additional documentation to support any requests for waiving of the required infiltration test. BES may waive the requirement for sites where infiltration is not feasible due to onsite constraints (excessive slope, landslide hazard, etc.) or in areas where infiltration rates are demonstrably adequate as substantiated through previous testing.

3. Facility Sizing Worksheet Instructions

All facilities sized with the [Simplified Approach Form](#) are presumed to comply with the City's pollution and flow control requirements.

Infiltration and discharge requirements are site specific and approved with the use of the Simplified Approach Form.

- 1) Enter square footage (sf) of total impervious area being developed or redeveloped in **BOX 1**.
- 2) Calculate Impervious Area Reduction Techniques:
 - a. Complete Tree Credit Worksheet and enter total in 1(a)
 - b. Enter sf for impervious area reduction techniques in 2(a) or 2(b)
 - c. Enter sum of the impervious area reduction techniques into **BOX 2**.
 - d. Subtract BOX 2 from BOX 1, enter the sum for Total Impervious Area Requiring Stormwater Management, **BOX 3**.
- 3) Calculate Surface Facilities Proposed:
 - a. Select appropriate stormwater management facilities based on infiltration rate.
 - b. Enter the square footage of Impervious Area managed that will flow into each facility type.
 - c. Multiply the Impervious Area by the Sizing Factor, and enter the resulting sum in the Facility Surface Area to the right. The area for each facility type must match the areas shown on any site plans submitted with the project, and with the areas of facilities shown on the Operations &

Maintenance Form for Private Stormwater Management Facilities (See [Appendix D.6](#)).

- d. Check whether the planter, swale, or basins are flow-through facilities, and indicate how overflow will be directed for final discharge location (check all that apply on the project).
 - e. Enter the sum of the Total Surface Facility Impervious Area Managed into **BOX 4**.
- 4) Calculate Subsurface Facilities Proposed:
- a. Select appropriate subsurface facility depending on source of inflow from either an otherwise unmanaged Impervious Area, or as an overflow from a Surface Facility.
 - b. Enter the square footage of Impervious Area that will flow into each facility type. If source of inflow is as an overflow from a Surface Facility, enter a value of zero.
 - c. Enter the diameter, depth, length, and width as required to describe the size of the facility.
 - d. Enter sum of the Total Subsurface Facility Impervious Area in **BOX 5**.
- 5) Calculate Total Stormwater Facility Impervious Area:
- a. Add BOX 4 and BOX 5 to sum the total Impervious Area in **BOX 6**.
- 6) Calculate Total Unmanaged Impervious Area.
- a. Subtract BOX 6 from BOX 3 and enter sum in **BOX 7**.
 - b. BOX 7 should be zero.
 - c. If there is a positive number in BOX 7, there is new or redeveloped impervious area not being managed. Indicate that area not being managed on attached site plans and provide a narrative for why the area cannot be managed.

Documentation Requirements

When the Simplified Approach is used to design stormwater facilities (see [Section 2.2](#)), the minimum submittal requirements are as follows.

1. **Scaled Site Plans** must include the following information (at a minimum):
 - Minimum scale of 1 inch to 10 feet
 - North arrow
 - Elevations and topography
 - Property lines
 - Lot area and setbacks
 - Footprints of structures to the roofline
 - Easements and driveways
 - Wells and septic systems
 - Utility lines
 - Width of right-of-way and curb height
 - Impervious areas
 - Type, location, and size of stormwater facility
 - Existing and proposed surface drainage
 - Proposed discharge point

See the Bureau of Development Services site plan checklist at www.portlandonline.com/bds

2. **Cross-Section and Details** of the proposed facility must be included with the plan set. Where sites are topographically varied, it may be imperative to show elevations of inlets, outlets, and discharge points on the cross-section to show how gravity drainage will be met.
3. The **Simplified Approach Form** must be completely filled out. The form includes tables for the required infiltration testing and instructions on how to perform an open pit test. See [Appendix F.2](#) for further details about infiltration testing and options. The form also provides the simplified sizing for the facilities.
4. The **Operations and Maintenance Form** (see [Appendix D.6](#)) must be recorded with the appropriate county and submitted to the Bureau of Environmental Services (BES) Document Services at 1900 SW 4th Ave., Portland, OR 97201.
5. The **O&M Specification** (see [Section 3.3](#)) must be recorded with the O&M Form and submitted to BES.
6. **Landscape plans** are required (see [Section 2.3.2 and Appendix D.1](#)).



SIMPLIFIED APPROACH FORM

PROJECT INFORMATION WORKSHEET

PROJECT INFORMATION

Submittal Date: _____ Permit Application Number: _____
 Owner Name: _____
 Owner Phone: _____ Owner Email: _____
 Designer Name: _____ Designer Firm: _____
 Designer Phone: _____ Designer Email: _____
 Designer License Number: _____ License Type: _____
 Applicant Name (if different from owner or designer) _____
 Applicant Phone: _____ Applicant Email: _____

SITE INFORMATION

Site Address: _____

 State Property ID (six-digit R number) for all parcels (included in development proposal): _____

 Brief Description of Proposed Development: _____

 Soil Classifications: NRCS Wetted Drainage Class: _____
 NRCS Hydrologic Soil Group: _____

Site Characteristics:

S.1 Do slopes exceed 20% anywhere within the project area?
 yes no
 S.2 Are there springs, seeps, or a high groundwater table within the project area? yes no
 If the answer to either S.1 or S.2 is **YES**, then a flow-through or partial infiltration facility with an overflow to an approvable discharge point is required.

Required Infiltration Testing

Date of Test: _____ Depth of Excavation (ft): _____

	TEST 1	TEST 2	TEST 3
A. Time (of day)			
B. Duration (hours) (1 hour minimum)			
C. Initial Water Depth (inches)			
D. Final Water Depth (inches)			
E. Infiltration Rate* (inches/hour)			Final Infiltration Rate

I acknowledge the accuracy of these infiltration testing results.

Signature of tester (required)

Print Name

Date

*Infiltration Rate = Initial Depth (in) – Final Depth (in) / Duration of Test (hours)

SIMPLIFIED APPROACH FORM

REQUIRED INFILTRATION TESTING SITE PLAN

TEST PIT LOCATION (SITE PLAN SKETCH)

Key information to include: 1) Site or parcel, 2) Adjacent road(s) or cross street(s), 3) Test pit location with dimensions



north

SIMPLIFIED APPROACH FORM

TREE CREDIT WORKSHEET

1 New Coniferous Trees

Enter number of NEW coniferous trees that meet qualifying requirements BOX A

Multiply Box A by **200** and enter results in Box B BOX B

2 New Broadleaf Trees

Enter number of NEW broadleaf trees that meet qualifying requirements BOX C

Multiply Box C by **100** and enter results in Box D BOX D

3 Existing Tree Canopy

Enter number of EXISTING trees with caliper of 1.5 to 6 inches BOX E1

Multiply Box E1 by **200** and enter results in Box E2 BOX E2

For each tree larger than 6.1 caliper inches, there is **400** square feet of credit **per each 6 caliper inches**.

List each tree (on a separate page, if necessary) larger than 6 caliper inches, include the actual caliper size, and determine the stormwater credit allowed per tree. Do not round up.

Trees (include only trees larger than 6 caliper inches)	Caliper Size (in inches)	Credit Units (divide by 6 to get units to calculate credit)	Credit	Stormwater Credit
		/6 =	x 400 sf	sf
		/6 =	x 400 sf	sf
		/6 =	x 400 sf	sf
		/6 =	x 400 sf	sf
		/6 =	x 400 sf	sf
		/6 =	x 400 sf	sf
TOTAL				sf

BOX F

4 TOTAL TREE CREDIT

Add boxes B, D, E2 and F, enter the TOTAL in Box G BOX G

For sites with **LESS than 1,000 SF** of new or redeveloped impervious area:

The amount in Box G is to be entered on Page 4, 1 Tree Credit.

For sites with **MORE than 1,000 SF** of new or redeveloped impervious area:

Multiply Box 1 on Page 6 by 0.1 and enter result in Box H BOX H

Enter the LESSER of Box G and Box H in Box I. BOX I

The amount in Box G is to be entered on Page 4, 1 Tree Credit.

SIMPLIFIED APPROACH FORM

FACILITY SIZING WORKSHEET

1 Total impervious area being developed or redeveloped **BOX 1**

Tree Credit: Enter total from Page 5, Box G or Box I _____ SF

Impervious Area Reduction Techniques Proposed: _____ SF

A. Ecoroof _____ SF

B. Pervious Pavement _____ SF

2 Total impervious area reductions **BOX 2**
(Add tree credit and impervious area reduction techniques square footage)

3 Total impervious area requiring stormwater management **BOX 3**
(Subtract Box 2 from Box 1)

4 Surface facilities proposed

	Impervious Area Managed		Sizing Factor		Facility Surface Area
A. Planter	_____ SF	x	0.06	=	_____ SF
B. Swale	_____ SF	x	0.09	=	_____ SF
C. Basin	_____ SF	x	0.09	=	_____ SF
D. Downspout Extension	_____ SF	x	0.10	=	_____ SF
E. Vegetated Filter Strip for walks and driveways	_____ SF	x	0.20	=	_____ SF

Overflow will be directed to *(check all that apply)*: Subsurface Facility Surface Water Stormwater Sewer Combined Sewer

5 Total surface facility impervious area managed **BOX 4**
(Add square footage from planters, swales, basins, downspout extensions, etc.)

6 Subsurface facilities proposed

The following subsurface facilities can receive overflow from the facilities listed above or can be used independently to manage stormwater from roofs. If stormwater is generated from anything other than roof area, the facilities are subject to the UIC (Underground Injection Control) requirements.

(See Section 2.3.3 for sizing information)

Facility Size

A. Drywell _____ sf _____ Diameter _____ Depth

B. Soakage Trench _____ sf _____ Length _____ Width

7 Total subsurface facility impervious area managed **BOX 5**
(Add square footage from proposed drywell, soakage trench)

8 Total stormwater facility impervious area managed **BOX 6**
(Add totals from Box 4 and Box 5)

9 Total impervious area without management **BOX 7**
(Subtract Box 6 from Box 3)

Escape Route: If the stormwater facility temporarily fails or rainfall exceeds the facility design capacity, describe where flows will drain to in order to maintain public safety and avoid property damage. Depending on site conditions, this may include storage in an overflow structure, parking lot, street, or landscaped area.

I certify the accuracy of this application.

Signature: _____ Date: _____

Printed Name: _____

APPENDIX D.4 PRESUMPTIVE APPROACH SUBMITTAL GUIDE

When the Presumptive Approach is used to design stormwater facilities, the minimum submittal requirements are as follows.

1. **Scaled Site Plans** including (at a minimum):

- Minimum scale of 1 inch to 10 feet
- North arrow
- Elevations and topography
- Property lines
- Lot area and setbacks
- Footprints of structures
- Easements and driveways
- Wells and septic systems
- Utility lines
- Width of right-of-way and curb height
- Impervious areas
- Type, location, and size of stormwater facility
- Existing and proposed surface drainage
- Proposed discharge point

See the Bureau of Development Services site plan checklist at www.portlandonline.com/bds

2. **Cross-Section and Details** of the proposed facility must be included with the plan set. Where sites are topographically varied, it may be imperative to show elevations of inlets, outlets, and discharge points on the cross-section to show how gravity drainage will be met.
3. A **Stormwater Management Report** must be submitted. An outline is provided on the next page to identify report requirements.
4. The final **Operations and Maintenance (O&M) Form** (see [Appendix D.6](#)) must be recorded with the appropriate county and submitted to BES Document Services at 1900 SW 4th Ave. Portland, OR 97201.
5. An **O&M Plan** (see [Appendix D.6](#)) must be developed, recorded with the appropriate County, and submitted to the Bureau of Environmental Services (BES) Document Services at 1900 SW 4th Ave., Portland, OR 97201.
6. **Landscaping plans** are required (see [Section 2.3.2 and Appendix D.1](#)).

Stormwater Management Report Outline

The Stormwater Management Report is required for every site improvement where the Presumptive or Performance Approach is used. All reports shall be paginated and securely fastened (including maps and exhibits).

1) Cover Sheet

- Project name and owner
- Site address
- Associated permit numbers
- Submittal date
- Engineer
- Firm
- Address
- Contact information

2) Designer's Certification and Statement

"I hereby certify that this Stormwater Management Report for _____ (name of project) has been prepared by me or under my supervision and meets minimum standards of the City of Portland and normal standards of engineering practice. I hereby acknowledge and agree that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me."

Design Professional's Oregon registration stamp

3) Table of Contents

4) Project Overview and Description

- Size and location of project site (vicinity map)
- Property zoning
- Type of development/proposed improvements
- Watershed description
- Permits required (local, state, federal)
- Existing vs. postconstruction conditions

5) Methodology

- Drainage at existing site
 - Potential impacts on the proposed site from existing conditions
 - Potential impacts from the proposed site on existing drainage
 - Techniques for mitigating potential conflicts or problems
- Infiltration testing results
- Narrative that defines the proposed stormwater management techniques, including discharge point(s) for runoff from private and public impervious areas
- Stormwater hierarchy category justification

6) Analysis

- Design assumptions
 - Design storms used
 - Computation methods
 - Software used
 - Safety factors, curve numbers, and design coefficients
 - Clarify variations from the norm
- Approved stormwater sizing calculator narrative form and printouts
- Conveyance requirements and design

- Table of impervious area treated (differentiates public vs. private and roof vs. pavement). See example table 1 below (“Catchment and Facility Table”).
- Comparison table of the flow rates for pre and post construction. Table must show that the project meets the flow control requirements set forth in [Section 1.3.2](#). See example Table 2 below (“Pre vs. Post Construction Flow Rates”).
- Determination of the escape route or inundation level for the 24-hour 100-year event

Example Table 1

Catchment and Facility Table (shows each catchment on proposed site as well as proposed facility)

Catchment/ Facility ID	Source (roof/road/other)	Impervious Area (sf/ac)	Ownership (private/public)	Facility Type	Facility Size (sf/ac)	Curve #
AA						
BB						

Example Table 2

Pre vs. Post Construction Flow Rates

Facility ID	Peak Flow Rate (cfs)								ToC (min)	
	2 yr		5 yr		10 yr		25 yr		Pre	Post
	Pre	Post	Pre	Post	Pre	Post	Pre	Post		
Project Site										
AA										
BB										

- 7) Engineering Conclusions
 - Based on compliance with Stormwater Management Manual
 - How water quality, flow control, and discharge requirements are satisfied
 - Post-construction peak flow= $\frac{1}{2}$ pre-development peak flow (2-yr 24-hr events)
- 8) Stormwater Facility Details/Exhibits
 - Contour maps of pre and post development
 - Impervious area identification
 - Existing and new drainageways
 - Watershed delineation
 - Point(s) of discharge
 - Delineation of each catchment (area treated by one facility)
 - Landscape plans (see [Appendix D.1](#))
- 9) Draft Operations and Maintenance Plan and O&M Form 3 (See [Chapter 3.2](#))
 - Must include entity responsible for long-term fiscal responsibilities of O&M
- 10) Additional Forms
 - Source Control Special Circumstances Installations (if applicable)
 - Special Circumstances (if applicable)
- 11) Associated Reports Submitted

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APPENDIX D.5 PERFORMANCE APPROACH SUBMITTAL GUIDE

If the proposed stormwater management plan meets the intent of all the *Stormwater Management Manual* requirements, but not as specified under the Simplified or Presumptive Approach, the applicant may submit the project under the Performance Approach and request an administrative technical review. The application must demonstrate that the proposed management plan meets or exceeds all of the City of Portland's stormwater requirements. Refer to [Section 2.2.3](#) for more information about the Performance Approach.

Technical staff under the direction of the Chief Engineer or designee will review Performance Approach submittals. The applicant can initiate a Performance Approach review by completing a Stormwater Management Report (as specified in [Appendix D.4](#)). The applicant shall provide additional materials and supporting information based on the specific request.

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APPENDIX D.6 OPERATIONS & MAINTENANCE SUBMITTAL GUIDE

City of Portland code requires the submittal of an operations and maintenance (O&M) plan for all required stormwater management facilities. The Bureau of Environmental Services (BES) must review and approve the plan. Failure to properly operate or maintain a stormwater management facility according to the O&M Plan may result in a civil penalty, as specified in 17.38.045: Enforcement.

For facilities designed under the Simplified Approach, the O&M Specifications described in [Section 3.2.1](#) and provided in [Section 3.3.1](#) can serve as the required O&M Plan. See those sections for more information.

For facilities designed under the Presumptive Approach or Performance Approach, a site-specific O&M Plan must be provided, as described in [Section 3.2.2](#) and outlined in [Section 3.3.2](#). See those sections for more information.

In addition to the O&M Specifications or site-specific O&M Plan, an O&M Form is required for all projects.. The applicant must sign the form, and the signature must be notarized. The O&M Form and a site plan **must be recorded and filed with the county Department of Assessment and Taxation in the county where the property site is located**. When completed accurately, this form meets the recording requirements in Multnomah, Clackamas, and Washington counties.

O&M Form Instruction

1. Site Legal Description

- a. The Site Legal Description shall include all of the tax lots (parcels) managed by the onsite stormwater management system. The information must be accurate and correctly filled out on the Form prior to submittal to the County for recording.
- b. To find a property's legal description, visit <http://www.portlandmaps.com> and browse to the property using the exact address. To locate the Site Legal Description at PortlandMaps.com, select the "Assessor" link on the top menu and locate the boxes labeled "Tax Roll" and "Instrument Number" on the page. If the Tax Roll description has "TL" in it, include the Instrument Number where indicated on Form 2. This information is intended as guidance; it may not be adequate to be accepted for filing by Multnomah County.

2. Site Plan

- a. A site plan showing all facility locations in relation to labeled streets, buildings, or other permanent features on the site is a required part of the O&M submittal. Please include schematic utilities (including existing-to-remain and proposed water, sanitary, and storm sewers), property lines, key site dimensions, and a north arrow. Illustrate the flow in the order which

- stormwater passes through each facility (also know as treatment train) for each unique drainage basin. Include notes and arrows illustrating sources of runoff, the direction of flow through all facilities, and the location and type of discharge point.
- b. Provide a site plan sketch on the O&M Form, Page 2, Step 2, or attach a site plan showing each of the items listed above.
 - c. Maintaining the stormwater management facility(s) shown on the site plan is a required condition of building permit approval for the identified property. The property owner is required to operate and maintain the facility(s) in accordance with the O&M Plan on file with the City of Portland. This requirement is binding on all current and future owners of the property. Failure to comply with the O&M Plan can trigger an enforcement action, including penalties.

If the stormwater system design needs to be modified during the course of a project, and prior to Substantial Completion, please contact BES at 503-823-7740 for guidance on how best to modify and update the O&M forms to reflect the system as built. If the O&M Form requires revision, either because the O&M Form on file with the City is inaccurate or because the owner(s) request and receive City approval to revise it, the owner must record a new O&M Form with the County. Call the Maintenance Inspection Program at (503) 823-5320 for guidance.

Maintenance Inspection Log

A maintenance inspection log is required to be maintained, and available, for inspection at the request of Maintenance Inspection Program personnel. See Section 3.3 for a Sample Stormwater Facility Monitoring Log.

Completed and Recorded O&M Plans must be filed with BES. Submit completed O&M Plans, including Form 2, to:

City of Portland, BES
Document Services
1900 SW Fourth Ave., Suite 5000
Portland, OR 97201

Office Hours are 8:00AM – 5:00PM, Monday through Friday
Call 503-823-7761 for assistance

County Recorder's Office Information

Multnomah County Recorder

Room 158

501 SE Hawthorne St.

Portland, OR 97214

<http://www.co.multnomah.or.us/at/services.html>

Phone: 503-988-3034

Washington County Recording Office

155 N. First Ave.

Suite 130, MS 9

Hillsboro, OR 97124

<http://www.co.washington.or.us/deptmts/at/recording/record.htm>

Phone: 503-846-8751

Clackamas County Recording Division

104 11th St.

Oregon City, OR 97045

<http://www.co.clackamas.or.us/recording/legible.htm>

Phone: 503-655-8661

O&M Plan Outline

Please refer to **Section 3.3** for guidance in creating the O&M Plan.

O&M Plan Outline

I. Description

- Summary of overall Stormwater Management Plan.
- Table identifying each stormwater facility, its size, the stormwater source to each facility, square footage treated, and discharge point.
- Specific location of stormwater facilities as shown on a site plan, including elements as described in Section 3.3 and above.
- If a stormwater facility deviates from the general design of the facility type as shown in Chapter 2, provide cross-section detail and plan view for the facility.
- Identification of who will assume responsibility for ongoing operations.

II. Inspection and Visual Indicators of Diminished Performance

- When and how often facilities will be inspected.
- Definition of what size storms require additional inspections.
- Description of visual indicators that would trigger maintenance activities.

III. Maintenance Procedures

- Specific maintenance procedures for each facility type.
- Likely deficiencies and corrective actions.
- Course of action for unexpected deficiencies.
- Site best management practices (BMPs) for effective stormwater management.

IV. Inspection and Maintenance Logs

- Example and instructions for maintaining required logs.

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CITY OF PORTLAND
Stormwater
Management
Manual

FORM 2

OPERATIONS & MAINTENANCE FORM

PRIVATE STORMWATER MANAGEMENT FACILITIES

This O&M Form supercedes document number _____

(for official county use only)

PROJECT NAME _____

PERMIT INFORMATION

Permit # _____

Permit Submittal Date _____

SITE INFORMATION *(include all parcels)*

R# (6 Digits) _____

Site Address _____

City / State / Zip _____

Preparation Date: _____

OWNER INFORMATION (ALL LEGAL OWNERS)

Name (1) _____

Name (2) _____

Address *(Mailing)* _____

City / State / Zip _____

O&M PREPARER INFORMATION

Name _____

Address *(Mailing)* _____

City / State / Zip _____

Phone *(area code required)* _____

Email _____

Site Legal Description:

Responsible Party for Maintenance *(check one)*

Homeowners Association Property Owner

Property Management Company Tenant

Other (describe) _____
(not Contractor or Consultant)

Contact Information for Responsible Party

Contact Name _____

Contact Organization _____

Phone *(area code required)* _____

Email: _____

Maintenance Practices and Schedule

These operation and maintenance practices are required in accordance with Portland City Code, Chapter 17.38.

The requirements are based on the current version of the *City of Portland Stormwater Management Manual* on the date of permit submittal.

For the **Simplified Approach**, please attach the current O&M Specifications for each facility type from the *Stormwater Management Manual*, Chapter 3.3.1.

For the **Presumptive and Performance Approaches**, please attach the approved, site specific O&M Plan per the *Stormwater Management Manual*, Chapter 3.3.2.

OPERATIONS & MAINTENANCE FORM

PRIVATE STORMWATER MANAGEMENT FACILITIES

SITE PLAN

Provide a site plan sketch in the area provided below, or attach a scaled site plan to this submittal that includes all of the information required as shown in Appendix D6 on page D.6-1, in Operations & Maintenance Form Instructions, Site Plan.

STEP 1 – COMPLETE THE FOLLOWING TABLE

Stormwater Facility Type (Chapter 2)	Stormwater Facility Size (sf)	Drainage is from Roof or Lot?	Impervious Area Treated (sf)	Discharge Point
Totals				

Maintaining the stormwater management facility or facilities listed above shown on the following (or attached) site plan is a required condition of building permit approval for the identified property. Property owners are required to operate and maintain facilities in accordance with the O&M plan on file with the City of Portland. This requirement is binding on all current and future owners of the property. Failure to comply with the O&M plan can trigger an enforcement action, including penalties. The O&M plan may be modified by written consent of current owners and written approval of the Bureau of Environmental Services.

STEP 2 – REQUIRED SITE PLAN

(insert or draw here, or attach separate sheet)

I Have Attached a Site Plan

OPERATIONS & MAINTENANCE FORM

PRIVATE STORMWATER MANAGEMENT FACILITIES

SIGNATURE AND ACKNOWLEDGEMENT

By signing below, the owner accepts and agrees to the terms and conditions contained in this O&M Form and in any document executed by filer and recorded with it. The owner further acknowledges that this documentation has been prepared on their behalf and that they are responsible for the quality and completeness of the O&M Plan. Any failure to comply with the terms of these plans may result in enforcement actions by BES requiring the property owner to restore the stormwater facilities to a functional state as approved under original requirements.

The owner also accepts that the City requires property owners to submit and record, with the County, complete and accurate O&Ms enforceable under City Code 17.38 and that substantial changes to the O&M require City approval prior to County recording. A revised O&M must state that it supersedes a previous O&M (with cited county document number; See Page 1).

THIS PAGE MUST BE SIGNED IN THE PRESENCE OF A NOTARY.

Property Owner or Authorized Representative (1) Signature

Property Owner or Authorized Representative (2) Signature

NOTARY SIGNATURE AND STAMP

INDIVIDUAL Acknowledgement

This acknowledgement is intended for property owned by individuals or trusts.

STATE of OREGON county of: _____

This instrument was acknowledged
before me on: *(date)* _____

By: *(owner 1)* _____

By: *(owner 2)* _____

Notary Signature _____

My Commission Expires _____

Notary Seal:

OR CORPORATE Acknowledgement

This acknowledgement is intended for corporation, government agencies, school districts, or other formal entities

STATE of OREGON county of: _____

This instrument was acknowledged
before me on: *(date)* _____

By: *(representative)* _____

As: *(Title)* _____

Of: *(Corporation)* _____

Notary Signature _____

My Commission Expires _____

Notary Seal:

APPENDIX D.7 SPECIAL CIRCUMSTANCES AND APPEALS SUBMITTAL GUIDE

Special Circumstances

Special circumstances on a proposed site may make it impractical to implement onsite pollution reduction or flow or volume control to the standards specified in Chapter 1 of this manual. In that case, the Bureau of Environmental Services (BES) will determine if all or a portion of the stormwater management obligations may be fulfilled in other ways, such as in the public right-of-way or outside of the limits of the development proposal, improvement or site. The [Special Circumstances Form](#) is required to request consideration for special circumstances. Development or improvement proposals on private property or in the right-of-way, such as land use cases, building permits, or public works permits, must use Form 3a. Improvements initiated by public agencies, such as Capital Improvement Projects or Public Works Projects, must use Form 3b.

For special circumstances or appeals regarding Section 1.3.3 and Chapter 4 of the *Stormwater Management Manual*, see [Appendix D.9](#).

No exceptions to meeting the stormwater management obligations are allowed. The applicant must account for the management of all stormwater runoff from the site. Stormwater management within the site must be achieved to the maximum extent feasible, as approved by BES, in all cases before any facilities outside of the proposed site or fees will be allowed.

Properties are **not** eligible for special circumstances if they were divided or partitioned after this *Stormwater Management Manual* was adopted (July 1, 1999) and the division or partition resulted in the special circumstance (e.g., structural or other physical limitations at the site).

If BES approves a special circumstances request, the applicant must construct an appropriately sized facility outside of the proposed site or pay a fee for the City to construct facilities outside of the proposed site. This [Offsite Management Fee](#) is calculated per square foot of unmanaged impervious surface. The fee may be pro-rated to account for portions of the stormwater management obligation met onsite (as determined by the City's review of proposed facilities within the site). The current Offsite Management Fee can be found on the BES website with the Sewer and Drainage Rates and Charges.

Special circumstances review will be conducted by an Administrative Review Committee of City staff and the BES Stormwater System Program Manager or designee.

How to Prepare a Special Circumstances Application

No application will be reviewed unless it is complete. A complete special circumstances application consists of the following elements:

- Completed appropriate **Special Circumstances Form** (Form 3a or 3B)
- One set of plans (site plan and any necessary details)
- Special Circumstances Application Fee
- Supplemental information specific to the project circumstances.

It is critical that information provided in the special circumstances application be clear, concise, accurate, and complete. Each special circumstances request must stand on its own merit and will be reviewed based on the specific conditions related to the project under consideration.

Form: Each of the **Special Circumstances Forms** consists of the following sections:

1. **Project Information.** Provide information about the project, its location, the property owner, and the project team.
2. **Special Circumstance.** Specify the request being made and the features of the project that make it a special circumstance.
3. **Stormwater Management Information.** Generally explain the proposed stormwater management facilities. Summarize how stormwater will be managed for pollution reduction, flow control, and infiltration, and indicate the proposed disposal point.

Plans: One set of plans (in addition to any plans submitted for permit processing) must accompany the Special Circumstance application. **Plans must show the total amount of impervious area being created and all stormwater management and conveyance facilities.** They should provide sufficient information to detail the areas considered to be a special circumstance, as well as any areas that may be affected by or that may affect those circumstances. The plans submitted under the Special Circumstances application must match the plans submitted for the development proposal.

Fee: For the current fee for a Special Circumstances application for development a proposals, see the BES website for the Sewer and Drainage Rates and Charges. There is no fee for projects initiated by public agencies.

Supplemental information (optional): Submitting supplemental information (engineering analyses, test data, etc.) that will help clarify the request or make it easier to understand is encouraged.

How to File a Special Circumstances Application

Applications will be screened for completeness, and the applicant will be notified within 3 working days that the application has been received and is complete. If an application is submitted with a building permit, public works permit, or land use case application, the completeness check will occur following BES staff assignment. Submittal of inaccurate or incomplete applications may cause a delay in considering the request.

Note: If the owner is different from the applicant, both the owner and the applicant are required to sign any required forms and attend any meetings as arranged.

If an application is submitted with a building permit, public works permit, or land use case application, the submittal should be submitted to the BES staff assigned to that development proposal.

For questions regarding the special circumstances submittal requirements or for instructions on submissions outside of the development review process, call 503-823-7761.

Decisions

Administrative reviews will be completed within 21 calendar days of the completeness check. Appointed staff will review the submittal before convening the Administrative Review Committee. Decisions are reached by consensus. The decisions will be recorded and e-mailed to the applicant within 5 business days of the decision. If an Offsite Management Fee is allowed, the fee must be paid prior to BES approval of the development proposal.

Appeals

Applicability

This appeals process applies to special circumstances decisions, as described above. It also applies to administrative or technical decisions related to other requirements of Chapters 1 through 3 (except Section 1.3.3) and decisions rendered regarding the approval of manufactured stormwater treatment devices (Appendix B). [Appendix D.9](#) describes a separate appeals process for Section 1.3.3 and for the source control requirements in Chapter 4.

The appeals process allows applicants to appeal staff interpretation of the City Code and of adopted policies and procedures that guide the review of development proposals. Applicants may appeal any issue related to interpretation of the stormwater management policy. For example, an applicant may appeal staff assessment of a site's stormwater management level or a permit denial. Applicants may not appeal the content or requirements of the policy, or technical parameters such as design storms, coefficients, and other technical criteria through this process.

This appeals process is not intended to address requested changes to technical specifications as adopted in the *Portland Standard Construction Specifications* or the Bureau of Environmental Services (BES) *Sewer and Drainage Facilities Design Manual*. In those cases, applicants should contact the BES Development Review Team (503-823-7761) to request consideration by the BES Standards and Practices Committee. That committee has a separate process to consider changes to technical standards.

Process

Appellants not satisfied with administrative or technical decisions may request in writing a public hearing by the BES Appeals Board, which comprises the Chief Engineer, Systems Development Manager, Pollution Prevention Services Manager, and Watershed Services Manager (or their designees). An outside member may also be included at the discretion of the Chief Engineer, depending on the nature of the appeal. The Stormwater System Program Manager will schedule a BES Appeals Board meeting to occur within 14 working days of receipt of the written appeal application. The applicant will be notified of the meeting date, place, and time. Public notice of the appeal request is given. At least three members of the board must be present for the meeting to take place. A member of the Administrative Review Committee or Technical Review Committee will present an overview of the request and the decision. The applicant, if present, may briefly address the board. Decisions are reached by a majority opinion of the board and are binding.

How to Prepare an Appeal Application

A complete appeal review application consists of:

- A written request to the Stormwater System Program Manager explaining the reason for the appeal.
- A copy of the Special Circumstance Administrative Review Committee's or Technical Review Committee's original determination.
- One set of plans (if applicable).
- Appeal Application Fee
- Supplemental information specific to the project circumstances.

It is critical for information provided in the appeal application to be clear, concise, accurate, and complete. Each appeal must stand on its own merit and will be reviewed based on the specific conditions related to the project under consideration.

Written Request: The written request must include:

- Information about the project or product (i.e., location, property owner, and the project team, etc).
- The decision being appealed.
- General reasons for the denial and new information rebutting the denial.
- General summary of the proposed stormwater management approach as applicable, including how stormwater is being managed for pollution reduction, flow control, and infiltration and the discharge point.

Plans: For development projects, one set of plans (in addition to any plans submitted for permit processing) must accompany the appeal application. Plans should provide sufficient information to detail the areas that are being appealed, as well as any areas that may be affected by or affect the appeal.

Fee: For the current application fee for Stormwater Appeals, see the BES website for the Sewer and Drainage Rates and Charges.

Supplemental information: Supplemental information (engineering analyses, test data, etc.) that will clarify the appeal is a welcome accompaniment to the submittal. For appeals related to the approval of manufactured stormwater treatment devices, all reports and analysis relevant to the performance of the device must be included.

How to File an Appeal

Applications will be screened for completeness. Submittal of inaccurate or incomplete applications may cause a delay in hearing the appeal.

Note: If the owner is different from the applicant, both the owner and the applicant are required to sign any required forms and attend any meetings as arranged.

Application packets should be mailed or delivered to:

City of Portland, BES
1120 SW 5th Ave., Room 1000
Portland, OR 97204
Attention: Stormwater System Program Manager

For questions regarding the appeal packet submittal, call the BES Development Review Hotline at 503-823-7761.

Decisions

Decisions will be recorded and e-mailed to the appellant within 5 business days.



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FORM 3A

SPECIAL CIRCUMSTANCES

FOR DEVELOPMENT PROPOSALS ON PRIVATE PROPERTY OR RIGHT OF WAY (R.O.W.)

This form is REQUIRED when applicant proposes to pay an offsite stormwater management fee.

Please fill this form out completely. For assistance completing it, consult with the Bureau of Environmental Services (BES) reviewer assigned to your project or with BES staff in the Development Services Center. Refer to Appendix D.7 of the *2014 Stormwater Management Manual* for more information.

The Special Circumstances Application fee, along with one (1) set of plans (**exclusive of any plans submitted for development proposal**), must be submitted along with this form. Plans are to clearly indicate the new or redeveloped impervious area and proposed stormwater management.

Information about the status of your application may be obtained by calling the BES hotline at 503-823-7761. Applicants will receive a copy of final decision via email.

(for official use only)

Received by: _____

Date: _____

Deemed complete on: _____

I PROJECT INFORMATION

Permit/LUR Number: _____ Site Tax Account Number (s): R _____

Project/Site Street Address: _____

City/State/Zip: _____

Cross Streets: _____

Project Name (if applicable): _____

Applicant Information

Applicant Name: _____ Firm Name: _____

Applicant Street Address: _____

City/State/Zip: _____

Applicant Phone: _____

Applicant Email: _____

Owner Information

Owner Name *(if different than applicant)*: _____

Owner Street Address: _____

City/State/Zip: _____

Owner Phone: _____

Owner Email: _____

SPECIAL CIRCUMSTANCES

FOR DEVELOPMENT PROPOSALS ON PRIVATE PROPERTY OR R.O.W.

Engineer Name (if applicable) _____ Firm Name: _____

Engineer Street Address: _____

City/State/Zip: _____

Engineer Phone Number (s): _____

Engineer Email: _____

Architect Name (if applicable) _____ Firm Name: _____

Architect Street Address: _____

City/State/Zip: _____

Architect Phone Number (s): _____

Architect Email: _____

Describe the development or redevelopment project (*one set of plans must be submitted with this form*):

2 SPECIAL CIRCUMSTANCES INFORMATION

Request to pay an offsite management fee for a (*check one*): Portion All of the stormwater requirements

Explain in more detail why stormwater cannot be managed onsite:

SPECIAL CIRCUMSTANCES

FOR DEVELOPMENT PROPOSALS ON PRIVATE PROPERTY OR R.O.W.

3 STORMWATER MANAGEMENT

Describe your proposed stormwater management if this special circumstances request is approved.

Were offsite solutions considered?

Indicate the proposed infiltration and discharge method:

Infiltration onsite
(refer to Section 1.3.1 of the Manual) _____ %

Discharge offsite
(refer to Section 1.3.1 of the Manual) 100% _____ %

Overflow will be directed to *(check all that apply)*:

- | | |
|--|---|
| <input type="checkbox"/> Subsurface Facility | <input type="checkbox"/> Surface Water |
| <input type="checkbox"/> Stormwater Sewer | <input type="checkbox"/> Combined Sewer |

Describe the method and location:

SPECIAL CIRCUMSTANCES

FOR DEVELOPMENT PROPOSALS ON PRIVATE PROPERTY OR R.O.W.

For the following requirements, indicate the percentage of impervious area that you plan to meet onsite:

Flow Control 100% _____% N/A (explain below)
(refer to Section 1.3.2 of the Manual)

Pollution Reduction 100% _____% N/A (explain below)
(refer to Section 1.3.2 of the Manual)

If you checked N/A for either **Flow Control** or **Pollution Reduction**, please explain:

Signature: (Applicant) _____ **Date:** _____

Print Name: (Applicant) _____

Signature: (Owner, if different) _____ **Date:** _____

Print Name: (Owner) _____



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Form 3B

SPECIAL CIRCUMSTANCES

IMPROVEMENTS BY PUBLIC AGENCIES

This form is REQUIRED when applicant proposes to pay an offsite stormwater management fee.

Please fill this form out completely. For assistance completing it, consult with the Bureau of Environmental Services (BES) staff assigned to your project. The details of your special circumstance must appear in this application. Additional information may be included if pertinent to the item being considered. Refer to Appendix D.7 of the *2014 Stormwater Management Manual* for more information.

One (1) set of plans must be submitted along with this form. Plans are to clearly indicate the new or redeveloped impervious area and proposed facilities.

Information about the status of your application may be obtained by calling the BES Project Manager. Applicants will receive a copy of final decision via email.

(for official use only)

Received by: _____

Date: _____

Deemed complete on: _____

I PROJECT INFORMATION

BES Project Number: _____ Agency Project Number (s): _____

Location and Extent: _____

Agency Name: _____ Project Manager: _____

Street Address: _____

City/State/Zip: _____

Phone: _____

Engineer Name: _____ Firm Name (if applicable): _____

Engineer Street Address: _____

City/State/Zip: _____

Engineer Phone: _____

Engineer Email: _____

Describe the development or redevelopment project (*one set of plans must be submitted with this form*):

SPECIAL CIRCUMSTANCES

IMPROVEMENTS BY PUBLIC AGENCIES

2 SPECIAL CIRCUMSTANCES INFORMATION

Request to pay an offsite management fee for a *(check one)* Portion All of the stormwater requirements

Explain why stormwater cannot be managed onsite in more detail *(attach documents if you need more room)*:

3 STORMWATER MANAGEMENT

Describe your proposed stormwater management if this special circumstances request is approved.
Were offsite solutions considered?

SPECIAL CIRCUMSTANCES

IMPROVEMENTS BY PUBLIC AGENCIES

Indicate the proposed infiltration and discharge method:

Infiltration onsite _____ %
(refer to Section 1.3.1 of the Manual)

Discharge Offsite 100% _____ %
(refer to Section 1.3.1 of the Manual)

Overflow will be directed to (check all that apply):

- Subsurface Facility
- Surface Water
- Stormwater Sewer
- Combined Sewer

Describe the method and location:

For the following requirements, indicate the percentage of impervious area that you plan to meet onsite:

Flow Control 100% _____ % N/A (explain below)
(refer to Section 1.3.2 of the Manual)

Pollution Reduction 100% _____ % N/A (explain below)
(refer to Section 1.3.2 of the Manual)

If you checked N/A for either **Flow Control** or **Pollution Reduction**, please explain:

Signature: (Applicant) _____ **Date:** _____

Print Name: _____

APPENDIX D.8 DEWATERING SUBMITTAL GUIDE

Before applying for City permits, it is recommended the applicant contact the Department of Environmental Quality (DEQ) Land and Water Quality Divisions before plan submittal and obtain the DEQ's approval or denial of a private system management proposal. Depending on the disposal location for the discharge, the DEQ requires National Pollutant Discharge Elimination System (NPDES) permits and Water Pollution Control Facility (WPCF) permits.

Testing and water analysis are usually required as outlined in [Section 4.4](#) of Chapter 4. Obtaining the results of the analysis is highly recommended prior to submitting building permit applications. Submitting the analytical data prior to permit submittal will help the review team strive to meet the timeline goals of the project.

The City reviews for capacity in the City conveyance system for all discharges. Estimated discharge rates are required to be submitted with the building permit application. It is recommended the estimated discharge rates be submitted in a timely manner to help the review team strive to meet the timeline goals of the project.

When temporary or permanent dewatering is proposed, the minimum submittal requirements are as follows:

1. **Scaled Site Plans** – minimum scale is 1 inch to 10 feet, and at a minimum includes:
 - property lines
 - North arrow
 - footprints of structures, if any
 - surface drainage
 - location and details of groundwater or stormwater treatment system, if applicable
 - estimated groundwater flow rate of discharge during all phases of development, if groundwater will be encountered
 - dewatering plan if collecting/channelizing or impounding stormwater or encountering groundwater
 - DEQ 1200C general construction NPDES permit number
 - Erosion Control Plan sheets that match the DEQ 1200C submitted erosion control sheets
 - proposed discharge location
 - submeter – must meet submeter specifications
 - sampling location and structure details
 - utility plans, includes both private and public, existing and proposed storm and sanitary conveyance systems

Also, see Bureau of Development Services Site Plan checklist:
www.portlandonline.com/bds.

The site plan information should be located on the erosion/civil sheets of the plan set.

2. The **Dewatering Form 4** must be completely filled out and signed. It must be submitted with the appropriate accompanying application(s) (**Batch Discharge Application Form 5, Submeter Application Form 6, Long-Term Discharge Application Form 7**) as identified on the Dewatering form.
3. **Dewatering Plan:** If dewatering the site of stormwater or groundwater, the Submittal of the Erosion Control Plan and Dewatering Plan required by the DEQ 1200 C general construction permit is required to accompany the submittal package. If the development is not required to obtain a DEQ 1200C permit, the submittal of a dewatering plan is required to accompany the submittal package.
4. **Analytical data**, if applicable, for groundwater or stormwater. Analytical data is required if the site is contaminated. Please submit the Environmental Phase II, if available. The analytical data must include the chain-of-custody and detection limits.
5. When using a private onsite management facility for groundwater flows, the **O&M Form (Appendix D.2)** must be recorded with the appropriate county and submitted. This applies to permanent groundwater dischargers that have vegetated facilities or other permanent dewatering water quality treatment devices.



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FORM 4

SOURCE CONTROL DEWATERING FORM

All building permit applications for new construction, additions, or improvement that will perform below-grade excavation or discharge groundwater, or perform ground-disturbing activities during the winter months (Oct-May) must complete and submit this form with the documents requested within this form.

(for official use only)

Date Received: _____

Received By: _____

Approved Date: _____

Approved Receiving System: _____

Date of Request: _____ **Building Permit Application Number:** _____

SITE AND CONTACT INFORMATION

Property Site Address: _____

Name of Responsible Party: _____

Responsible Party Phone *(area code required)*: _____

Responsible Party Mailing Address: _____

City/State/Zip: _____

Name of Contractor: _____

Contractor Phone: _____ Contractor Email Address: _____

DISCHARGE INFORMATION

- | | YES | NO |
|--|--------------------------|--------------------------|
| 1 Will there be temporary dewatering and discharges of groundwater?
(Includes mixed groundwater and stormwater)

If YES , applicant must complete a submeter application and batch discharge application. Submit those applications with this form. | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Will there be permanent dewatering and discharges of groundwater?

If YES , applicant must complete a submeter application and long-term dewatering application, submit a recorded O&M Plan, if applicable, and include with this form. | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Will there be stormwater-only dewatering discharges during construction?
(applicable only if questions 1 and 2 are answered NO)

If YES , fill out the batch discharge application and include it with this form.
If NO , sign this form and submit with building plans. | <input type="checkbox"/> | <input type="checkbox"/> |

Project Discharge Rate: *(If the rate will change based on the depth of the excavation, list those depths with the projected rates.):*

Maximum Discharge Rate (gpm): _____

Duration of Discharge (dates from and to): From _____ To _____

If site conditions change and a discharge offsite is needed, you must call (503) 823-5320 or (503) 823-7180.

SOURCE CONTROL

DEWATERING FORM

Intended Receiving System for the Discharge? (check the following relevant box)

- City Storm City Sanitary City Combined Private Storm
 Private Infiltration Private UIC (Drywell) – City UIC prohibited

Other : _____

If proposing discharge to a private system, please ensure that the Department of Environmental Quality (DEQ) has been notified.

BES may require correspondence from DEQ stating they have been informed of the proposed discharge.

STATEMENT

By signing this form I acknowledge I am the responsible party for the above address and acknowledge that discharges off this site to a City conveyance system are regulated under City Code Chapters 17.39, 17.38, 17.36 and 17.34. By answering no to all three discharge questions, I certify there will be no channelized or pumped stormwater associated with construction activities or groundwater entering a City conveyance system on a permanent or temporary basis. I am also aware that sewer volume charges or system development charges may apply per chapter 17.36 for this discharge. If it is found there is an offsite discharge of either groundwater or stormwater as defined in this statement and the discharge has not been authorized, I am aware that penalties can be assessed per City Code Chapters 17.39 and 17.34. If site conditions change, and a discharge to a City system is needed, I will contact the City by calling 503-823-7122 or 503-823-7180 to obtain authorization to discharge.

Signature: _____

Printed Name: _____

Date Signed: _____



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FORM 5

SOURCE CONTROL BATCH DISCHARGE APPLICATION

This form is required for requests to discharge temporary groundwater or channelized / impounded or pumped stormwater associated with construction activities into a city conveyance system.

(for official use only)

Batch Discharge Number:

_____ - _____

Fee Required: Yes No

Fee Paid: Yes Check No. _____ No

Date of Request: _____ Building Permit Application Number: _____

REQUEST BY

Contact Name: _____

Company Name: _____

Company Address: _____

City/State/Zip : _____

Telephone: _____ Mobile Phone: _____

Email Address: _____

DISCHARGE GENERATOR

Facility Name: _____

Facility Address: _____

City/State/Zip: _____

Facility Contact: _____ Phone: _____

Description of Wastewater (if applicable, attach analytical data report): _____

Proposed Date(s) of Discharge: _____

Discharge Volume: _____ gallons per day Requested Rate of Discharge: _____ gallons per minute

Building Permit/ City Project Number: _____

City of Portland Project Manager (if applicable) : _____

Proposed Point of Disposal (attach diagram): _____

Signature: _____ Date: _____

Printed Name: _____



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FORM 6

SOURCE CONTROL
SUBMETER APPLICATION
CONSTRUCTION AND GROUNDWATER DISCHARGE

(for official use only)

Date Application Received (Month/Day/Year) : _____

Receiving Sewer Type: Sanitary/Combined Storm

Meter Type: Odometer Digital

Reviewed By: _____ Date: _____

Date of Request: _____ Building Permit Application Number: _____

PROJECT INFORMATION

Project Name: _____

Project Address: _____ City/State/Zip : _____

Contact Name: _____

Company Address: _____ City/State/Zip: _____

Mailing Address: _____ City/State/Zip: _____

Telephone: _____ Fax: _____

Anticipated Construction Start Date: _____ End Date: _____

Will ongoing dewatering activities occur onsite once construction is complete?

Yes (Complete Section 1 and 2 Below) No (Complete Section 1 Only)

BILLING INFORMATION

Have you opened a sewer account with Portland Utilities?

Yes Account No: _____ No Contact City (503-823-7856) to set up an account.

Section 1—Contact Information During Construction

Contact Person: _____

Company Name: _____

Billing Address: _____

City/State/Zip: _____

Telephone: _____ Fax: _____

Section 2—Contact Information Post-Construction

Contact Person: _____

Company Name: _____

Billing Address: _____

City/State/Zip: _____

Telephone: _____ Fax: _____

METER INFORMATION

City Code 17.36.050 – ALL meters shall register in cubic feet

Meter Serial Number	Meter Dials	Stationary Zeros	Install Read
No. 1 : _____	1: _____	1: _____	1: _____
No. 2 : _____	2: _____	2: _____	2: _____

Signature: _____ Date: _____

Printed Name: _____



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FORM 7

**SOURCE CONTROL
LONG-TERM DEWATERING APPLICATION**

This form is required for requests to permanently discharge groundwater into a city conveyance system.

(for official use only)

Permit or Authorization Number: _____

Fee Required: Yes No

Fee Paid: Yes Check No. _____ No

Date of Request: _____ Building Permit Application Number: _____

REQUEST BY

Contact Name: _____

Company Name: _____

Company Address: _____

City/State/Zip : _____

Telephone: _____ Mobile Phone: _____

Email Address: _____

DISCHARGE GENERATOR

Facility Name: _____

Facility Address: _____

City/State/Zip: _____

Facility Contact: _____ Phone: _____

Description of Discharge *(if applicable, attach analytical data report)*: _____

Discharge Volume: _____ gallons per day Requested Rate of Discharge: _____ gallons per minute

Building Permit/ City Project Number: _____

City of Portland Project Manager *(if applicable)*: _____

Proposed Point of Disposal *(attach diagram)*: _____

Signature: _____ Date: _____

Printed Name: _____



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FORM 8

SOURCE CONTROL SPECIAL CIRCUMSTANCES

This form is required if you are requesting alternatives to standard structural source controls, or exceptions per Chapter 4 of the City's Stormwater Management Manual, and other special requests you would like reviewed by the Pollution Prevention Division.

Special Circumstances will require an additional review process and may delay issuance of related building permits. If this request cannot be satisfied by the administrative review process, the appeals process, as described in Appendix D.9 of the Stormwater Management Manual, may be implemented by the applicant.

Date of Request: _____ **Building Permit Application Number:** _____

I FACILITY INFORMATION

Facility Name (if applicable): _____

Phone: _____

Facility Address or Location: _____

City/State/Zip: _____

Type of Business/Facility: _____

Facility Contact or Owner: _____

2 APPLICANT INFORMATION

Applicant Name: _____

Applicant Phone: _____ Applicant Email: _____

Applicant Mailing Address: _____

City/State/Zip: _____

Building Permit No. (if applicable): _____

3 REVIEW TYPE *(select one)*

Technical Review (Chapter 4, sections 4.5, 4.6, 4.7, 4.9, 4.12)

Advanced Technical and Engineering Review (Chapter 4, sections 4.4, 4.8, 4.10, 4.11, 4.13 and Chapter 1, section 1.3.3.)

Special Circumstances *(check appropriate box and provide a description)*

Request for an alternative source control method. Alternative description:

Request for review of EXCEPTION qualifications. Exception description:

Other. Description:

SOURCE CONTROL

SPECIAL CIRCUMSTANCES

4 THE FOLLOWING ITEMS NEED TO ACCOMPANY THIS FORM:

- A detail or vendor specification for each alternative source control.
- A site plan of the facility/property clearly identifying the location on the site that will be impacted by this special request. Existing and proposed utilities may need to be shown to ensure regulatory compliance with local, state and federal regulations. (A hand-drawn sketch, not to scale, is acceptable as long as it is legible.)
- A check made payable to the City of Portland for the application fee (see SWMM Fee Schedule) if this is an Advanced Technical and Engineering Review type.

Provide a brief explanation for your request *(use additional pages if necessary)*:

Signature: _____ Date: _____

Printed Name: _____

(for office use only)

Received by: _____ Date: _____

Fee Required: Yes No

Fee Paid: Yes Check No. _____ No

Approved Denied Other (see comments below)

City Comments:

Signature: _____ Date: _____

APPENDIX D.9 SOURCE CONTROL ADMINISTRATIVE REVIEWS AND APPEALS SUBMITTAL GUIDE

The administrative review and appeals process described in this appendix applies to requirements outlined in Section 1.3.3 (Additional Pollution Reduction Requirements for Vehicle and Equipment Traffic Areas) and Chapter 4 (Source Control Requirements). [Appendix D.7](#) provides a separate appeals process for the requirements of Chapters 1 through 3 (except Section 1.3.3).

Administrative Reviews

There are two types of source control administrative reviews: technical review and advanced technical and engineering review. The type of administrative review is determined by the criteria and process presented in this appendix.

Technical Review

If the proposed (alternative) source control meets the intent but not the letter of the requirements, or if some (not all) of the requirements may not be met because of zoning, property constraints, or other regulations, the applicant may request approval through a technical review process. This applies only to the following sections of Chapter 4:

[4.5: Solid Waste Storage Areas, Containers, and Trash Compactors](#)

[4.6: Material Transfer Areas/Loading Docks](#)

[4.7: Fuel Dispensing Facilities and Surrounding Traffic Areas](#)

[4.9: Equipment and/or Vehicle Washing Facilities](#)

[4.12: Covered and Uncovered Vehicle Parking Areas](#)

The applicant must demonstrate that the proposed system meets or exceeds the protection provided by the source control requirements.

The technical reviewer cannot evaluate a request for more than one exception from the same section in Chapter 4 (e.g., a request to eliminate both the sanitary drain and cover in a washing area) or a complete exception from the requirements. Those requests require an advanced technical and engineering review (see next page).

Technical staff will evaluate technical reviews under the direction of the Pollution Prevention Manager or designee. The applicant can initiate a technical review by completing the [Source Control Special Circumstances Form](#) located in this appendix and submitting site plans and additional materials that support the request. There is no fee for a technical review. Applicants are not allowed to attend the technical review meeting.

Advanced Technical and Engineering Review

If the proposed (alternative) source control meets the intent but not the letter of the requirements or does not qualify for the technical review outlined above, the applicant may request approval through an advanced technical and engineering review process. This applies only to the following sections of the manual:

- 1.3.3: Additional Pollution Reduction Requirements for Vehicle and Equipment Traffic Areas**
- 4.4: Site Dewatering and Discharges**
- 4.8: Above-Ground Storage of Liquid Materials, Including Tank Farms**
- 4.10: Exterior Storage and Processing of Bulk Materials**
- 4.11: Soil, Stormwater, and Groundwater Management for Development on Land with Suspected or Known Contamination or Adjacent to Contaminated Sites**
- 4.13: Water Reclaim and Reuse Systems**

The applicant must demonstrate that the proposed system meets or exceeds the source control requirements.

An Administrative Review Committee of City staff and the project's Bureau of Environmental Services (BES) Environmental Manager will evaluate advanced technical and engineering reviews. The applicant can initiate an advanced technical and engineering review by completing the **Source Control Special Circumstances Form 8** located in this appendix and submitting the application fee, site plans and additional materials, based on the request. The applicant may elect to attend the advanced technical and engineering review meeting.

How to Prepare an Application for a Technical Review/Advanced Technical and Engineering Review

A complete application consists of:

- completed **Source Control Special Circumstances Form 8**
- one complete set of plans.
- Source Control Special Circumstances fee
- supplemental information specific to the project circumstances

It is critical that information in the application be clear, concise, accurate, and completely written. Each application must stand on its own merit and will be reviewed based on the specific conditions of the project under consideration.

Form: The form consists of the following sections:

- 1. Facility Information.** Provide the facility's name and phone number, location, type of business, and contact person or owner.
- 2. Applicant Information.** Provide the applicant's name, address, phone number, and email address and the building permit number.
- 3. Review Type and Special Circumstance.** Specify the type of review (as outlined previously) and the request being made, along with the features of the project that make it a special circumstance.
- 4. Accompanying Items.** Provide the required accompanying items.

Plans: One complete set of plans (in addition to any plans submitted for permit processing) must accompany the application. Plans should provide sufficient information to detail the areas considered to be a special circumstance, as well as any areas that may be affected by or that may affect those circumstances.

Fee: A fee is required only for advanced technical and engineering review and must be submitted with the application. See the Sewer and Drainages Rates and Charges on the BES website for the current application fee.

Supplemental information (optional): Supplemental information (engineering analyses, test data, etc.) that will help clarify the request or make it easier to understand is a welcome accompaniment to the submittal.

How to File a Source Control Special Circumstances Application

The complete application must be received by 4:00 pm on Friday to be considered the following Wednesday. Applications will be screened for completeness. Submittal of an inaccurate or incomplete application may cause a delay in considering the request.

Technical review applications can be emailed to the appropriate source control plan reviewer or mailed or delivered to:

Bureau of Environmental Services
Attention: Source Control Special Circumstances
1900 SW 4th Ave, Suite 5000
Portland, OR 97201

Advanced technical and engineering review applications should be mailed or delivered to:

Bureau of Environmental Services
Attention: Source Control Special Circumstances
6543 N Burlington Ave
Portland, OR 97203

For questions about the source control application, call 503-823-7122.

Decisions

Administrative reviews will be completed within 14 business days of receipt of the submittal. The Administrative Review Committee will consist of City staff assigned by the project's Environmental Manager. An appointed staff member will review the submittal before calling a committee meeting to present a brief overview. Decisions are reached by consensus. The decisions will be recorded and mailed to the appellant within 5 business days of the decision.

Note: In the Columbia South Shore Well Field Wellhead Protection Area, some source control measures in Chapter 4 are protective measures that cross over to the Water Bureau's *Columbia South Shore Well Field Wellhead Protection Area Reference Manual* (June 25, 2003). Therefore, if an alternative or exception is allowed from the BES source control requirements, other or additional protective measures from the Water Bureau manual may apply. The manual can be found on the Water Bureau website at <http://www.portlandonline.com/water/index.cfm?c=29602>

Appeals

Appellants not satisfied with administrative review decisions may request in writing a public hearing by the BES Appeals Board, which comprises the Chief Engineer, Systems Development Manager, Pollution Prevention Services Manager, and Watershed Services Manager (or their designees). An outside member may also be included at the discretion of the Chief Engineer or Pollution Prevention Manager, depending on the nature of the appeal. The project's Environmental Manager will schedule a BES Appeals Board meeting to occur within 14 days of receipt of the written appeal application. The applicant will be notified of the meeting date, place, and time. Public notice of the appeal request is given. At least three members of the board must be present for the meeting to take place. A member of the Administrative Review Committee will present an overview of the request and the decision. The applicant, if present, may briefly address the board. Decisions are reached by a majority opinion of the board and are binding.

Applicants may appeal staff interpretation of the City Code and of adopted policies and procedures that guide the review of development proposals. Applicants may appeal any issue related to interpretation of the stormwater management policy (e.g., staff assessment of a site's stormwater management level or a permit denial). Applicants may **not** appeal the content or requirements of the policy, or technical parameters such as designs for oil/water separators, storms, coefficients, and other technical criteria through this appeal process.

How to Prepare an Application for Appeals Board Review

A complete appeal review application consists of:

- a written request to the project's Environmental Manager explaining the reason for the appeal
- a copy of the original Administrative Review Committee's determination
- Source Control Appeal fee
- one set of plans
- supplemental information specific to the project circumstances

It is critical for information provided in the appeal application to be clear, concise, accurate, and complete. Each appeal must stand on its own merit and will be reviewed based on the specific conditions of the project under consideration.

Written Request: The written request must include:

- information about the project, its location, the property owner, and the project team
- the decision being appealed
- a general summary of the proposed source control systems and approach, including how this approach will meet the intent of the requirements

Plans: One set of plans (in addition to any plans submitted for permit processing) must accompany appeal applications. Plans should provide sufficient information to detail the areas that are being appealed, as well as any areas that may be affected by or affect the appeal.

Fee: The Source Control Appeal Fee must be submitted with the application. See the Sewer and Drainages Rates and Charges on the BES website for the current Source Control Appeal Fee.

Supplemental information (optional): Supplemental information (engineering analyses, test data, etc.) that will help clarify the appeal is a welcome accompaniment to the submittal.

How to File an Appeal

The appeal application must be received by 4:00 pm on Friday to be heard the following Wednesday. Applications will be screened for completeness. Submittal of an inaccurate or incomplete application may cause a delay in hearing the appeal.

Application packets should be mailed or delivered to:

Bureau of Environmental Services
Attention: Source Control Appeals
6543 N Burlington Ave
Portland, OR 97203

For questions about the appeal application submittal, call 503-823-7122.

Decisions

Decisions will be recorded and mailed to the appellant within 5 business days.

Appendix E.1 STORMWATER POLLUTION REDUCTION STORM DEVELOPMENT METHODOLOGY

May 20, 2004

INTRODUCTION

The development of design storms for the sizing of stormwater pollution reduction (treatment) facilities generally involves a statistical analysis of local rainfall data, whereas a certain storm volume, duration, and peak intensity (or rainfall distribution) is identified to achieve a predetermined treatment volume goal. This treatment volume goal will vary from jurisdiction to jurisdiction, but is generally 80 to 95% of the average annual runoff. It can be linked to each jurisdiction's municipal stormwater discharge permit (MS4 permit) definition of MEP (maximum extent practicable) as it relates to the removal of pollutants from stormwater. This definition is rarely clear, but justification for the treatment volume goal generally involves social/political, economic, and environmental considerations. Without a firm grasp on the environmental consideration at this time (i.e. what percentage of average annual runoff volume needs to be treated such that the effluent water quality isn't harmful to fish or aquatic systems or groundwater resources?), the economic and social/political considerations are most widely used. An optimization model can be developed to determine a treatment volume that will result in the "biggest bang for the buck", or the point at which additional percentage points of annual treatment volume begin to require a disproportionately large increase in treatment facility size (see attached Figure 4). However the treatment volume goal is justified, the link to how treatment facilities are actually sized, and whether they end up achieving the intended goal, can be lost in translation.

TREATMENT VOLUME GOAL

Before the adoption of the September 2004 Stormwater Management Manual revision, Portland relied on a single treatment storm methodology, using a storm of 0.83 inches over 24 hours (NRCS Type 1A rainfall distribution). Used since 1994, the original intent of this design storm was to: 1) treat the "first-flush" or first 0.5 inches of runoff from all storm events and 2) pass 100% of 95% of all storm events through the treatment facility. There did not seem to be a direct environmental or economic justification for choosing 95% of storm events at the time. The justification was mainly social/political in that it sounded like a reasonable standard.

The City of Eugene uses a treatment goal of 80% of the average annual runoff, and the justification seems to be both social/political and economic, as an attempt was made to choose a treatment intensity at the "knee" of an intensity versus percentage of annual runoff volume treated curve. Gresham also uses 80% of the average annual runoff, with a similar justification (URS performed both studies). The Washington State Department of Ecology (and thus many other jurisdictions in Washington) uses 91%, and claims that an economic analysis was performed to justify the goal.

Rather than stating a treatment volume goal without a link to environmental or economic considerations, Portland has chosen to consider economic factors to provide the most "bang for the buck". From a social/political and environmental perspective it is also desirable to set a minimum value to this goal. A continuous simulation analysis, summarized as Figure 4, has been performed on multiple years of rainfall data to determine the percentage of average annual

rainfall that should be treated to maximize treatment efficiency. This analysis indicates a knee in the curve somewhere between 80 and 85 percent of the average annual volume. It may not be desirable to set the treatment goal directly at the economically optimal point, as stormwater treatment facilities do not always operate at their optimal design flow rates. Filters blind over time, or swales accumulate sediments that decrease the effective treatment flow rate through them. A margin of safety should be incorporated into the treatment volume goal. For these reasons, the City of Portland has chosen to set its treatment volume goal at 90% of the average annual rainfall volume.

TREATMENT STORM ANALYSIS

Over the past several years, Portland's 0.83" storm and justification have been questioned by other northwest jurisdictions. Agencies such as NOAA Fisheries are unsure which stormwater management regulations to use in the Pacific Northwest, as from an outside perspective the water quality storms and overall treatment goals used by various jurisdictions seem to vary dramatically. On the surface, Washington State DOE appears to use a treatment volume roughly double that of Portland's, although with the incorporation of the V_b/V_r (volume of basin / volume of runoff) factor they are basically equal (both result in the use of $2/3^{\text{rd}}$ of the 2-year, 24-hour storm volume). The City of Eugene uses 1.4"/24 hours, and the City of Gresham uses 1.2"/12 hours. Their treatment storm volumes appear greater than Portland's (1.4" and 1.2" compared with 0.83"), but with the incorporation of the V_b/V_r ratio, are actually less (1.4" and 1.2" compared with 1.66").

While the City of Eugene uses 1.4"/24 hours for volume based treatment facilities, they use the intensities of 0.13"/hr and 0.22"/hr (for off-line and on-line facilities, respectively) for flow rate based facilities. These dual sizing standards result in treatment of 80% of the average annual runoff for rate based facilities, and 100% treatment of the 80th percentile storm for volume based facilities. At this time it is unclear how the treatment of X% of the average annual runoff with rate based systems is comparable to treating the Xth percentile storm with volume based facilities. Rather than sizing to the Xth percentile storm for volume based facilities, it is recommended to use a different methodology (see discussion under Volume Based Treatment Systems). In either case, the need for separate rate and volume based facility sizing standards is clear if the treatment volume goal is to remain consistent.

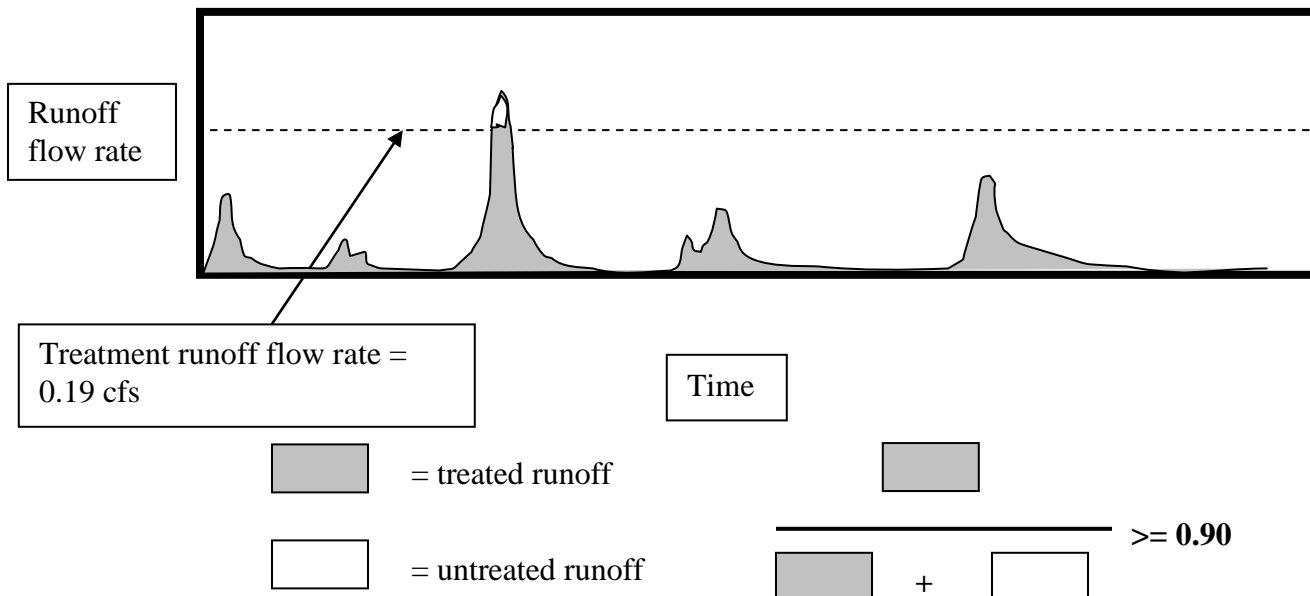
RATE BASED TREATMENT SYSTEMS

Stormwater treatment systems can be divided into two categories based on the methods used to size them: rate (or flow) and volume (or detention) based systems. Rate based systems used in Portland include swales, sand filters, and Stormfilter cartridge systems. Rate based systems remove pollutants with physical processes that settle or filter particulates as the flow passes through the system. The actual volume of the facility doesn't play a major role in the pollutant removal process, as there isn't a significant detention period for the water to remain in the system for any length of time.

A continuous simulation model can easily be used to determine the average annual runoff volume percentage treated by a rate based system. An assumption is that 100% of the runoff less than or equal to the peak treatment flow rate is fully treated, while the flows that exceed the peak treatment flow rate receive no treatment. Different assumptions can be made for on and off-line treatment systems. Likewise, an analysis of continuous rainfall intensity data can determine the average annual rainfall volume that is associated with a particular range of rainfall intensities. This type of analysis was completed for four different rain gages representing the different quadrants of Portland, and is summarized in Exhibit 5. 5, 10 and 20-minute intensities were analyzed to determine the intensities associated with the 90% rainfall volume goal. For 5-minute intensities, rainfall intensities of 0.19 inches per hour or less were determined to account for 90% of the average annual rainfall volume.

Eugene performed an analysis on 50 years of Eugene Airport rainfall data and also concluded that a rainfall intensity of 0.19"/hr would be needed to treat 90% of the average annual runoff volume.

Figure 1: Continuous simulation determination of 90% treatment flow rate



VOLUME BASED TREATMENT SYSTEMS

Unlike rate based systems, volume (or detention) based systems provide a significant storage volume for water to accumulate and be detained for a period of time. Pollutants are removed through physical (settlement) and/or biological processes. Volume based facilities used in Portland include wet ponds and wetlands. Unlike rate based systems, it is not easy to model volume based systems with continuous simulation models or rainfall analysis. Storm detention time needs to be factored into the model, and the mixing of water within the facility from one storm to the next creates a complex process that cannot be simulated accurately at this time. The currently accepted methodology used to size volume based treatment facilities (in Portland's SWMM, Gary Minton's *Stormwater Treatment* textbook, and many other jurisdictions) is to set the wet portion of the pond or wetland (permanent pool) equal to the full volume of runoff generated by the predetermined water quality storm, and apply a safety factor (Vb/Vr ratio).

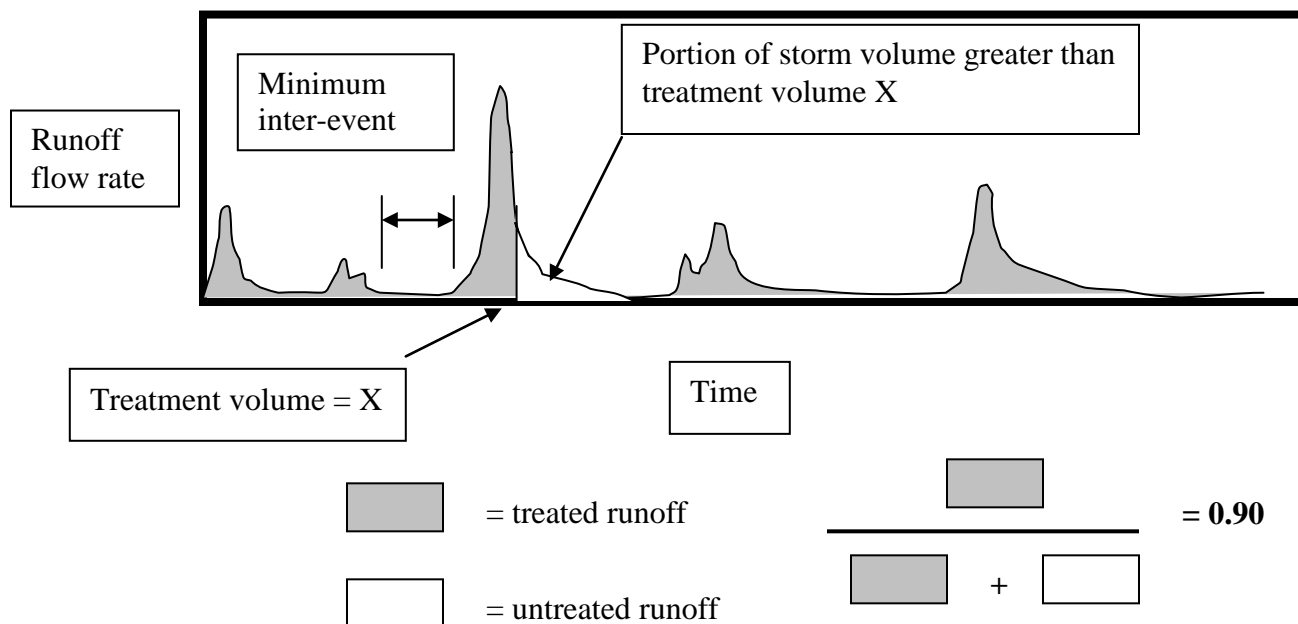
The volumes of most jurisdictions' water quality storms are set at their average annual treatment volume goal. For example, if the goal is to treat 80% of the average annual flow volume, the treatment storm depth is set to the 80% percentile storm. Eugene's goal is to treat 80% of the average annual volume. Their water quality storm is 1.4"/24 hours, which is equal to the 80th percentile storm. 80% of their storm events have a depth of 1.4 inches or less. In Portland's case, the 0.83" storm is not equal to the 90th percentile storm. An estimate would put it somewhere between the 60th and 65th percentile storm. This had been compensated for in the September 2002 Stormwater Management Manual by requiring volume-based facilities to use twice the volume of runoff generated by the 0.83" storm, or a Vb/Vr ratio of 2, but this factor should most likely be a function of soil type. In a recent version of *Stormwater Treatment Northwest* (Vol 9, No 4), Gary Minton and Roger Sutherland suggest that Pacific Northwest monitoring data indicates that a Vb/Vr ration of 1 may be adequate to achieve a TSS removal of 80%.

The City of Eugene has performed an analysis on 50 years of Eugene Airport rainfall data, and concluded that 90% of rainfall events are less than 2.4 inches in depth. Hourly rainfall intensity data was used in the analysis, storm depths of 0.01 inches or less were eliminated from the analysis, and a minimum inter-event time of 6 hours was used. A slight change in the modeling assumptions has a significant impact on the outcome. In the December 2003 issue of *Stormwater Treatment Northwest*, Gary Minton stated that an analysis he did of 24-hour rainfall data from the Seattle-Tacoma International Airport indicated that with a storm depth of about 1.35 inches, 90% of the runoff would be treated over time. The specific assumptions that were used in Dr. Minton's analysis are not known, but he was not using the 90th percentile Seattle-Tacoma storm. The Washington State Department of Ecology's Western Washington Stormwater Manual targets the capture of 91% of the average annual runoff for water quality, which they equate to two-thirds of a 2-year storm event (roughly 1.65 inches). Again, this storm event is not equivalent to the 91st percentile Western Washington storm.

A way of modeling the rainfall that could result in a clearer link to the treatment goal may be to determine the volume of a wet basin that will result in an average storm detention time of 24, 36, or 48 hours, depending on the anticipated TSS settling velocity in the vicinity of the site. The assumed inter-event time could be adjusted to ensure that enough detention time is provided between each storm event. An assumption could be made that storms with total volumes less than the "90% treatment storm" would receive 100% treatment. Storms with total volumes greater than the "90% treatment storm" would receive partial treatment- 100% treatment for the volume equal to the 90% storm volume, and 0 treatment for the volume greater than the 90%

storm volume. This may be overly conservative, as some very long, drawn-out storms (>24 hours) with total volumes greater than the designated treatment volume, may in fact receive greater than 24 hours of detention time for the entire storm, or 100% effective treatment.

Figure 2: Continuous simulation determination of 90% treatment volume



CONCLUSION AND RECOMMENDATION

The Portland water quality design storm shall be stated as a volume treatment goal- e.g. “90% of the average annual runoff shall be treated”, and will be clarified by stating the peak rainfall intensity, and total volume components. This achieves two things:

- 1) Volume based facilities and rate based facilities will be theoretically sized to achieve treatment of the same percentage of average annual runoff volume.
- 2) With the treatment rainfall intensity already given, the SBUH or other hydrograph based hydrologic analysis method won't be needed to size rate based treatment facilities, simplifying the design process. Rather, the Rational Method can be used to calculate the runoff treatment flow rate, based on the site's time of concentration.

To achieve the treatment of 90% of the average annual rainfall volume, rate based facilities must be sized to treat rainfall at 0.19 inches per hour for sites with 5-minute time of concentration or less, 0.16 inches per hour for sites with a 10-minute time of concentration, and 0.13 inches per hour for sites with a 20-minute time of concentration.

For volume based facilities, Portland shall continue to size wet basins using 0.83 inches of rainfall over 24 hours (NRCS Type 1A rainfall distribution), with a V_b/V_r ratio of 2. Further analysis will be completed during the September 2010 Stormwater Management Manual revision process.

There should no longer be the perception of extreme water quality design storm discrepancies between Portland's Stormwater Management Manual and the Department of Ecology's Stormwater Management Manual for Western Washington, answering questions raised by NOAA Fisheries during review of Portland's manual.

In the long term, as more is learned about the capabilities of stormwater treatment facilities and their relationship to environmental, economic, and social considerations, Portland's treatment storm characteristics shall be re-analyzed and compared with those of other local jurisdictions periodically to determine if changes are necessary.

Figure 3: Water Quality Design Storm Pacific Northwest Comparison

Jurisdiction	Average Annual Rainfall (inches)	Treatment Goal (average annual runoff %)	WQ Storm Volume (inches) Vr	Volume Based Facility Sizing Factor	WQ Storm Duration (hours)	WQ Storm Intensity for Off-Line Facilities (in/hr)	WQ Storm Intensity for On-Line Facilities (in/hr)
City Of Gresham	37.4	80	1.2	1	12	0.11	0.20
City Of Eugene	46.6	80	1.4	1	24	0.13	0.22
City Of Corvallis	43.2	90	0.90, 0.3 mean ann. storm for wet ponds	3	24	Not Specified: 0.90" storm peak 10 min intensity (per NRCS 1A dist.) = 0.29 in/hr	
Clean Water Services-Oregon	36	85	0.36	1	4	WQ Volume / 4 hours = 0.09 in/hr	
DOE Western Washington SWMM	Varies 36-46	91	"6-month storm volume"-Varies	1	24	91% treatment: varies by jurisdiction, HSPF continuous simulation, different on & off-line	
City Of Tacoma	37.6	91	"6-month storm volume"	1	24	91% treatment, HSPF continuous simulation, different on & off-line	
City Of Seattle	38.6	Not Clear	"Mean annual storm" = 0.47	1	24	6-month storm (64% of 2-year storm or 1.08 inches) peak 10-min intensity using SBUH = 0.35 in/hr	
King County-Washington	38.6	95	"Mean annual storm" = 0.47- 0.65	3	24	60% of 2-yr storm flow rate using KCRTS continuous simulation, or 64% of 2-yr storm flow rate using SBUH	
Oregon State DEQ	Varies 37 approx. average	Not Clear	2-year storm: 2.4" in Portland	1	24	Not Specified: 2.4" storm peak 10 min intensity (per NRCS 1A dist.) = 0.78 in/hr	
City Of Portland (1996-Sept. 2004)	36	Not Clear: 95% Claim	0.83	2	24	Not Specified: 0.83" storm peak 10 min intensity (per NRCS 1A dist.) = 0.27 in/hr	
City Of Portland (Recommended for Sept. 2004)	36	90	90% Ave. annual treatment volume*	1 if Vr = 1.7, 2 if Vr = 0.83	24	90% treatment as shown by continuous simulation (see Figure 5) = 0.19 to 0.13 in/hr, depending on site's ToFC	

* As defined by the recommended analysis of 24 years of Portland rainfall data, assuming a minimum inter-event time of 12 hours and minimum rainfall amount of 0.01 inches (see Figure 6). Portion of storm volume below specified treatment volume receives 100% treatment, portion of storm volume above specified treatment volume receives 0% treatment.

Figure 4: Rainfall Intensity Versus Percentage of Annual Rainfall Volume
 Rainfall data taken from each of four Portland quadrants, then averaged. 8/12/2004
Fancher

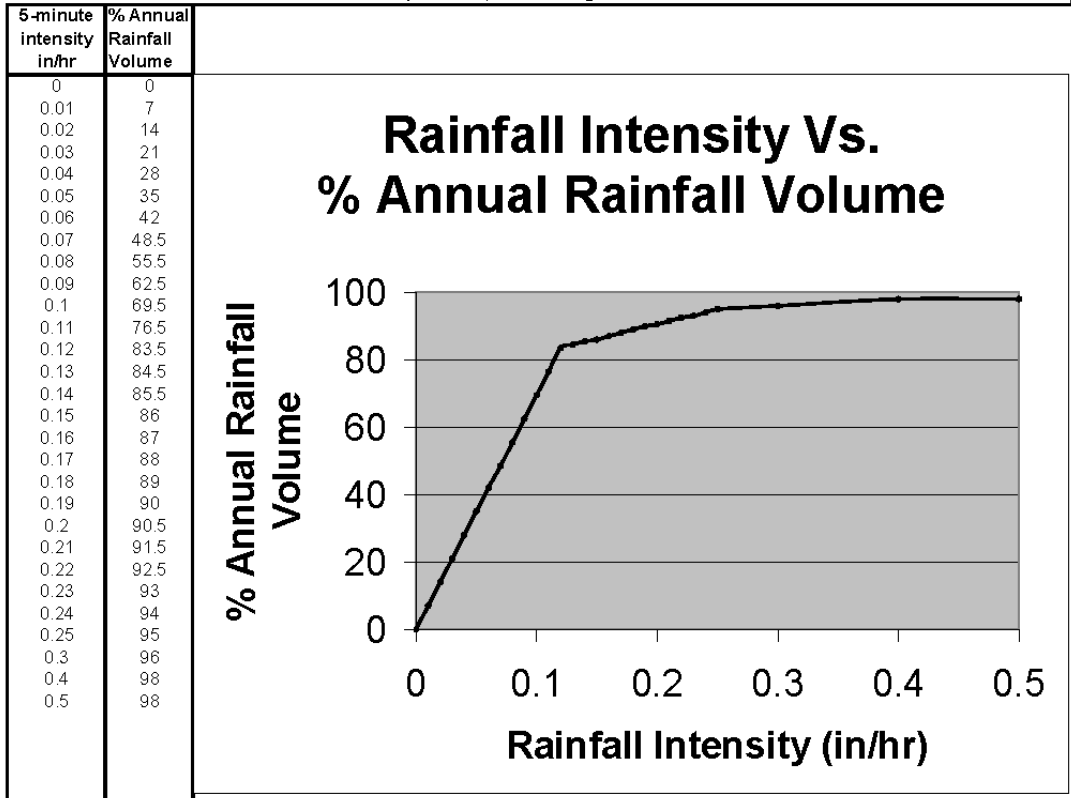


Figure 5: BES Stormwater Pollution Reduction Storm Analysis April 30, 2004

Intensities Resulting in Treatment of 90% of Rainfall Volume (in/hr)

Assumption: Percentage of rainfall less intense than specified intensity receives 100% treatment, percentage of rainfall more intense than specified intensity receives 0 treatment.

5 minute intensity NW	0.19	Average = 0.19 in/hr
5 minute intensity SW	0.19	
5 minute intensity SE	0.20	
5 minute intensity NE	0.19	
10 minute intensity NW	0.15	Average = 0.16 in/hr
10 minute intensity SW	0.15	
10 minute intensity SE	0.165	
10 minute intensity NE	0.16	
20 minute intensity NW	0.13	Average = 0.13 in/hr
20 minute intensity SW	0.12	
20 minute intensity SE	0.14	
20 minute intensity NE	0.135	

Figure 6: BES Stormwater Pollution Reduction Storm Analysis April 30, 2004

Volumes Resulting in Treatment of 90% of Rainfall Volume (in/hr)

Assumptions: Percentage of storm volume less than specified volume receives 100% treatment, percentage of storm volume greater than specified volume receives 0 treatment. Storm event is defined by a minimum of 0.01 inches of rainfall with a minimum inter-event period of 12 hours.

Place & Time	Total Rainfall (in)	Number of 12-hr Storms	Average Storm Size (in)	90% Treatment Storm Size (in)	Average 90% Treatment Storm Size (in)
NW 97-98	80.15	169	0.47	1.6	Average = 1.7 in
NW 90-91	65.5	163	0.40	1.3	
NW 83-84	83.9	202	0.42	1.9	
NW 80-81	95.37	247	0.39	2.1	
SW 97-98	73.85	176	0.42	1.4	Average = 1.7 in
SW 90-91	61.83	180	0.34	1.25	
SW 83-84	82.37	201	0.41	1.9	
SW 80-81	67.45	160	0.42	2.1	
SE 97-98	74.41	185	0.40	1.6	Average = 1.8 in
SE 90-91	63.71	184	0.35	1.3	
SE 83-84	82.75	192	0.43	2.0	
SE 80-81	65.41	163	0.40	2.3	
NE 97-98	74.00	180	0.41	1.4	Average = 1.7 in
NE 90-91	64.62	176	0.37	1.2	
NE 83-84	72.27	217	0.33	1.7	
NE 80-81	65.37	188	0.35	2.3	

Appendix: Local Pollution Reduction Storm Specifications

MEMORANDUM

TO: Greg Gescher, CP&P Supervisor
FROM: Bruce Moser, Project Manager
DATE: December 15, 2003
SUBJECT: Stormwater Quality Facility Design Storm

This memo reviews the stormwater quality design storm event for the City of Corvallis, and recommends using a NRCS Type 1A storm event of 0.9 inch in 24 hours.

Background

NPDES Phase 1 and 2 Stormwater regulations require agencies to implement stormwater quality treatment by the use of best management practices. NPDES Phase 1 and 2 Permits do not include a specific requirement for meeting a design storm and treatment level. The State of Oregon DEQ has not established stormwater quality criteria for NPDES Phase 1 for receiving streams that are not water quality limited (TMDLs have not been established).

The Corvallis SWMP includes the requirement to retrofit all existing stormwater outfalls with water quality facilities, and to require new development to install stormwater quality facilities. The SWMP includes Technical Memorandum No. 3, dated Nov. 10, 1999, in which Brown&Caldwell staff recommended that the City of Corvallis use 2/3's of the 2 year, 24 hour rainfall event, or 1.67 inches for 24 hours for the stormwater treatment design storm event. This level of treatment exceeds the level other agencies in Oregon are currently using.

Discussion

Agencies in Oregon that have NPDES stormwater permits have established differing criteria for the stormwater quality design storm event to capture and treat. Agencies have reviewed local rainfall data to determine the level of storm event to capture that represents a percentage of the total rainfall. This methodology is based on the assumption that the majority of pollutants are mobilized and transported prior to the peak of a large rainfall event. Several stormwater quality studies have substantiated this assumption.

The process for review of rainfall data involves review of historical rainfall events to establish a level of 24 hour precipitation that represents a given percentage of the total volume of rainfall. The City of Portland has established design criteria of 95% of total stormwater runoff is to be treated to remove 70% of Total Suspended Solids (TSS). The design storm to capture has been established as 0.83 inches in 24 hours, using NRCS Type 1A curve. The City of Eugene has established the design criteria of 90% of total stormwater runoff to be treated, but the TSS removal criteria is not mentioned. City of Eugene staff assume that a properly designed stormwater quality BMP will remove 80% of TSS. City of Eugene has established the design storm as 0.21 inches in one hour for on-line facilities, and 0.12 inches in one hour for off-line facilities. This is based on using 1.0 inch

in 24 hour as the design storm, using the NRCS Type 1A curve. The on-line facilities have a greater design storm based on the assumption that the effectiveness of an on-line facility will be impacted by flow when compared to an off-line facility.

Establishing Stormwater Quality Treatment Design Storm Event for Corvallis

The design rainfall event and treatment level is not currently identified under existing or anticipated regulatory requirements for the City of Corvallis. The SWMP does not specify treatment levels, but community input frequently referenced the water quality requirements that larger Oregon cities were meeting. A reasonable expectation for the implementation of stormwater quality facilities in Corvallis would be meeting community standards established in other Oregon cities that require stormwater treatment.

The stormwater receiving streams in Corvallis do not have established TMDL's, and none are anticipated to be implemented in the foreseeable future. In addition, the EPA Implementation Plan for Corvallis has not established a water quality treatment requirement with the exception of water temperature.

The methodology for developing the storm event for design treatment levels for the City of Corvallis uses review of historical daily rainfall over the last 42 years from the Hyslop rainfall gage (located 4 miles north of Corvallis) to determine the 24 hour event that would provide 90% capture for treatment. The 42 year historical data was tabulated to establish the average yearly rainfall of 43.20 inches. The amount of yearly rainfall that equals 90% of this yearly rainfall is 38.87 inches. The next step of the methodology was to establish a daily rainfall amount that collectively meets the 38.88 inches over the 42 years of data. The historical rainfall data was input to a spreadsheet "if, then" command to record all daily rainfall less than or equal to 0.9 inches. Rainfall greater than 0.9 inches was converted to 0.9 inches for the 24 hour period. The data was again tabulated and averaged to determine the yearly average rainfall amount, which was calculated to be 38.99 inches. This level nearly matches the target the yearly average for 90% rainfall of 38.88 inches.

The following table compares the annual average rainfall and design storm events for Portland, Corvallis, and Eugene.

City	Portland	Corvallis	Eugene
Annual Ave. Rainfall (inches)	37.07	43.20	50.90
24 Hr. Design Storm (inch/24 hour)	0.83	0.90	1.00

Recommendation

Based on review of other agency design storm methodology and review of local rainfall data, the stormwater quality design storm event for the City of Corvallis is recommended to be 0.9 inches in 24 hours, using the NRCS Type 1A distribution curve.

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Design & Construction Standards

Clean Water Services Design and Construction Standards are the administrative and technical requirements for the design of sanitary and surface water management systems which are used for residential or commercial development. The new Design and Construction Standards Resolution and Order 04-9 (R&O 04-9) became effective on March 1, 2004 and replaces the previous version of the standards.

Unless otherwise specifically identified in the land use conditions, all new development submittals within the District's boundaries--development within cities--should comply with R&O 04-9.

- [Click here to view or download Resolution and Order 04-9 \(PDF\).](#)
- [AutoCAD users may click here for PNG files.](#) A CD containing PDF files of the document is also available for purchase at Clean Water Services Permit Counter, 1000 Commercial Street, Suite 270, Hillsboro. The cost for the CD is \$100.
- [Click here for language changes January 6, 2004.](#)
- [You may also access Resolution and Order 03-11 effective January 1, 2005.](#)

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Last Site

**APPENDIX B:
WATER QUALITY & QUANTITY
FACILITY DESIGN**

1.0 GENERAL REQUIREMENTS FOR WATER QUALITY AND QUANTITY FACILITIES

1.1 Erosion Protection

- a. Inlets to water quality and quantity facilities shall be protected from erosive flows through the use of an energy dissipater or rip rap stilling basin of appropriate size based on flow velocities. Flow shall be evenly distributed across the treatment area.
- b. All exposed areas of water quality and quantity facilities shall be protected using coconut or jute matting. Coconut matting or high density jute matting (Geojute Plus or approved equal) shall be used in the treatment area of swales and below the WQV levels of ponds. Low density jute matting (EconoJute or approved equal) may be used on all other zones.

1.2 Vegetation

- a. Vegetation shall be in accordance with the Appendix D: Landscape Requirements.
- b. No invasive species shall be planted or permitted to remain within the facility which may affect its function, including, but not limited to the following:
 - 1. Himalayan blackberry (*Rubus discolor*)
 - 2. Reed canarygrass (*Phalaris arundinacea*)
 - 3. Teasel (*Dipsacus fullonum*)
 - 4. English Ivy (*Hedra helix*)
 - 5. Nightshade (*Solanum* sp.)
 - 6. Clematis (*Clematis ligusticifolia* and *C. vitifolia*)
 - 7. Cattail (*Typhus latifolia*)
 - 8. Thistle (*Cirsium arvense* and *C. vulgare*)
 - 9. Scotch Broom (*Cytisus scoparius*)

- 8) A vehicle turnaround shall be provided when the access road exceed 40' in length.

2.0 WATER QUALITY FACILITY DESIGN

This section presents methodology for designing water quality facilities.

2.1 Water Quality Volumes and Flows

(Reproduced from Appendix A: Hydrology and Hydraulics; Section 1)

The water quality storm is the storm-required by regulations to be treated. The storm defines both the volume and rate of runoff.

- a. Water Quality Storm: Total precipitation of 0.36 inches falling in 4 hours with a storm return period of 96 hours.
- b. Water quality volume (WQV) is the volume of water that is produced by the water quality storm.
- c. Water Quality Volume (WQV): 0.36-inches over 100-percent of the new impervious area.

$$\text{Water Quality Volume (cf)} = \frac{0.36(\text{in}) \times \text{Area (sf)}}{12 (\text{in/ft})}$$

- d. Water Quality Flow (WQF): The average design flow anticipated from the water quality storm.

$$\text{Water Quality Flow (cfs)} = \frac{\text{Water Quality Volume (cf)}}{14,400 \text{ Sec}}$$

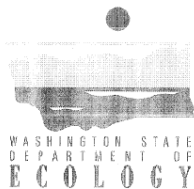
Or

$$\text{Water Quality Flow (cfs)} = \frac{0.36(\text{in}) \times \text{Area (sf)}}{12(\text{in/ft})(4 \text{ hr})(60 \text{ min/hr})(60 \text{ sec/min})}$$

2.2 Pretreatment

- a. Pretreatment Required

Sheet flow of impervious surfaces into water quality facilities will not be allowed without pretreatment. Incoming flows to the water quality facility must be pretreated using a water quality manhole in accordance with section 2.3 or other pre-treatment method as approved by the District/City. Other methods of pretreatment may include proprietary devices, filter



Stormwater Management Manual for Western Washington


- Volume I - Minimum Technical Requirements
and Site Planning**
- Volume II - Construction Stormwater Pollution Prevention**
- Volume III - Hydrologic Analysis and
Flow Control Design/BMPs**
- Volume IV - Source Control BMPs**
- Volume V - Runoff Treatment BMPs**

Prepared by:

Washington State Department of Ecology
Water Quality Program

August 2001

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(Replaces Publication Number 91-75)

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Chapter 4 - General Requirements for Stormwater Facilities

Note: All Figures in Chapter 4 are courtesy of King County

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.

4.1 Design Volume and Flow

4.1.1 Water Quality Design Storm Volume

The volume of runoff predicted from a 24-hour storm with a 6-month return frequency (a.k.a., 6-month, 24-hour storm).

Wetpool facilities are sized based upon use of the NRCS (formerly known as SCS) curve number equations in Chapter 2 of Volume III, for the 6-month, 24-hour storm. Treatment facilities sized by this simple runoff volume-based approach are the same size whether they precede detention, follow detention, or are integral with the detention facility (i.e., a combined detention and wetpool facility).

Unless amended to reflect local precipitation statistics, the 6-month, 24-hour precipitation amount may be assumed to be 72 percent of the 2-year, 24-hour amount. Precipitation estimates of the 6-month and 2-year, 24-hour storms for certain towns and cities are listed in Appendix I-B of Volume I. For other areas, interpolating between isopluvials for the 2-year, 24-hour precipitation and multiplying by 72% yields the appropriate storm size. Isopluvials for 2-year, 24-hour amounts for Western Washington are reprinted in Volume III.

4.1.2 Water Quality Design Flow Rate

Downstream of Detention Facilities: The full 2-year release rate from the detention facility.

An approved continuous runoff model should identify the 2-year return frequency 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% 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 TSS 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. Ecology encourages design of systems that engage a bypass at higher flow rates provided the reduction in pollutant loading exceeds that achieved with bypass at the water quality design flow rate.

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 a continuous runoff model is treated to the applicable performance goals (e.g., 80 percent TSS removal at the water quality design flow rate and 80 percent TSS 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, and the applicable annual average performance goal is likely to be met.

Estimation of Water Quality Design Flow Rate for Facilities Preceding Detention or when Detention Facilities are not required:

Until a continuous runoff model is available that identifies the water quality design flow rate directly, that flow rate shall be estimated using Table 4.1, and its following directions for use:

- Step 1 Determine whether to use the 15-minute time series or the 1-hour time series. At the time of publication, all BMPs except wetpool-types should use the 15-minute time series.
- Step 2 Determine the ratio corresponding with the effective impervious surface associated with the project. For effective impervious areas between two 5 percent increments displayed in the table, a straight line interpolation may be used, or use the higher 5 percent increment value.
- Step 3 Multiply the 2-year return frequency flow for the post-developed site, as predicted by an approved continuous runoff model, by the ratio determined above.

City of Tacoma Surface Water Management Manual

Volume I Minimum Technical Requirements and Site Planning

Prepared by:

Tacoma Public Works
Environmental Services

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related natural resources. Based upon gross level applications of continuous runoff modeling and assumptions concerning minimum flows needed to maintain beneficial uses, watersheds must retain the majority of their natural vegetation cover and soils, and developments must meet the Flow Control Minimum Requirement of this chapter, in order to avoid significant natural resource degradation in lowland streams.

The Roof Downspout Control BMPs described in Chapter 3 of Volume III, and the Dispersion and Soil Quality BMPs in Chapter 5 of Volume V are insufficient to prevent significant hydrologic disruptions and impacts to streams and their natural resources. Therefore, Ecology has suggested that the City and other local governments should look for opportunities to encourage and require additional BMPs such as those in Sections 5.2 through 5.4 of Volume V through updates to their site development standards and land use plans.

3.5.6 Minimum Requirement #6: Runoff Treatment

Thresholds

The following require construction of stormwater treatment facilities (see Table 3.1):

- Projects in which the total of effective pollution-generating impervious surface (PGIS) 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) is three-quarters (3/4) of an acre or more in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site.

Treatment Facility Sizing

Water Quality Design Storm Volume: The volume of runoff predicted from a 24-hour storm with a 6-month return frequency (a.k.a., 6-month, 24-hour storm). Wetpool facilities are sized based upon the volume of runoff predicted through use of the Natural Resource Conservation Service curve number equations in Chapter 2 of Volume III, for the 6-month, 24-hour storm.

Water Quality Design Flow Rate:

- *Preceding Detention Facilities or when Detention Facilities are not required:* The flow rate at or below which 91% of the runoff volume will be treated, as estimated by an approved continuous runoff model. Design criteria for treatment facilities are assigned to achieve the applicable performance goal at the water quality design flow rate.
- 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



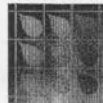
Stormwater Treatment Technical Requirements Manual

Issued November 2000



City of Seattle

Title 22.800 Stormwater, Grading & Drainage Control Code



Volume 1: Source Control Technical Requirements Manual

Volume 2: Construction Stormwater Control Technical Requirements Manual

Volume 3: Flow Control Technical Requirements Manual

Volume 4: Stormwater Treatment Technical Requirements Manual

2.2 Sequence of Facilities

concentration. TC depends on several factors, including ground slope, ground roughness, and distance of flow.

The Soil Conservation Service (SCS) runoff curve number to be used with the SBUH method shall be 98 for impervious surfaces, and 85 or greater for pervious surfaces unless one of the following conditions is met:

- A lower SCS curve number is justified for an area incorporating one or more site design options (see City of Seattle Directors' Rule for Flow Control), or
- A soil report by an experienced geotechnical/civil engineer indicates site soils are sufficiently pervious to allow a smaller SCS curve number to be used.

In the City of Seattle, the design storm used by the SBUH method for design of treatment facilities is based on a standard SCS Type 1A storm event hyetograph where, during the peak 10-minute period, 5.40% of the total rainfall occurs. Note that for design of flow control facilities, a modified SBUH method is used where 9.92% of the rainfall occurs during the ten-minute period at the peak of the storm event (see Appendix A).

Water Quality Design Flow

Flow-through treatment structures, such as biofiltration facilities, media filtration facilities, and oil control facilities, must be sized based on runoff from the 6-month, 24-hour storm event, which has a rainfall runoff volume of 1.08 inches. This value is based on the assumption that the 6-month, 24-hour storm volume is 64% of the volume of the 2-year, 24-hour storm event.⁴ For these types of facilities, water quality design flow, Q_{wq} , is equal to the peak flow (measured in cfs). Using the SBUH method, this peak occurs during the ten-minute interval between 470 and 480 minutes, when 5.40% of the total rainfall volume occurs. Additional information on the SBUH method is provided in Appendix A. For storage treatment facilities, such as wetponds, wetvaults, and stormwater wetlands, sizing is based on the volume of runoff from the mean annual storm event, which for Seattle is 0.47 inches. Additional information on determining water quality design flows for storage treatment facilities is contained in Chapter 4.

2.2 SEQUENCE OF FACILITIES

As specified in the water quality menus, where more than one water quality facility is used, the order is often prescribed. This is because the specific pollutant removal role of the second or third facility in a treatment train often assumes that significant solids settling has already occurred. For example, phosphorus removal using a two-facility treatment train relies on the second facility (sand filter) to remove a finer fraction of solids than those removed by the first facility.

There is a larger question, however, of whether water quality facilities should be placed upstream or downstream of detention facilities. In general, all water quality facilities may be installed upstream of detention facilities, although presettling basins are needed for sand filters and infiltration basins. Not all water quality facilities, however, can be located

⁴ Ref: Stormwater Management Manual for the Puget Sound Basin; The Technical Manual (1992). Publication 91-75, Washington State Department of Ecology, Olympia, Washington.

CHAPTER 6 WATER QUALITY DESIGN



KING COUNTY, WASHINGTON SURFACE WATER DESIGN MANUAL

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6.2 GENERAL REQUIREMENTS FOR WQ FACILITIES

This section presents the general requirements for water quality (WQ) facilities. When detail in the WQ designs is lacking, refer to Chapter 5 for guidance. In cases where requirements are extremely costly, a less expensive alternative that is functionally equivalent in terms of performance, environmental effects, health and safety, and maintenance can be sought through the adjustment process (see Section 1.4).

Use of Metal Materials

Galvanized metals leach zinc into the environment, especially in standing water situations. High zinc concentrations, sometimes in the range that can be toxic to aquatic life, have been observed in the region.¹² 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.

6.2.1 WATER QUALITY DESIGN FLOWS

Water Quality Design Flow

The water quality design flow is defined as follows:

- **Preceding detention: 60% of the developed two-year peak flow rate, as determined using the KCRTS model** with 15-minute time steps calibrated to site conditions (see Chapter 3). *Note: If KCRTS is not being used on a project, the WQ design flow may also be estimated using 64% of the 2-year 24-hour precipitation in the SBUH model.*¹³
- **Downstream of detention: The full 2-year release rate from the detention facility.**

The KCRTS model will typically be used to compute the WQ design flow. When examining the peak flow rates associated with various runoff volumes, it was found that detained flows and undetained flows must be described differently. However, unlike peak flows, the KCRTS model computation of volume of runoff is unaffected by whether or not the runoff is detained. Therefore, facilities such as wetponds, which are sized by a simple volume-based approach that does not route flows through a detention pond/facility, are the same size whether they precede or follow detention.

Note that facilities which are sized based on volume and which include routing of flows through a detention pond/facility, such as the detailed sand filter method, are significantly smaller when located downstream of detention, even though the same volume of water is treated in either situation. This is because the detention pond/facility routing sequence stores peaks within the pond and releases them at a slow rate, reducing the size of the sand filter pond subsequently needed (the volume needed to store the peaks need not be provided again in the sand filter pond).

Flow Volume to be Treated

When water quality treatment is required pursuant to the core and special requirements of this manual, it is intended that a minimum of **95% of the annual average runoff volume** in the (8 year) time series, as determined with the KCRTS model, be treated. Designs using the WQ design flow (as discussed above) will treat this minimum volume.

Treatable Flows

As stated in Chapter 1, only runoff from target pollution-generating surfaces must be treated using the water quality facility options indicated in the applicable water quality menu. These surfaces include both

¹² Finlayson, 1990. Unpublished data from reconnaissance of Metro Park and Ride lot stormwater characteristics.

¹³ The Department of Ecology WQ design flow is based on the flow predicted by the SBUH model for 64% of the 2-year 24-hour precipitation. This is roughly equivalent to the WQ design flows given here for the KCRTS model.

6.4.1.1 METHODS OF ANALYSIS

This section describes methods of analysis for the following two wetpond sizes:

- **Basic wetpond** (see below)
- **Large wetpond** (see page 6-73).

□ BASIC WETPOND

The primary design factor that determines a wetpond's **particulate removal efficiency** is the volume of the wetpool in relation to the volume of stormwater runoff from the *mean annual storm*.²⁵ The larger the wetpond volume in relation to the volume of runoff, the greater the potential for pollutant removal. 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 as follows:

- Dissipating energy at the inlet
- Providing a large length-to-width ratio
- Providing a broad surface for water exchange across cells rather than a constricted area.

Maximizing the flowpath between inlet and outlet, including the vertical path, also enhances treatment by increasing residence time.

Wetponds designed using the method below (with the volume = $3V$) and the required design criteria in Section 6.6.2.2 are expected to meet the Basic WQ menu goal of 80% TSS removal. The actual performance of a wetpond may vary, however, due to a number of factors, including design features, maintenance frequency, storm characteristics, pond algae dynamics, and waterfowl use.

Procedures for determining a wetpond's dimensions and volume are outlined below.

Step 1: Identify required wetpool volume factor (f). A basic wetpond requires a volume factor of 3. This means that the required wetpond volume is 3 times the volume of runoff V , from the mean annual storm (see Steps 2 and 3).

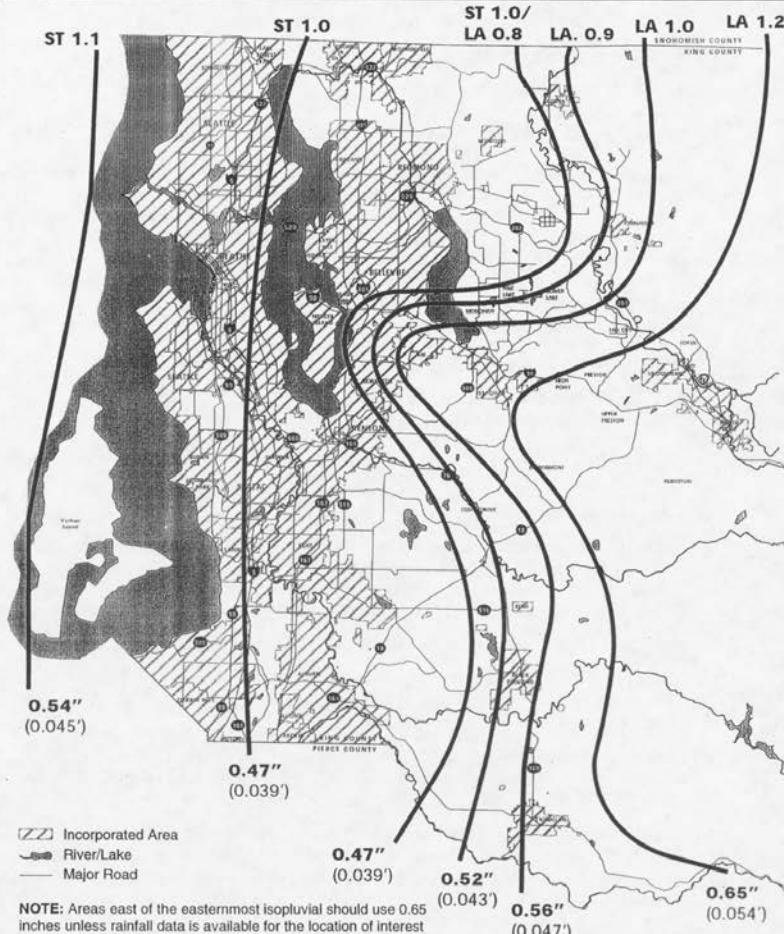
Step 2: Determine rainfall (R) for the mean annual storm. The rainfall for the mean annual storm R is obtained by locating the project site on Figure 6.4.1.A (p. 6-71) and interpolating between isopluvials. Convert to feet for use in Equation (6-13).

Step 3: Calculate runoff from the mean annual storm (V) for the developed site. The runoff volume V , is the amount of rainfall that runs off a particular set of land covers. To determine V , each portion of the wetpond tributary area is assigned to one of four cover types, each having a different runoff coefficient: impervious surface, till grass, till forest, or outwash.

- **Impervious surface** is a compacted surface, such as pavement, gravel, soil, or other hard surfaces, as well as open water bodies. *Note: The effective impervious computations given in Chapter 3, Table 3.2.2.D-E may be used, unless more detailed information is available-if desired.*
- **Till grass** is post-development grass or landscaped area and onsite forested land on till soil that are not permanently in sensitive area buffers or covenants. *Till* is soil that does not drain readily and, as a

²⁵ The *mean annual storm* is a statistically derived rainfall event defined by the U.S. Environmental Protection Agency in "Results of the Nationwide Urban Runoff Program", 1986. It is defined as the annual rainfall divided by the number of storm events in the year. The NURP studies refer to pond sizing using a V_p/V_r ratio: the ratio of the pond volume V_p to the volume of runoff from the mean annual storm V_r . This is equivalent to using a volume factor f times V_r .

FIGURE 6.4.1.A PRECIPITATION FOR MEAN ANNUAL STORM IN INCHES (FEET)



NOTE: Areas east of the easternmost isopleth should use 0.65 inches unless rainfall data is available for the location of interest

²⁴ The mean annual storm is a conceptual storm found by dividing the annual precipitation by the total number of storm events per year

result, generates large amounts of runoff. For this application, till soil types include Buckley and bedrock soils, and alluvial and outwash soils that have a seasonally high water table or are underlain at a shallow depth (less than 5 feet) by glacial till. U.S. Soil Conservation Service (SCS) hydrologic soil groups that are classified as till soils include a few B, most C, and all D soils. See Chapter 3 for classification of specific SCS soil types.

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F.2 Infiltration Testing

F.3 Topsoil Specification

F.4 Plant Lists

APPENDIX F.1 DEPTH TO GROUNDWATER INVESTIGATION

Several areas within the City of Portland have known shallow groundwater. Within areas of known or suspected shallow groundwater, additional information about the depth to groundwater (DTW) must be collected to ensure that the proposed underground injection control (UIC) system meets minimum separation distances between the bottom of a UIC and seasonal high groundwater, as required by Oregon Department of Environmental Quality (DEQ) guidelines for private UICs or by the requirements of the water pollution control facility (WPCF) permit for publicly owned UICs that DEQ issued to the City of Portland on June 1, 2005 and modified in 2010. The minimum separation distance between the bottom of the UIC and seasonal high groundwater is 5 feet.

When a public or private¹ UIC is proposed within the regulated area, a site-specific investigation is required to determine the seasonal high depth to groundwater. DTW investigations are required for areas where the estimated depth to seasonal high groundwater contour is less than 50 feet. The City of Portland derived this map from the *Estimation of Depth to Ground Water and Configuration of the Water Table in the Portland, Oregon Area*, prepared by the United States Geological Survey (USGS) (<http://pubs.usgs.gov/sir/2008/5059/>). This information is available online in two locations:

- Through www.PortlandMaps.com, within the Stormwater Management mapping under the Environmental category for any selected location; and
- Through USGS mapping at http://or.water.usgs.gov/projs_dir/puz/.

Depth to Groundwater Investigation Requirements

The DTW investigation requires sufficient time to plan for and perform the necessary steps to collect a reliable measurement, including obtaining permits, performing utility locates, borings, piezometer/well installation, collection of water level measurements, and decommissioning of the monitoring well. The DTW investigation, including design, installation oversight, water measurements, and decommissioning, must be performed by an Oregon licensed registered geologist (RG), certified engineering geologist (CEG), or professional engineer (PE) with experience in hydrogeologic investigations and well design and installation; the investigation may include either the installation of a temporary piezometer(s) or groundwater monitoring well(s). The qualified professional is responsible for developing an appropriate scope of work to document the DTW, including:

- Determining the number and location(s) of the DTW measurements needed to address project objectives. (It is recommended, but not required, to have each piezometer or well location surveyed to a datum.)
- Determining the appropriate method for obtaining DTW measurements (e.g., piezometer or monitoring well).

¹ The requirements in this document do not apply to UICs specifically excluded by DEQ (e.g., privately owned residential footing and roof drains).

- Determining the appropriate depth of the boring(s). (Boring depth must be a minimum of 20 feet deeper than the proposed UIC depth.)
- Observing and describing soils encountered during drilling.
- Developing an appropriate well or piezometer design.
- Ensuring that construction and abandonment of piezometer or monitoring well complies with Oregon Administration Rules 690-240.
- Obtaining depth to groundwater measurements.²
- Estimating the measured DTW to be representative of the “groundwater seasonal high,” based on available data and best professional judgment.
- Documenting the procedures used and the results of the DTW investigation.
- Submitting a signed and stamped DTW investigation report.

To the extent practicable, DTW measurements should be obtained in the immediate vicinity (less than or equal to 75 feet) of the proposed UIC. If high-quality shallow groundwater level data is available (e.g., piezometer, monitoring well, drinking water well, irrigation well) within 200 feet of the proposed UIC location, this data may be considered in lieu of site-specific data.

Requirements and Guidelines for Obtaining DTW Measurements

Using the following guidelines to collect and evaluate site-specific groundwater information will ensure that new UICs will meet the vertical separation requirement.

Permitting

Piezometers, monitoring wells, temporary wells, geotechnical holes, and other holes must be drilled, installed, and abandoned in accordance with Oregon Administrative Rules (OAR) 690-240 *Construction, Maintenance, Alteration, Conversion and Abandonment of Monitoring Wells, Geotechnical Holes and Other Holes in Oregon*. These rules require the licensed well constructor to provide notice and pay the associated fee(s) to the Oregon Water Resources Department (OWRD) prior to drilling or abandoning any new monitoring well, piezometer, or geotechnical hole. Additional information is available on OWRD’s website: www.wrd.state.or.us.

Utility Clearance

Boring locations must be checked for underground utilities prior to any drilling activity. The Oregon Utility Notification Center’s (OUNC) one-call number provides a free service to home owners, contractors, and other excavators, informing them of any buried facilities in the area

² If groundwater is not encountered (e.g., saturated conditions are not observed, no water seeps are observed) within 20 feet of the proposed bottom of the UIC, a piezometer or monitoring well does not need to be installed.

where they are planning to dig. The OUNC must be called two business days prior to digging. To request locates for proposed excavation, call the One-Call Center at 1-800-332-2344.

Piezometer/Well Design

The piezometer or well design should include the following, where necessary:

- Total boring depth.
- Appropriate well screen interval.
- Piezometer or well materials (e.g., well screen, filter pack, casing). Factory-fabricated prepacked wells screens may be used. New or reused equipment must be thoroughly decontaminated by steam cleaning or high-pressure hot water washing unless delivered in packaging with documentation of proper decontamination.
- Appropriate annular seal.
- Appropriate surface seal and security casing.

Piezometer/Well Borehole Drilling and Installation

Continuous soil sampling is recommended to allow detailed characterization of subsurface soil and identification of groundwater depth. The RG, CEG, or PE must prepare and submit a detailed boring log of subsurface conditions. Soil boring logs should be in accordance with the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)* (ASTM D2488-00). Borings must be advanced to the groundwater level, or to a minimum of 20 feet below the proposed total depth of the UIC or 10 feet below a proposed UIC of 5 feet or less. If water is encountered in the boring, it must be noted on the drilling log.

The appropriate drilling method should be selected by the RG, CEG, or PE in conjunction with the driller, based on anticipated site-specific geologic and hydrogeologic conditions, anticipated boring depth, site accessibility, availability of equipment, and piezometer/well design. All equipment placed into the boreholes must be properly decontaminated prior to use.

Any investigation-derived material (e.g., soil cutting, water, personal protective gear) generated during drilling activities must be properly contained, characterized, and disposed in accordance with applicable state and federal regulations. Soil and water disposal must be documented.

Depth to Water Measurements

Following piezometer/well installation, water levels must be allowed to equilibrate for a minimum of 24 hours in fine-grained soils. After the water level has stabilized, an electronic water level indicator or a weighed tape should be used to measure the depth to water. Measurements should be made relative to ground surface and to the nearest 1/8 inch (~0.01 feet). The observer must make at a minimum two measurements over a period of about 15 minutes to show the results are static.

Estimating Depth to Seasonal High Groundwater

The site-specific DTW measurement must be used to estimate the depth to seasonal high groundwater. Seasonal water-table fluctuations were evaluated in the draft *Estimation of Depth to Ground Water and Configuration of the Water Table in the Portland, Oregon Area* report, prepared by the USGS and used to determine the seasonal correction factor (SCF). The SCF represents a long-term measurement of the seasonal water-table fluctuations. The SCF was set at

6 feet, using the USGS estimated mean of observed seasonal water table fluctuations for the unconsolidated sedimentary aquifer. To correct for seasonal variation, the SCF used to estimate depth to seasonal high groundwater is applied during periods of seasonal groundwater lows (late fall) and water level transition (summer and winter months). In March through May (seasonal high groundwater), no correction is added.

To correct site-specific DTW measurements to seasonal high DTW estimates, the following correction should be made:

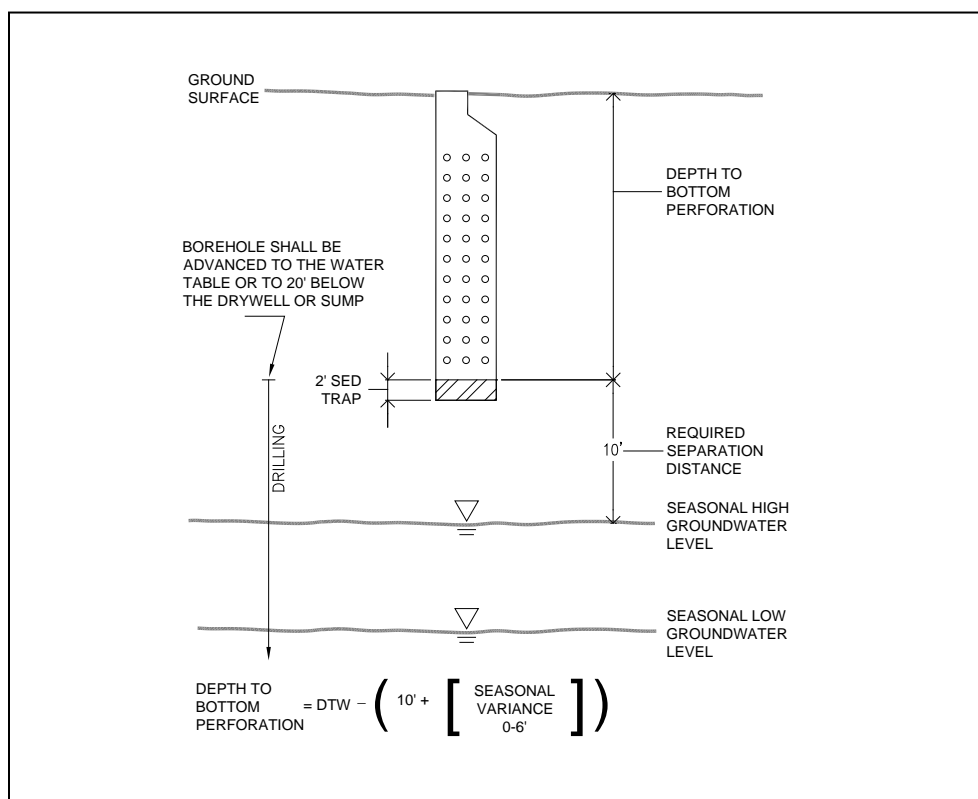
$$DTW_{SH} = DTW_{SS} - SCF$$

Where: DTW_{SH} = Estimated seasonal high depth to groundwater (feet)
 DTW_{SS} = Measured site-specific depth to groundwater (time specific)
SCF = Seasonal correction factor
6 feet for measurements June through February
0 feet for measurements in March through May

If water is not encountered in the soil boring, advanced 20 feet below the proposed UIC completion depth, it must be documented on the boring log and in the investigation report. In this case, the depth to water is assumed to be outside the range of seasonal fluctuation; the minimum required separation distance for the proposed bottom of the UIC to seasonal high groundwater is therefore met by default. The borehole may be decommissioned immediately, in accordance with OAR 690-240.

Exhibit F.1-2 illustrates the depth to groundwater investigation.

Exhibit F.1 -2: Depth to Groundwater Investigation



Decommissioning

Borings, piezometers, temporary wells, and wells must be abandoned in accordance with OAR 690-240. Specific decommissioning procedures must be determined by a licensed driller and the registered geologist or professional engineer.

Minimum Requirements for DTW Investigation Report

The DTW Investigation report must contain, but is not limited to:

- A copy of the State of Oregon Monitoring Well Log Report or Geotechnical Hole Report, as appropriate.
- A map showing the final location of each well or piezometer and tax lot boundaries.
- Latitude and longitude of each well or piezometer.
- Description of field procedures (drilling method, sampling method, development method, depth to groundwater measurements, etc.).
- Measured water level to the nearest hundredth of a foot.
- Detailed soils log prepared by, or under the direct supervision of, the RG, CEG, or PE.
- Construction diagram for each well/piezometer.
- Summary of groundwater depth measurements (depth measured, elevation, date, time).
- Discussion/basis for estimation of seasonal high depth to groundwater measurement.
- Construction and investigation reports stamped and signed by the RG, CEG, or PE.

Depth to Groundwater Investigation Report Submittal and Usage

Two copies of the OWRD well or piezometer construction report and the signed and stamped DTW investigation report must be submitted with the development permit application to the City and to DEQ with the UIC rule authorization application, which can be obtained at

<http://www.deq.state.or.us/wq/uic/forms.htm>.

The corrected site-specific depth to seasonal high groundwater must be used to verify that the proposed UIC will meet the separation distances set by DEQ to obtain rule authorization for private UICs or ensure compliance under the City's WPCF permit. If separation distances cannot be met, an alternative design must be developed that meets separation distance requirements.

APPENDIX F.2 INFILTRATION TESTING

To properly size and locate stormwater management facilities, it is necessary to characterize the soil infiltration conditions at the location of the proposed facility. All projects that propose onsite infiltration must evaluate existing site conditions and determine:

1. If the infiltration rate is adequate to support the proposed stormwater management facility (satisfied through the Simplified Approach Infiltration Test).
- or
2. The design infiltration rate prior to facility design (satisfied through Presumptive or Performance infiltration testing conducted by a qualified professional).

The following sections provide the approved standard infiltration testing specifications.

Simplified Approach Infiltration Test Requirements

The Simplified Approach provides a method that can be conducted by a nonprofessional for design of simple stormwater systems on small projects. This method, the Simplified Approach Infiltration Test, is applicable only to projects on private property with less than 10,000 square feet of new or redeveloped impervious area (see [Section 2.2.1](#)). The results of infiltration testing must be documented on the Simplified Approach Form (see [Appendix D.3](#)).

On a site with steep slopes or shallow groundwater, BES may require a geotechnical report in order to evaluate the suitability of the proposed facility and its location. BES staff may also require an encased falling head or a double-ring infiltrometer infiltration test under the Presumptive and Performance Infiltration Testing Requirements in order to verify that the Simplified Approach is appropriate.

The Simplified Approach Infiltration Test cannot be used to find a design infiltration rate. The intent of the Simplified Approach Infiltration Test is to determine whether or not the local infiltration rate is adequate (2 inches/hour or greater) for the predesigned stormwater facilities described in [Section 2.3](#) (infiltration swales, basins, planters, drywells, and trenches). The Simplified Approach Infiltration Test does not need to be conducted by a licensed professional.

Simplified Approach Infiltration Test Procedure

1. A Simplified Approach Infiltration Test is required where the facility is proposed or within the immediate vicinity. The test must be conducted in the twenty-four months prior to the date the plans are submitted for review.
2. Excavate a test hole to the depth of the bottom of the infiltration system. The test hole can be excavated with small excavation equipment or by hand using a shovel, auger, or post hole digger. If a layer hard enough to prevent further excavation is encountered, or if noticeable moisture/water is encountered in the soil, stop and measure this depth from the surface and record it on the Simplified Approach Form. Proceed with the test at this depth.
3. Fill the hole with water to a height of about 6 inches from the bottom of the hole, and record the exact time it takes for the water to draw down to the bottom of the test pit. Check the water level at regular intervals (every 1 minute for fast-draining soils to every 10 minutes for slower-draining soils) for a minimum of 1 hour or until all of the water has infiltrated. Record the distance the water has dropped from the top edge of the hole for each time interval.
4. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to accurately portray the soil's ability to infiltrate at different levels of saturation. The **third test** provides the best measure of the infiltration rate at saturated conditions.
5. For each test pit required, submit all three testing results with the date, duration, drop in water height, and conversion into inches per hour.

If the results of the Simplified Approach Infiltration Test show an average infiltration rate greater than 2.0 inches per hour, the applicant can proceed with Simplified Approach facility design (where applicable). The Simplified Approach requires one infiltration test for every proposed facility. If the applicant would like to use an infiltration rate for design purposes, a Presumptive or Performance Infiltration Test must be conducted.

Presumptive and Performance Infiltration Test Requirements

The Presumptive Approach ([Section 2.2.2](#)) or Performance Approach ([Section 2.2.3](#)) must be used for all public and private developments where the Simplified Approach is not applicable. The qualified professional must exercise judgment in the selection of the infiltration test method. The three infiltration testing methods used to determine a design infiltration rate are:

- Open pit falling head (see [page F.2-4](#))
- Encased falling head (see [page F.2-6](#))
- Double-ring infiltrometer (see [page F.2-7](#))

Where satisfactory data from adjacent areas using similar infiltration testing methods is available that demonstrates infiltration testing is not necessary, the infiltration testing requirement may be waived by the BES design reviewer. A recommendation for forgoing infiltration testing must be submitted in a report which includes supporting data and is stamped and signed by the project geotechnical engineer or project geologist.

Testing Criteria

1. Testing must be conducted or overseen by a qualified professional. This professional must be a Professional Engineer (PE) or Registered Geologist (RG) licensed in the State of Oregon.
2. The depth of the test must correspond to the facility depth. If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within 4 feet of the bottom of the planned infiltration system, the testing should be conducted within that confining layer. Based on DEQ requirements and conformance with [Appendix F.1](#), the boring log must be continued to a depth adequate to show separation between the bottom of the infiltration facility and the seasonal high groundwater level. (The boring depth will vary, based on facility depth.) See [Appendix F.1](#) for further details on depth to water investigations.
3. Tests must be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location. The test must be conducted in the twenty-four months prior to the date the plans were submitted for review.
4. Infiltration testing should not be conducted in engineered or undocumented fill.

Minimum Number of Required Tests

Land Division

- A total of two infiltration tests for every 10,000 square feet of lot area available for new or redevelopment.
- An additional test for every 10,000 square feet of lot area available for new or redevelopment.
- At least one test for any potential street facility.
- One test for every 100 lineal feet of infiltration facility.
- No more than five tests are required per development (at the discretion of the qualified professional assessing the site, as well as the City of Portland).

Tests performed for a proposed land division can be used at the building permit stage as long as the results of the test are submitted with the separate applications and were conducted within twenty-four months prior to the date the plans were submitted for review.

Building Permits

- The Simplified Approach requires one infiltration test for every proposed facility.
- The Presumptive and Performance Approaches:
 - Require at least one test for any proposed street facility.
 - Require one test for every 100 lineal feet of proposed infiltration facility.
 - The number of tests is at the discretion of the qualified professional assessing the site, as well as the City of Portland.

Where multiple types of facilities are used, it is likely that multiple tests will be necessary, since an infiltration test can test only a single location. It is highly recommended to conduct an infiltration test at each stratum used. BES staff may require additional testing. If additional testing is required during plan review, the applicant must provide 24-hours notice to BES staff and specify the time and location that the test will take place.

Factors of Safety

Exhibit F.2-1 lists the minimum allowable factors of safety applied to field obtained infiltration rates for use in stormwater system design. To obtain the infiltration rate used in design, divide the infiltration rate measured in the field by the factor of safety. The factor of safety used in design should be chosen by collaboration between the geotechnical engineer or geologist overseeing the infiltration testing and the civil engineer designing the stormwater management system. Determination of the factor of

safety should include consideration of project specific conditions such as soil variability, testing methods, consequences of system failure, complexity of proposed construction, etc. Note that the maximum allowable design infiltration rate is 20 inches per hour.

Exhibit F.2-1: Minimum Allowable Factor of Safety

Test Method	Minimum Required Factor of Safety
Encased Falling Head	2
Open Pit Falling Head	2
Double-Ring Infiltrometer	Public Facilities: 1 Private Facilities: 2

Presumptive & Performance Infiltration Testing Instructions

Open Pit Falling Head Procedure

The open pit falling head procedure is performed in an open excavation and therefore is a test of the combination of vertical and lateral infiltration.

1. Excavate a hole with bottom dimensions of approximately 2 feet wide by 2 feet deep into the native soil to the elevation of the proposed facility bottom. The test can be conducted in a machine-excavated pit or a hand-dug pit using a shovel, post hole digger, or hand auger. If smooth augering tools or a smooth excavation bucket are used, scratch the sides and bottom of the hole with a sharp pointed instrument, and remove the loose material from the bottom of the test hole.
2. Fill the hole with clean water a minimum of 12 inches, and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to presoak the native material..
3. Determine how the water level will be accurately measured. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit are convenient reference points. The tester and excavator should conduct all testing in accordance with OSHA regulations.
4. After the presaturation period required by #2 above, refill the hole with water to 12 inches and record the draw-down time. Alternative water head heights may be used for testing provided the presaturation height is adjusted accordingly and the water head height used in infiltration testing is no more than 50 percent of

water head height in the proposed stormwater system during the design storm event. Measure the water level to the nearest 0.01 foot ($\frac{1}{8}$ inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower draining soils) or until all of the water has drained. In faster draining soils (sands and gravels), it may be necessary to shorten the measurement interval in order to obtain a well defined infiltration rate curve. Constant head tests may be substituted for falling head tests at the discretion of the professional overseeing the infiltration testing.

5. Repeat the infiltration test until the change in measured infiltration rate between two successive trials is no more than 10 percent. The trial should be discounted if the infiltration rate between successive trials increases. At least three trials must be conducted. After each trial, the water level must be readjusted to the 12 inch level. Enter results into the data table (See [Exhibits F.2-3](#) and [F.2-4](#)).
6. The average infiltration rate over the last trial should be used to calculate the design infiltration rate without a factor of safety applied. Alternatively, the infiltration rate measured over the range of water head applicable to the project stormwater system design may be used at the discretion of the professional overseeing the testing. The final rate must be reported in inches per hour.
7. Upon completion of the testing, the excavation must be backfilled.
8. For very rapidly-draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, conduct the test in the following manner:
 - A. Approximate the area over which the water is infiltrating.
 - B. Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.
 - C. Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches).

Note that a maximum infiltration rate of 20 inches per hour can be used in stormwater system design.

Encased Falling Head Test

The encased falling head procedure is performed with a 6-inch casing that is embedded approximately 6 inches into the native soil. The goal of this field test is to evaluate the vertical infiltration rate through a 6-inch plug of soil, without allowing any lateral

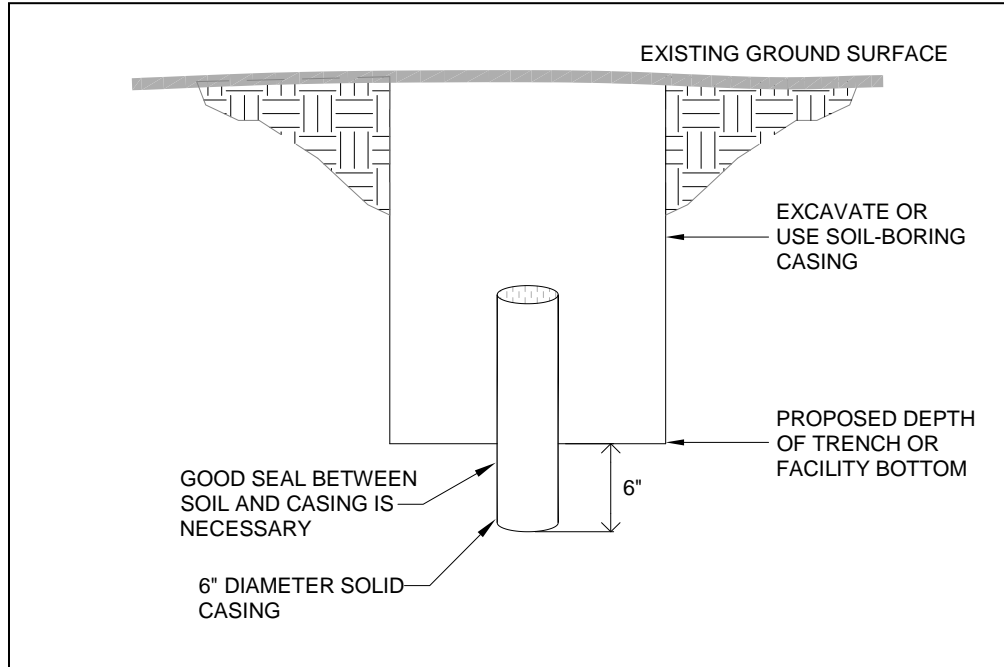
infiltration. The test is not appropriate in gravelly soils or in other soils where a good seal with the casing cannot be established.

1. Embed a solid 6-inch diameter casing into the native soil at the elevation of the proposed facility bottom (see [Exhibits F.2-3](#) and [F.2-4](#)). Ensure that the embedment provides a good seal around the pipe casing so that percolation will be limited to the 6-inch plug of the material within the casing. This method can also be used when testing within hollow stem augers, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger.
2. Fill the pipe with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth for at least 4 hours (or overnight if clay soils are present) to presoak the native material. Any soil that sloughed into the hole during the soaking period should be removed. In sandy soils with little or no clay or silt, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.
3. To conduct the first trial of the test, fill the pipe to approximately 12 inches above the soil and measure the water level to the nearest 0.01 foot ($\frac{1}{8}$ inch). Alternative water head heights may be used for testing provided the presaturation height is adjusted accordingly and the water head height used in infiltration testing is 50 percent or less than the water head height in the proposed stormwater system during the design storm event. The level should be measured with a tape or other device with reference to a fixed point. The top of the pipe is often a convenient reference point. Record the exact time.
4. Measure the water level to the nearest 0.01 foot ($\frac{1}{8}$ inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. In faster draining soils (sands and gravels), it may be necessary to shorten the measurement interval in order to obtain a well defined infiltration rate curve. Constant head tests may be substituted for falling head tests at the discretion of the professional overseeing the infiltration testing. Successive trials should be run until the percent change in measured infiltration rate between two successive trials is minimal. The trial should be discounted if the infiltration rate between successive trials increases. At least three trials must be conducted. After each trial, the water level is readjusted to the 12 inch level. Enter results into the data table (see [Exhibits F.2-3](#) and [F.2-4](#)).
5. The average infiltration rate over the last trial should be used to calculate the unfactored infiltration rate. Alternatively, the infiltration rate measured over the

range of water head applicable to the project stormwater system design may be used at the discretion of the professional overseeing the testing. The final rate must be reported in inches per hour.

6. Upon completion of the testing, the casing should be pulled and the test pit backfilled.

Exhibit F.2-2: Encased Falling Head Procedure



Double Ring Infiltrometer Test

The double-ring infiltrometer test procedure should be performed in accordance with ASTM 3385-94. The test is performed within two concentric casings embedded and sealed to the native soils. The outer ring maintains a volume of water to diminish the potential of lateral infiltration through the center casing. The volume of water added to the center ring to maintain a static water level is used to calculate the infiltration rate. The double-ring infiltrometer is appropriate only in soils where an adequate seal can be established.

Infiltration Test Report Requirements

If an Infiltration Test Report is required under the Simplified Approach, it must be submitted within two weeks of BES staff request. For Presumptive and Performance Approaches, the Infiltration Test Report must be attached to the project's Stormwater Management Report. The following information must be included in the Infiltration Testing Report:

1. Statement of project understanding (proposed stormwater system).
2. Name, contact information, professional license information and qualifications of the person conducting the infiltration test.
3. Summary of subsurface conditions encountered, including soil textures and the depth that they were found.
4. Summary of pre-saturation timing.
5. Summary of infiltration testing including location and number of tests and testing method used. Discussion of how the tests were performed (i.e. pipe type or diameter or test pit dimensions).
6. Infiltration testing results in inches per hour for each interval as well as the average for the entire testing period
7. Recommended design infiltration rate.
8. Groundwater observations within exploration and an estimate of the depth to seasonal high groundwater.
9. Site plan showing location of infiltration tests.
10. Boring or test pit logs. Boring or test pit logs will be required when an applicant's proposal relies on the presence of specific subsurface strata that allows infiltration. The logs must include an associated soil classification consistent with ASTM D2488-00, Standard Practice for Classification for Description and Identification of Soils (Visual-Manual Procedure). The logs must also include any additional pertinent subsurface information, such as soil moisture conditions, depth and description of undocumented or engineered fill, soil color and mottling conditions, soil stiffness or density, and approximate depth of contact between soil types.

11. A summary of the entire Infiltration Test Infiltration Test Data Tables ([Exhibit F.2-3](#) shows an example Infiltration Test Data Table and [Exhibit F.2-4](#) shows a blank table)

Exhibit F.2-3: Example Infiltration Test Data Table

Location: Lot 105, Point Heights Subdivision		Date: 6/28/2008		Test Hole Number: 3	
Depth to bottom of hole: 57 inches		Dimension of hole: 0.5 feet diameter		Test Method: Encased Falling Head	
Tester's Name: C.J. Tester Tester's Company: Tester Company Tester's Contact Number: 555-1212					
Depth (feet):			Soil Texture:		
0-0.5			Black Top Soil		
0.5-1.0			Brown SM		
1.0-2.2			Brown ML		
2.2-5.1			Brown CL		
Presaturation Start Time:					
Presaturation End Time:					
Time:	Time interval (minutes):	Measure ment, (feet):	Drop in water level, (feet):	Infiltration rate, (inches per hour):	Remarks:
9:00	0	3.75	-		Filled with 6"
9:20	20	3.83	0.08		
9:40	20	3.91	0.08	2.88	
10:00	20	3.98	0.07	2.52	
10:20	20	4.04	0.06	2.16	
10:40	20	4.11	0.07	2.52	
11:00	20	4.17	0.06	2.16	
11:20	20	4.225	0.055	1.98	
					Adjusted to 6" level for Trial #2

Exhibit F.2-4: Infiltration Test Data Table

Location:		Date:		Test Hole Number:	
Depth to bottom of hole:		Dimension of hole:		Test Method:	
Tester's Name: Tester's Company: Tester's Contact Number:					
Depth (feet):			Soil Texture:		
Presaturation Start Time:					
Presaturation End Time:					
Time:	Time Interval (minutes):	Measurement, (feet):	Drop in water level, (feet):	Infiltration rate, (inches per hour):	Remarks:

APPENDIX F.3 BLENDED SOIL SPECIFICATION FOR VEGETATED STORMWATER SYSTEMS

The following specification is taken from the *2010 City of Portland Standard Construction Specifications*, as amended or corrected. Facilities include swales, planters, curb extensions, and basins.

01040.14(d) Stormwater Facility Blended Soil

NOTE: This specification is required for all public facilities. Private facilities must use blended topsoil that meets the General Composition requirements of 01040.14 (d) (1). Testing and submittals are not required for private facilities unless they are requested by the Bureau permitting the work.

01040.14 Topsoil - Furnish topsoil containing no substance detrimental to the growth of plants and that is free of plants designated by the Oregon Department of Agriculture as Type "A" or Type "B" weeds. Unsuitable topsoil, or topsoil placed without approval in areas to be planted, may be required to be replaced at no additional cost.

(d) Stormwater Facility Blended Soil – Following the general provisions for topsoil, and incorporating the following requirements, furnish imported blended soil for all vegetated stormwater facilities conforming to the following:

(1) General Composition - Use material that is any blend of loamy soil, sand, and compost that is 30-40% compost (by volume) and meets the other criteria in this specification.

(2) Analysis Requirements for the Blended Material:

a. Particle Gradation - A sieve analysis of the blended material, including compost, shall be conducted in conformance with ASTM C117/C136, AASHTO T11/T27, ASTM D422/D1140, or ASTM D6913. The analysis shall include the following sieve sizes: 1 inch, 3/8 inch, #4, #10, #20, #40, #60, #100, #200. The gradation of the blend shall meet the following gradation criteria.

Sieve Size	Percent Passing
1 inch	100
# 4	75 -100
# 10	40-100
# 40	15-50
# 100	5-25
# 200	5-15

b. Acidity - The pH (Power of Hydrogen) of the blended material shall be tested and be between 6 to 8.

(3) General Requirements for the Blended Material:

- a. The material shall be loose and easily broken into small pieces
- b. It shall be well mixed and homogenous.
- c. It shall be free of wood pieces, plastic, and other foreign matter.
- d. It shall have no visible free water.

(4) Compost - The compost shall be derived from plant material and provided by a member of the US Composting Council Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.

The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions designed to promote aerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have no visible free water and produce no dust when handled. It shall meet the following criteria, as reported by the US Composting Council STA Compost Technical Data Sheet provided by the vendor.

- 100% of the material must pass through a 1/2-inch screen.
- The pH of the material shall be between 6 min. and 8.5 max.
- Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight.
- The organic matter content shall be between 30 and 70% (dry weight basis).
- Soluble salt content shall be less than 6.0 mmhos/cm.
- Maturity Indicator shall be greater than 80% for Germination and Vigor.
- Stability shall be 'Stable' to 'Very Stable'.
- Carbon/Nitrogen (C/N) ratio shall be less than 25:1.
- Trace metals test result = "Pass."

(5) Submittals - At least 14 working days in advance of construction, submit the following:

a. Documentation for the two analyses described in section 01040.14(d)(2) of this specification (particle gradation and pH) shall be performed by an accredited laboratory with current certification. The date of the analyses shall be no more than 90 calendar days prior to the date of the submittal. Include the following information in the report:

- Name and address of the laboratory.

- Phone contact and e-mail address for the laboratory.
 - Test data, including the date and name of the test procedure.
- b.** For the compost component of the blended soil, a compost technical data sheet from the vendor. The analysis and report must conform to the sampling and reporting requirements of the US Composting Council Seal of Testing Assurance (STA) program. The analysis shall be performed and reported by an approved independent STA program laboratory and be no more than 90 calendar days prior to the date of the submittal.
- c.** Up to two 5-gallon buckets of the blended material, as requested.

(6) Stormwater Facility Blended Soil Installation - See 01040.43(e).

Construction

01040.43(e) Stormwater Facility Blended Soil:

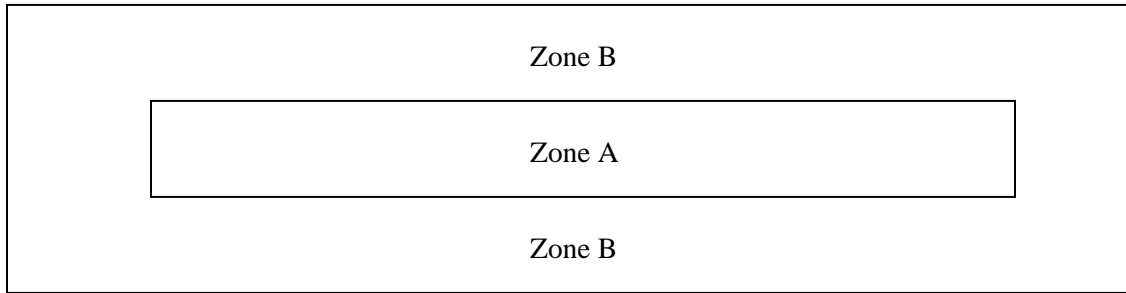
- (1) Protection of the Soil** - The material shall be protected from all sources of contamination, including weed seeds, while at the supplier, in conveyance, and at the project site.
- (2) Wet and Winter Conditions** - Hauling and placement of the material will not be allowed when the weather is too wet or the ground is frozen or saturated as determined by the Owners Representative.
- (3) Placement of the Soil** – Place the material in loose lifts, not to exceed 8 inches each and each lift shall be compacted with a water-filled landscape roller. Do not otherwise mechanically compact the material.
- (4) Timing of Plant Installation** - Weather permitting and as approved, install plants as soon as possible after placing and grading the soil in order to minimize erosion and further compaction.
- (5) Erosion Control** - Temporary erosion control measures are required until permanent stabilization measures are functional.
- (6) Protection of the Installed Soil** - In all cases, the protect installed material from foot or equipment traffic and surface water runoff. Install temporary fencing or walkways as needed to keep workers, pedestrians, and equipment out of the area. Under no circumstances should materials and equipment be stored on top of the installation area.

APPENDIX F.4 PLANTING TEMPLATES AND PLANT LISTS

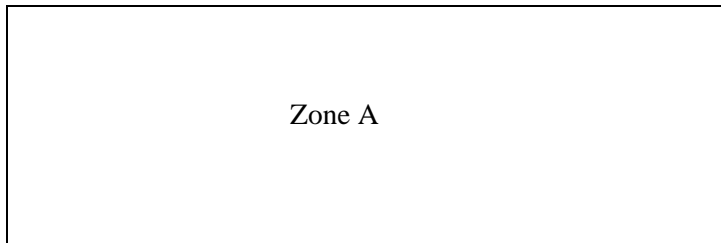
Zone A: Area of the facility defined as the bottom of the facility to the designed high water mark. This area has moist to wet soils and plants located here shall be tolerant of mild inundation.

Zone B: Area of the facility defined as the side slopes from the designed high water line up to the edge of the facility. This area typically has dryer to moist soils, with the moist soils being located further down the side slopes. Plants here should be drought tolerant and help stabilize the slopes.

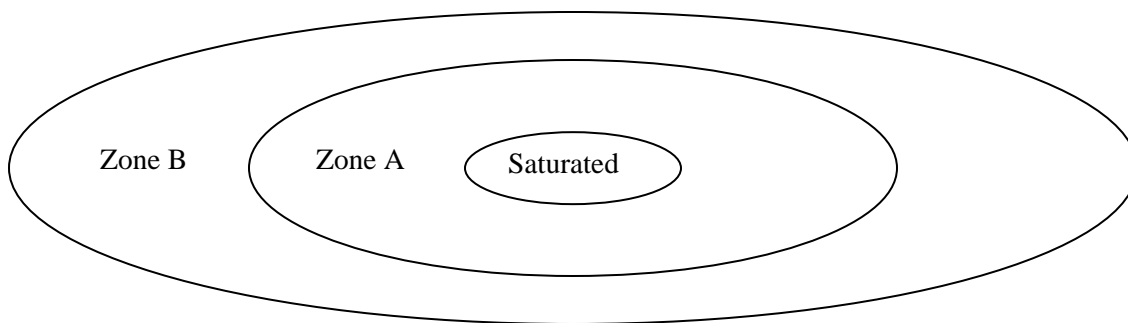
Swale Planting Zones



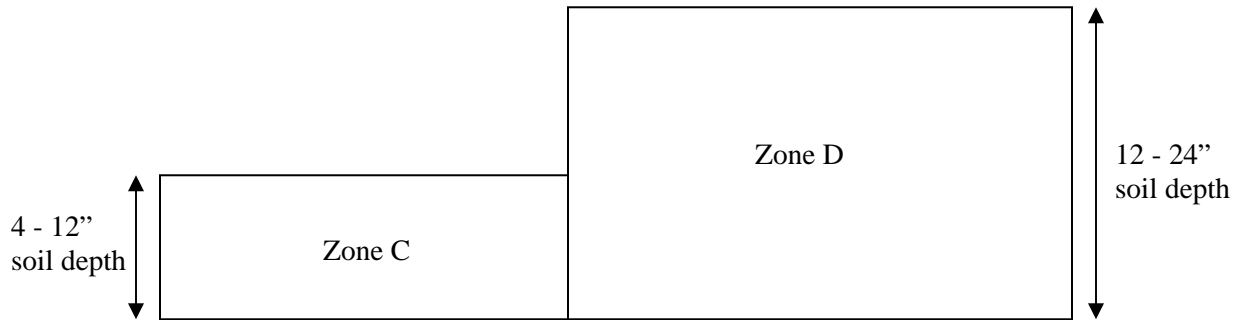
Planter Planting Zones



Basin Planting Zones



Ecoroof Planting Zones



Grassy Swale Native Seed Mix

Percentages are by weight:

<i>Hordeum brachyantherum</i> (Meadow Barley)	= 25%
<i>Danthonia californica</i> (California Oat-grass)	= 15%
<i>Elymus glaucus</i> (Blue Wild Rye)	= 10%
<i>Bromus carinatus</i> (California Brome)	= 10%
<i>Festuca romerii</i> (Roemer's fescue)	= 10%
<i>Deschampsia cespitosa</i> (Tufted hairgrass)	= 10%
<i>Agrostis exarata</i> (Spike bentgrass)	= 10%
<i>Alopecurus geniculatus</i> (Water foxtail)	= 5%
<i>Deschampsia elongata</i> (Slender hairgrass)	= 5%

Stormwater Management Facility Plant List

Plant Name	Proposed Facility Type						Characteristics				
	Zone	Private					Public	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
Botanic name, Common Name		Swale	Planter	Basin	Dry Pond	Wet Pond	Basin				
Herbaceous Plants											
<i>Aster suspicatus</i> , Douglas' Aster	B	X		X				Y	N	36"	12"
<i>Athyrium felix-femina</i> , Lady Fern	B	X		X			X	Y	N	36"	24"
<i>Blechnum spicant</i> , Deer Fern	B	X		X			X	Y	N	24"	24"
<i>Bromus carinatus</i> , California Brome Grass	A			X			X	Y	Y	18"	12"
<i>Bromus sitchensis</i> , Alaska Brome	A			X			X	Y	Y	18"	12"
<i>Bromus vulgaris</i> , Columbia Brome	A			X			X	Y	Y	18"	12"
<i>Camassia leichtlinii</i> , Camas Lily	A	X	X	X				Y	N	24"	12"
<i>Camassia quamash</i> , Common Camas	A/B	X	X	X			X	Y	N	24"	12"
<i>Carex deweyana</i> , Dewey Sedge	A	X	X	X			X	Y	Y	36"	12"
<i>Carex densa</i> , Dense Sedge	A	X	X	X			X	Y	Y	24"	12"
<i>Carex obnupta</i> , Slough Sedge	A	X	X	X			X	Y	Y	4'	12"
<i>Carex rupestris</i> , Curly Sedge	A	X	X	X				N	Y	14"	12"
<i>Carex stipata</i> , Sawbeak Sedge	A	X	X	X				N	N	20"	12"
<i>Carex testacea</i> , New Zealand Orange Sedge	A	X	X	X			X	N	Y	24"	12"
<i>Carex vesicaria</i> , Inflated Sedge	A	X	X	X			X	Y	N	36"	12"
<i>Deschampsia cespitosa</i> , Tufted Hair Grass	A/B	X	X	X			X	Y	N	36"	12"
<i>Eleocharis acicularis</i> , Needle Spike Rush	A	X	X	X			X	Y	Y	30"	12"
<i>Eleocharis ovata</i> , Ovate Spike Rush	A	X	X	X			X	Y	Y	30"	12"
<i>Eleocharis palustris</i> , Creeping Spike Rush	A			X			X	Y	Y	30"	12"
<i>Elymus glaucus</i> , Blue Wild Rye	B	X		X			X	Y	Y	24"	12"

Stormwater Management Facility Plant List

Plant Name	Proposed Facility Type						Characteristics				
	Zone	Private					Public	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
Botanic name, Common Name		Swale	Planter	Basin	Dry Pond	Wet Pond	Basin				
Herbaceous Plants (continued)											
<i>Festuca occidentalis</i> , Western Fescue Grass	A	X		X			X	Y	N	24"	12"
<i>Festuca rubra</i> , Red Fescue	B	X		X			X	Y	Y	24"	12"
<i>Glyceria occidentalis</i> , Western Manna Grass	A			X			X	Y	Y	18"	12"
<i>Hebe 'Autumn Glory'</i> , Hebe	B	X		X				N	Y	14"	12"
<i>Iris douglasiana</i> , Douglas Iris	B	X		X			X	Y	N	18"	12"
<i>Iris sibirica</i> , Siberian Iris	A	X	X	X				N	N	36"	12"
<i>Iris tenax</i> , Oregon Iris	B	X		X			X	Y	N	18"	12"
<i>Juncus balticus</i> , Baltic Rush	A	X	X	X				N	N	20"	12"
<i>Juncus effusus</i> var. <i>pacificus</i> , Soft rush	A	X	X	X			X	Y	Y	36"	12"
<i>Juncus ensifolius</i> , Dagger-leaf Rush	A	X	X	X			X	N	N	10"	12"
<i>Juncus patens</i> , Spreading Rush	A	X	X	X			X	N	Y	36"	12"
<i>Juncus tenuis</i> , Slender Rush	A	X	X	X			X	Y	Y	36"	12"
<i>Lupinus micranthus</i> , Small Flowered Lupine	B	X		X			X	Y	N	18"	12"
<i>Lupinus polyphyllus</i> , Large-leaved Lupine	A/B	X		X				Y	N	36"	12"
<i>Polypodium glycyrrhiza</i> , Licorice Fern	A	X	X	X				Y	Y	12"	12"
<i>Polystichum munitum</i> , Sword Fern	A/B	X		X			X	Y	Y	24"	24"
<i>Pteridium aquilinum</i> , Bracken Fern	B	X		X				Y	Y	5'	12"
<i>Scirpus acutus</i> , Hardstem Bulrush	A	X	X	X				N	N	10"	12"
<i>Scirpus americanus</i> , American Bulrush	A	X	X	X			X	Y	Y	30"	12"
<i>Scirpus microcarpus</i> , Small Fruited Bulrush	A			X			X	Y	Y	24"	12"
<i>Scirpus validus</i> , Softstem Bulrush	A	X	X	X				N	N	5'	12"

Stormwater Management Facility Plant List

Plant Name Botanic name, Common Name	Zone	Proposed Facility Type					Characteristics				
		Private					Public	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
		Swale	Planter	Basin	Dry Pond	Wet Pond	Basin				
Herbaceous Plants (continued)											
<i>Sedum oregonum</i> , Oregon Stonecrop	B	X						Y	Y	4"	12"
<i>Sisyrinchium californicum</i> , Yellow-eyed Grass	A/B	X	X	X				N	Y	6"	12"
<i>Veronica liwanensis</i> , Speedwell	A	X		X				N	N	2"	12"
Large Shrubs and Small Trees											
<i>Acer circinatum</i> , Vine Maple	A/B	X	X	X			X	Y	N	15'	10'
<i>Amelanchier alnifolia</i> , Western Serviceberry	B	X		X			X	Y	N	20'	10'
<i>Ceanothus sanguineus</i> , Oregon Redstem Ceanothus	B	X		X			X	Y	Y	7'	4'
<i>Holodiscus discolor</i> , Oceanspray	B	X		X			X	Y	N	6'	4'
<i>Lonicera involucrata</i> , Black Twinberry	B	X		X			X	Y	N	5'	4'
<i>Oemleria cerasiformis</i> , Indian Plum	B	X		X			X	Y	N	6'	4'
<i>Philadelphu lewisii</i> , Wild Mock Orange	B	X		X			X	Y	N	6'	4'
<i>Ribes sanguineum</i> , Red-Flowering Current	B	X		X			X	Y	N	8'	4'
<i>Rubus parviflorus</i> , Thimbleberry	B	X		X			X	Y	N	8'	4'
<i>Rubus spectabilis</i> , Salmonberry	A	X	X	X			X	Y	N	10'	4'
<i>Salix fluviatilis</i> , Columbia Willow	A/B	X	X	X			X	N	N	13'	6'
<i>Salix lucida</i> var. 'Lasiandra', Pacific Willow	A	X	X	X			X	Y	N	13'	6'
<i>Salix purpurea nana</i> , Blue Arctic Willow	B	X		X				N	N	8'	6'
<i>Salix stichensis</i> , Sitka Willow	A	X	X	X			X	Y	N	20'	6'

Stormwater Management Facility Plant List

Plant Name	Proposed Facility Type						Characteristics				
	Zone	Private			Public			NW Native	Evergreen	Potential Hgt.	O.C. Spacing
Botanic name, Common Name		Swale	Planter	Basin	Dry Pond	Wet Pond	Basin				

Large Shrubs and Small Trees (continued)

<i>Sambucus cerulea</i> , Blue Elderberry	B	X		X			X	Y	N	10'	10'
<i>Sambucus racemosa</i> , Red Elderberry	B	X		X			X	Y	N	10'	10'
<i>Spiraea douglasii</i> , Douglas Spiraea	A/B	X	X	X			X	Y	N	7'	4'
<i>Viburnum edule</i> , Highbush Cranberry	A/B	X	X	X			X	Y	N	6'	4'

Shrubs

<i>Ceanothus velutinus</i> , Snowbrush	B	X		X			X	Y	Y	4'	3'
<i>Cornus sericea</i> , Red-twig Dogwood	A	X	X	X			X	Y	N	6'	4'
<i>Cornus sericea 'Kelseyii'</i> , Kelsey Dogwood	B	X		X			X	N	N	24"	24"
<i>Gaultheria shallon</i> , Salal	B	X		X			X	Y	Y	24"	24"
<i>Mahonia aquifolium</i> , Oregon Grape	B	X		X			X	Y	Y	5'	3'
<i>Mahonia nervosa</i> , Dull Oregon Grape	B	X		X			X	Y	Y	24"	24"
<i>Physocarpus capitatus</i> , Pacific Ninebark	A/B	X	X	X				Y	N	10'	3'
<i>Rosa gymnocarpa</i> , Baldhip Rose	B	X		X			X	Y	N	3'	3'
<i>Rosa nutkana</i> , Nootka Rose	B	X		X			X	Y	N	8'	3'
<i>Rosa pisocarpa</i> , Swamp Rose	A/B	X	X	X			X	Y	N	8'	3'
<i>Symphoricarpos alba</i> , Common Snowberry	B	X		X			X	Y	N	6'	3'

Groundcovers

<i>Arctostaphylos uva-ursi</i> , Kinnickinnick	B	X		X				Y	Y	6"	12"
<i>Fragaria chiloensis</i> , Coastal Strawberry	B	X		X				Y	Y	6"	12"

Stormwater Management Facility Plant List

Plant Name <i>Botanic name, Common Name</i>	Zone	Proposed Facility Type					Characteristics				
		Private					Public	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
		Swale	Planter	Basin	Dry Pond	Wet Pond	Basin				
Groundcovers (continued)											
<i>Fragaria vesca</i> , Woodland Strawberry	B	X		X				N	Y	10"	12"
<i>Fragaria virginiana</i> , Wild Strawberry	B	X		X				N	Y	10"	12"
<i>Helictotrichon sempervirens</i> , Blue Oat Grass	B	X		X				N	Y	24"	12"
<i>Mahonia repens</i> Creeping Oregon Grape	B	X		X				Y	Y	12"	12"
Trees											
<i>Abies grandis</i> , Grand Fir	B			X			X	Y	Y	150'	
<i>Acer griseum</i> , Paperbark Maple	B	X		X				N	N	30'	
<i>Acer macrophyllum</i> , Big Leaf Maple	B	X		X			X	Y	Y	60'	
<i>Alnus rubra</i> , Red Alder	A	X		X			X	Y	N	80'	
<i>Arbutus menziesii</i> , Madrone	B			X			X	Y	N	35'	
<i>Crataegus douglasii</i> , Black Hawthorn	A	X		X			X	Y	N	40'	10'
<i>Fraxinus latifolia</i> , Oregon Ash	A/B	X		X			X	Y	N	30'	
<i>Malus fusca</i> , Pacific Crabapple	A	X	X	X			X	Y	N	30'	10'
<i>Metasequoia glyptostroboides</i> , Dawn Redwood	B			X			X	N	N	80'	
<i>Populus tremuloides</i> , Quaking Aspen	A			X			X	Y	N	40'	
<i>Prunus emarginata var. mollis</i> , Bitter Cherry	A/B	X	X	X			X	Y	N	50'	
<i>Pseudotsuga menziesii</i> , Douglas Fir	B	X		X			X	Y	Y	200'	
<i>Quercus garryana</i> , Oregon White Oak	B	X		X			X	Y	N	100'	

Stormwater Management Facility Plant List

Plant Name <i>Botanic name, Common Name</i>	Zone	Proposed Facility Type					Characteristics				
		Private					Public	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
		Swale	Planter	Basin	Dry Pond	Wet Pond	Basin				
Trees (continued)											
<i>Rhamnus purshiana</i> , Cascara	A/B	X	X	X			X	Y	N	30'	
<i>Salix hookeriana</i> , Hooker's Willow	A/B	X	X	X			X	Y	N	15'	
<i>Salix scouleriana</i> , Scouler's Willow	A/B	X	X	X			X	Y	N	15'	
<i>Thuja plicata</i> , Western Red Cedar	A			X			X	Y	Y	150'	
<i>Tsuga heterophylla</i> , Western Hemlock	A	X		X			X	Y	Y	125'	
<i>Tsuga mertensiana</i> , Mountain Hemlock	B	X		X			X	Y	Y	125'	

Ecoroof Plant List

Plant Name	Characteristics						
	Zone	NW Native	Evergreen	Potential Hgt.	O.C. Spacing	Full Sun	Partial Shade
<i>Botanic name, Common Name</i>							
Sedums and Succulents							
<i>Delosperma ssp.</i> , Ice Plant	C	N	Y	4"		X	
<i>Malephora crocea</i> var. <i>purpureo crocea</i> 'Tequila Sunrise', Coppery Mesemb	C	N	Y	10"		X	
<i>Sedum</i> 'Autumn Joy'	C	N	N	24"		X	
<i>Sedum acre</i> , Biting Stonecrop	C	N	Y	2"		X	
<i>Sedum album</i> , White Stonecrop	C	N	Y	3"		X	
<i>Sedum divergens</i> , Pacific Stonecrop	C	N	Y	3"		X	
<i>Sedum hispanicum</i> , Spanish Stonecrop	C	N	Y	3"		X	
<i>Sedum kamtschaticum</i> , Kirin-so	C	N	N	6"		X	
<i>Sedum oreganum</i> , Oregon Stonecrop	C	Y	Y	4"		X	X
<i>Sedum sexangular</i> , Tasteless Stonecrop	C	N	Y	4"		X	
<i>Sedum spathulifolium</i> , Stonecrop	C	Y	Y	4"		X	
<i>Sedum spurium</i> , Two-row Stonecrop	C	N	Y	6"		X	X
<i>Sempervivum tectorum</i> , Hens and Chicks	C	N	Y	6"		X	
Herbaceous Plants							
<i>Achillea millefolium</i> , Common Yarrow	C	N	N	36"		X	
<i>Achillea tomentosa</i> , Woolly Yarrow	C	N	N	8"		X	
<i>Arenaria montana</i> , Sandwort	C	N	N	4"		X	
<i>Artemisia</i> 'Silver Mound', Artemisia	C	N	N	12"		X	
<i>Aurinaria saxatilis</i> , 'Compacta'	C	N	N	6"		X	
<i>Castilleja foliosa</i> , Indian Paintbrush	C	Y	N	10"		X	

Eceroof Plant List

Plant Name	Characteristics						
	Zone	NW Native	Evergreen	Potential Hgt.	O.C. Spacing	Full Sun	Partial Shade
<i>Botanic name, Common Name</i>							

Herbaceous Plants (continued)

<i>Dianthus ssp.</i>	C	N	N	12"		X	X
<i>Erigeron discoideus</i> , Fleabane	C	N	N	12"		X	X
<i>Festuca glauca</i> , Blue Fescue	C	N	Y	12"		X	X
<i>Fragaria chiloensis</i> , Coastal Strawberry	C	Y	Y	10"		X	X
<i>Fragaria virginiana</i> , Wild Strawberry	C	Y	Y	10"		X	X
<i>Gaillardia aristata</i> , Birds-eye gilia	C	N	N	20"		X	X
<i>Gazania linearis</i> 'CO Gold', Gazania	C	N	N	6"		X	
<i>Gilia capitata</i> , Blue Thimble Flower	C	Y	N	12"		X	
<i>Koeleria macrantha</i> , June Grass	C	N	N	24"		X	X
<i>Linaria reticulata</i> , Purplenet Toadflax	C	N	N	20"		X	
<i>Lobularia maritima</i> , Sweet Alyssum	C	N	N	12"		X	
<i>Polypodium glycyrrhiza</i> , Licorice Fern	C	Y	Y	12"		X	X
<i>Polystichum munitum</i> , Sword Fern	C	Y	Y	24"		X	X
<i>Potentilla nepalensis</i> , Nepal Cinquefoil	C	N	N	14"		X	X
<i>Potentilla neumanniana</i> , Cinquefoil	C	N	N	14"		X	
<i>Thymus serpyllum</i> , Creeping Thyme	C	N	N	3"		X	
<i>Veronica liwanensis</i> , Speedwell	C	N	N	2"		X	X

Shrubs and Small Trees

<i>Amalanchier alnifolia</i> , Saskatoon Serviceberry	D	Y	N	20'		X	
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Ecoroof Plant List

Plant Name	Characteristics						
	Zone	NW Native	Evergreen	Potential Hgt.	O.C. Spacing	Full Sun	Partial Shade
<i>Botanic name, Common Name</i>							

Shrubs and Small Trees (continued)

<i>Berberis thunbergii</i> , Japanese Barberry	D	N	N	4'		X	
<i>Gaultheria shallon</i> , Salal	D	Y	Y	24"		X	X
<i>Lavandula angustifolia</i> 'Hidcote', Dwarf English Lavander	D	N	Y	30"		X	
<i>Mahonia aquifolium</i> , Oregon Grape	D	Y	Y	5'		X	X
<i>Mahonia nervosa</i> , Dull Oregon Grape	D	Y	Y	24"		X	X
<i>Mahonia repens</i> , Creeping Oregon Grape	D	Y	Y	12"		X	X
<i>Nanadina domestica</i> , Heavenly Bamboo	D	N	N	4'		X	X
<i>Ribes sanguineum</i> , Red-Flowering Current	D	Y	N	12'		X	X
<i>Rosa nutkana</i> , Nootka Rose	D	Y	N	10'		X	
<i>Symphoricarpos mollis</i> , Creeping Snowberry	D	Y	N	18"		X	X
<i>Thymus vulgaris</i> , Common Thyme	D	N	Y	12"		X	X

Greenstreets Plant List

Plant Name	Facility Type			Characteristics					
	Zone	Swale	Curb Extension	Planter	NW Native	Evergreen	Potential Hgt.	O.C. Spacing	Under Powerlines
<i>Botanic name, Common Name</i>									

Herbaceous Plants

<i>Carex densa</i> , Dense Sedge	A	X	X	X	Y	Y	24"	12"	
<i>Carex morrowii</i> , Ice Dance	A	X	X	X	N	Y	24"	12"	
<i>Carex obnupta</i> , Slough Sedge	A	X	X	X	Y	Y	48"	12"	
<i>Deschampsia cespitosa</i> , Tufted Hair Grass	A/B	X	X	X	Y	N	48"	12"	
<i>Helictotrichon sempervirens</i> , Blue Oat Grass	B	X	X		N	Y	24"	12"	
<i>Juncus patens</i> , Spreading Rush	A	X	X	X	N	Y	36"	12"	

Shrubs

<i>Cornus sericea 'Kelseyii'</i> , Kelsey Dogwood	A/B	X	X	X	N	N	24"	24"	
<i>Euonymus japonicus</i> 'Microphyllus' Boxleaf Evergreen	B	X	X		N	Y	24"	24"	
<i>Mahonia nervosa</i> , Dull Oregon Grape	B	X	X		Y	Y	24"	24"	
<i>Spiraea betulifolia</i> , Birchleaf Spiraea	A/B	X	X	X	Y	N	24"	24"	
<i>Spiraea densiflora</i> , Sub-alpine Spiraea	A/B	X	X	X	Y	N	24"	24"	
<i>Spiraea japonica</i> , Japanese spirea cultivars: Dart's Red, Goldflame, Goldmound, Little Princess, Magic Carpet	A/B	X	X	X	N	N	24"- 36"	24"	

Groundcovers

<i>Arctostaphylos uva-ursi</i> , Kinnickinnick	B	X	X		Y	Y	6"	12"	
<i>Fragaria chiloensis</i> , Coastal Strawberry	B	X	X		Y	Y	6"	12"	

Greenstreets Plant List

Plant Name	Zone	Facility Type			Characteristics				
		Swale	Curb Extension	Planter	NW Native	Evergreen	Potential Hgt.	O.C. Spacing	Under Powerlines
<i>Botanic name, Common Name</i>									
<i>Mahonia repens</i> , Creeping Oregon Grape	B	X	X		Y	Y	12"	12"	
<i>Rubus calcynoides & pentalobus</i> , Creeping Bramble	A	X	X		N	Y	6"	12"	

Greenstreets Plant List

Plant Name	Zone	Facility Type			Characteristics					
		Public	Swale	Curb Extension	Planter	NW Native	Evergreen	Potential Hgt.	O.C. Spacing	Under Powerlines
<i>Botanic name, Common Name</i>										

Accent Plants

<i>Camassia leichtlinii</i> , Great Camas	A/B	X	X	X	Y	N	24"	12"	
<i>Camassia quamash</i> , Common Camas	A/B	X	X	X	Y	N	24"	12"	
<i>Iris douglasiana</i> , Douglas Iris	B	X	X		Y	N	18"	12"	
<i>Iris tenax</i> , Oregon Iris	B	X	X		Y	N	18"	12"	

Street Trees

<i>Acer campestre 'Evelyn'</i> , Queen Elizabeth Hedge Maple	A/B	X	X	X	N	N	30'		N
<i>Betula jacquemontii</i> , Jacquemontii Birch	A/B	X	X	X	N	N	60'		N
<i>Celtis occidentalis</i> , Hackberry	A/B	X	X	X	N	N	50'		N
<i>Koelreuteria paniculata</i> , Goldenrain Tree	A/B	X	X	X	N	N	30'		Y
<i>Nyssa sylvatica</i> , Black Tupelo	A	X	X	X	N	N	50'		N
<i>Prunus virginiana 'Canada Red'</i> , Canada Red Chokecherry	A/B	X	X	X	N	N	25'		Y
<i>Quercus shumardii</i> , Shumard Oak	A/B	X	X	X	N	N	70'		N
<i>Rhamnus purshiana</i> , Cascara	A/B	X	X	X	Y	N	30'		Y

Pond Plant List

Plant Name	Planting Zone			Characteristics			
	Wet to Saturated	Moist to Dry	Dry/Upland	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
<i>Botanic name, Common Name</i>							
Herbaceous Plants							
<i>Alisma plantago-aquatica</i> , Water Plantain	X			Y	N	24"	12"
<i>Alopecurus geniculatus</i> , Water Foxtail		X		Y	Y	18"	12"
<i>Aster suspicatus</i> , Douglas' Aster	X	X		Y	N	36"	12"
<i>Bidens cernua</i> , Nodding Beggerticks		X		Y	N	24"	12"
<i>Blechnum spicant</i> , Deer Fern	X	X		Y	N	24"	24"
<i>Bromus sitchensis</i> , Alaska Brome		X	X	Y	Y	18"	12"
<i>Camassia quamash</i> , Common Camas		X		Y	N	24"	12"
<i>Carex deweyana</i> , Dewey Sedge	X	X		Y	Y	36"	12"
<i>Carex obnupta</i> , Slough Sedge	X			Y	Y	4'	12"
<i>Deschampsia cespitosa</i> , Tufted Hair Grass		X		Y	N	36"	12"
<i>Eleocharis ovata</i> , Ovate Spike Rush	X			Y	Y	30"	12"
<i>Eleocharis palustris</i> , Creeping Spike Rush	X			Y	Y	30"	12"
<i>Elymus glaucus</i> , Blue Wild Rye		X		Y	Y	24"	12"
<i>Glyceria occidentalis</i> , Western Manna Grass	X	X		Y	Y	18"	12"
<i>Lemna minor</i> , Common Lesser Duckweed	X						
<i>Juncus effusus var. pacificus</i> , Soft rush	X	X		Y	Y	36"	12"
<i>Juncus ensifolius</i> , Dagger- leaf Rush	X	X		Y	Y	24"	12"

Pond Plant List

Plant Name	Planting Zone			Characteristics			
	Wet to Saturated	Moist to Dry	Dry/Upland	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
Botanic name, Common Name							

Herbaceous Plants (continued)

<i>Juncus oxymeris</i> , Pointed Rush	X	X		Y	Y	24"	12"
<i>Juncus patens</i> , Spreading Rush	X	X		N	Y	36"	12"
<i>Juncus tenuis</i> , Slender Rush	X	X		Y	Y	36"	12"
<i>Lupinus polyphyllus</i> , Large-leaved Lupine		X		Y	N	36"	12"
<i>Myosotis laxa</i> , Small-flowered Forget-Me-Not	X			Y	N	18"	12"
<i>Polystichum munitum</i> , Sword Fern	X	X		Y	Y	24"	24"
<i>Sagittaria latifolia</i> , Wapato	X			Y	N	24"	12"
<i>Potamogeton natans</i> , Floating leafed Pondweed	X			Y	Y	18"	12"
<i>Scirpus acutus</i> , Hardstem Bulrush	X			N	N	10"	12"
<i>Scirpus microcarpus</i> , Small Fruited Bulrush		X		Y	Y	24"	12"
<i>Sisyrinchium idahoense</i> Blue-eyed Grass		X		N	Y	6"	12"
<i>Sparganium emersum</i> , Narrowleaf Bur-reed	X			Y	N	24"	12"
<i>Veronica liwanensis</i> , Speedwell	X	X		N	N	2"	12"
<i>Viola palustris</i> , Marsh Violet	X	X		Y	N	6"	6"

Large Shrubs and Small Trees

<i>Acer circinatum</i> , Vine Maple	X	X		Y	N	15'	10'
<i>Amelanchier alnifolia</i> , Western Serviceberry			X	Y	N	20'	10'
<i>Holodiscus discolor</i> , Oceanspray			X	Y	N	6'	4'
<i>Lonicera involucrata</i> , Black Twinberry			X	Y	N	5'	4'

Pond Plant List

Plant Name	Planting Zone			Characteristics			
	Wet to Saturated	Moist to Dry	Dry/Upland	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
Botanic name, Common Name							

Large Shrubs and Small Trees (continued)

<i>Oemleria cerasiformis</i> , Indian Plum		X	X	Y	N	6'	4'
<i>Philadelphu lewisii</i> , Wild Mock Orange			X	Y	N	6'	4'
<i>Ribes sanguineum</i> , Red-Flowering Current			X	Y	N	8'	4'
<i>Rubus parviflorus</i> , Thimbleberry		X		Y	N	8'	4'
<i>Rubus spectabilis</i> , Salmonberry	X	X		Y	N	10'	4'
<i>Salix fluviatilis</i> , Columbia Willow	X	X		N	N	13'	6'
<i>Salix lucida</i> var. 'Lasiandra', Pacific Willow	X	X		Y	N	13'	6'
<i>Salix stichensis</i> , Sitka Willow	X	X		Y	N	20'	6'
<i>Sambucus racemosa</i> , Red Elderberry		X		Y	N	10'	10'
<i>Spiraea douglasii</i> , Douglas Spiraea		X		Y	N	7'	4'
<i>Viburnum edule</i> , Highbush Cranberry		X		Y	N	6'	4'

Shrubs

<i>Cornus sericea</i> , Red-twig Dogwood	X	X		Y	N	6'	4'
<i>Fragaria vesca</i> , Woodland Strawberry		X	X	N	Y	10"	12"
<i>Fragaria virginiana</i> , Wild Strawberry		X	X	N	Y	10"	12"
<i>Mahonia aquifolium</i> , Oregon Grape		X	X	Y	Y	5'	3'
<i>Mahonia nervosa</i> , Dull Oregon Grape		X		Y	Y	24"	24"

Pond Plant List

Plant Name	Planting Zone			Characteristics			
	Wet to Saturated	Moist to Dry	Dry/Upland	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
Botanic name, Common Name							

Shrubs (continued)

<i>Physocarpus capitatus</i> , Pacific Ninebark	X			Y	N	6'	3'
<i>Rosa gymnocarpa</i> , Baldhip Rose	X			Y	N	3'	3'
<i>Rosa nutkana</i> , Nootka Rose		X		Y	N	8'	3'
<i>Rosa pisocarpa</i> , Swamp Rose	X			Y	N	8'	3'
<i>Spiraea betulifolia</i> , Birchleaf Spiraea		X		Y	N	24"	24"
<i>Symphoricarpus alba</i> , Snowberry		X		Y	N	3'	3'

Trees

<i>Abies grandis</i> , Grand Fir		X		Y	Y	150'	
<i>Acer macrophyllum</i> , Big Leaf Maple		X		Y	Y	60'	
<i>Alnus rubra</i> , Red Alder	X	X		Y	N	80'	
<i>Arbutus menziesii</i> , Madrone			X	Y	N	35'	
<i>Cornus nuttallii</i> , Western flowering Dogwood		X	X	Y	N	20'	
<i>Crataegus douglasii</i> , Black Hawthorn	X			Y	N	40'	
<i>Fraxinus latifolia</i> , Oregon Ash	X	X		Y	N	30'	
<i>Malus fusca</i> , Pacific Crabapple	X	X		Y	N	30'	
<i>Pinus ponderosa</i> , Ponderosa Pine			X	Y	Y	70'	
<i>Pinus monticola</i> , Western White Pine		X	X	Y	Y	90'	
<i>Prunus emarginata</i> var. <i>mollis</i> , Bitter Cherry	X			Y	N	50'	
<i>Pseudotsuga menziesii</i> , Douglas Fir		X		Y	Y	200'	

Pond Plant List

Plant Name	Planting Zone			Characteristics			
	Wet to Saturated	Moist to Dry	Dry/Upland	NW Native	Evergreen	Potential Hgt.	O.C. Spacing
<i>Botanic name, Common Name</i>							

Trees (continued)

<i>Quercus garryana</i> , Oregon White Oak		X		Y	N	100'	
<i>Rhamnus purshiana</i> , Cascara	X			Y	N	30'	
<i>Salix hookeriana</i> , Hooker's Willow	X	X		Y	N	15'	
<i>Salix scouleriana</i> , Scouler's Willow	X	X		Y	N	15'	
<i>Thuja plicata</i> , Western Red Cedar	X	X		Y	Y	150'	

Appendix G Table of Contents

- G.1 Simplified and Presumptive Approach Facility Details for Private Property (SW 100's)**
- G.2 Performance Approach Facility Details (SW 200's)**
- G.3 Green Street Details (SW 300's)**
- G.4 Green Street Checklist**
- G.5 Source Control and other Supplemental Details (SW 500's)**

Appendix G.1 Table of Contents

SW-100: Ecoroof

SW-110: Pervious Pavement (For Private Only)

SW-120: Swale

SW-130: Planter

SW-140: Basin

SW-150: Facility Overflow Configurations

SW-151: Facility Hybrid Configuration E

SW-152: Facility Hybrid Configuration F

SW-160: Filter Strip

SW-170: Drywell

SW-180: Soakage Trench – East Side

SW-181: Soakage Trench – West Side

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

Simplified and Presumptive Facilities Table of Contents

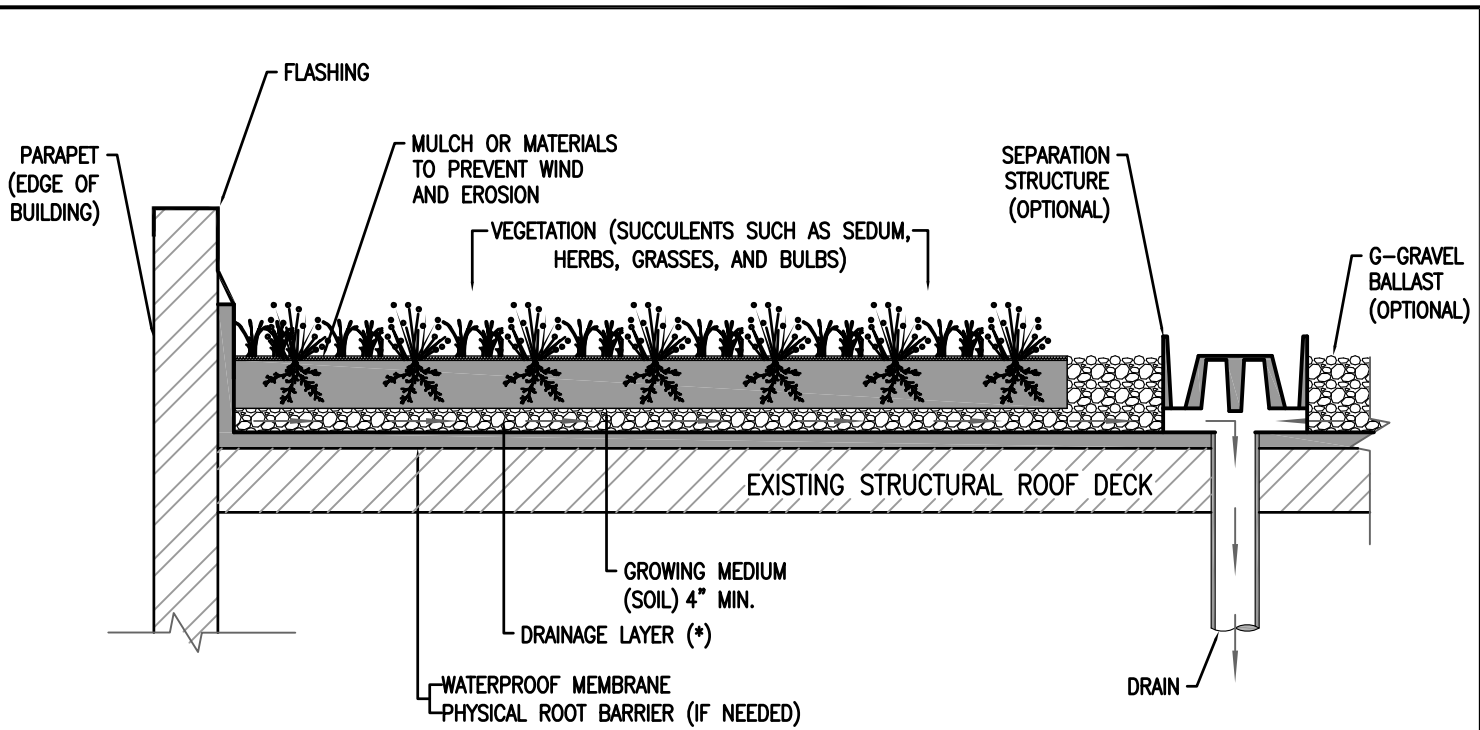
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TOC



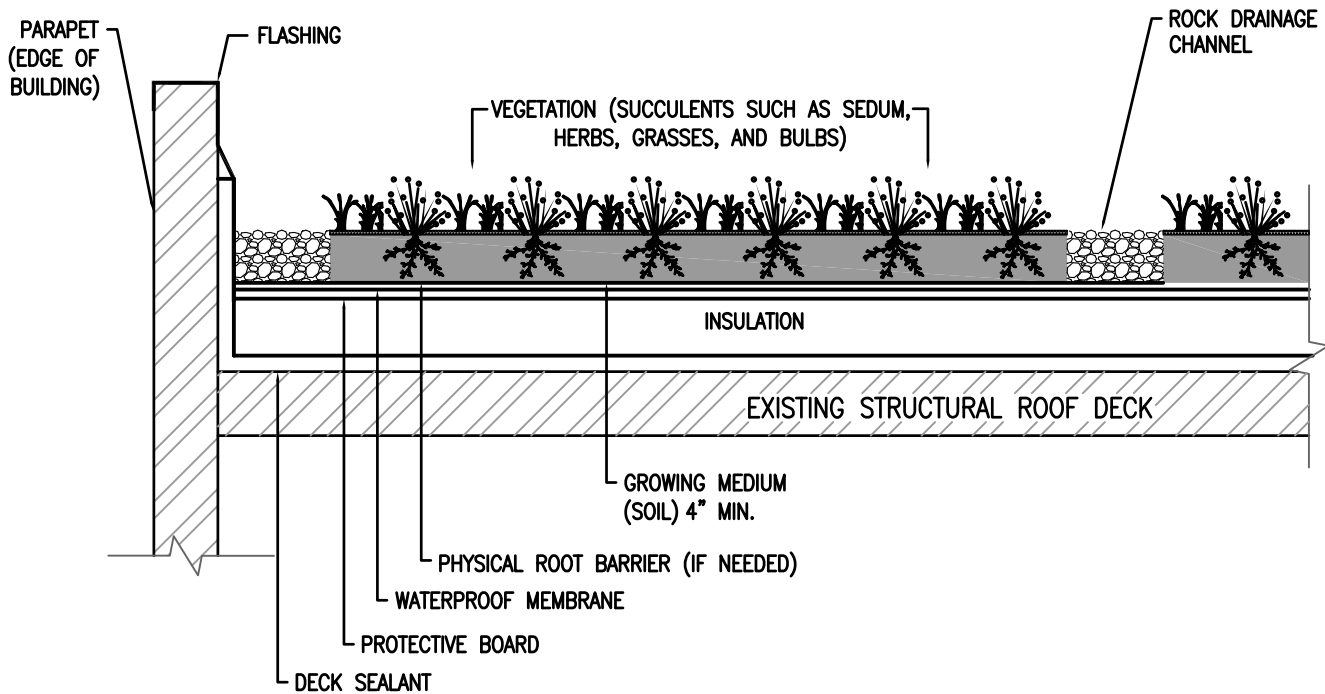
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* SEE OTHER DETAIL BELOW FOR OPTION.

ECOROOF WITH DRAINAGE LAYER



ECOROOF WITH DRAINAGE CHANNELS

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive / Performance Design Approach -

Ecoroof

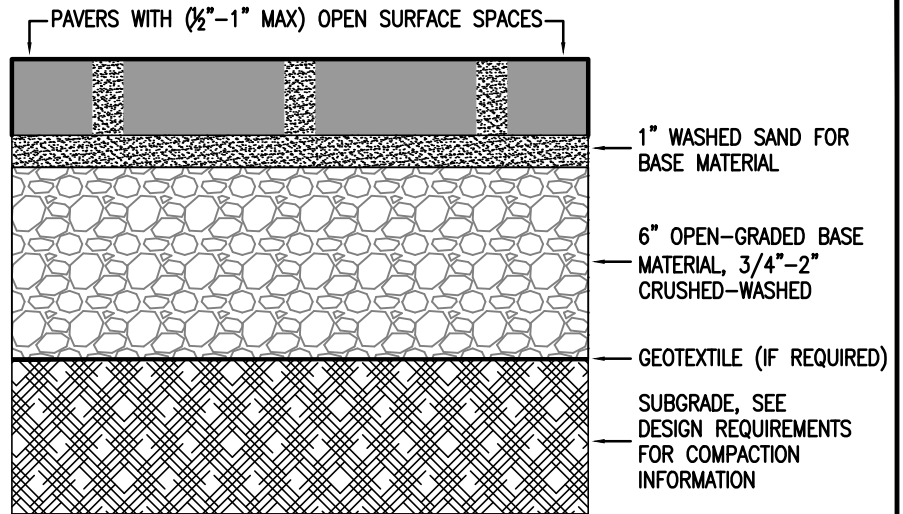
NUMBER

SW-100



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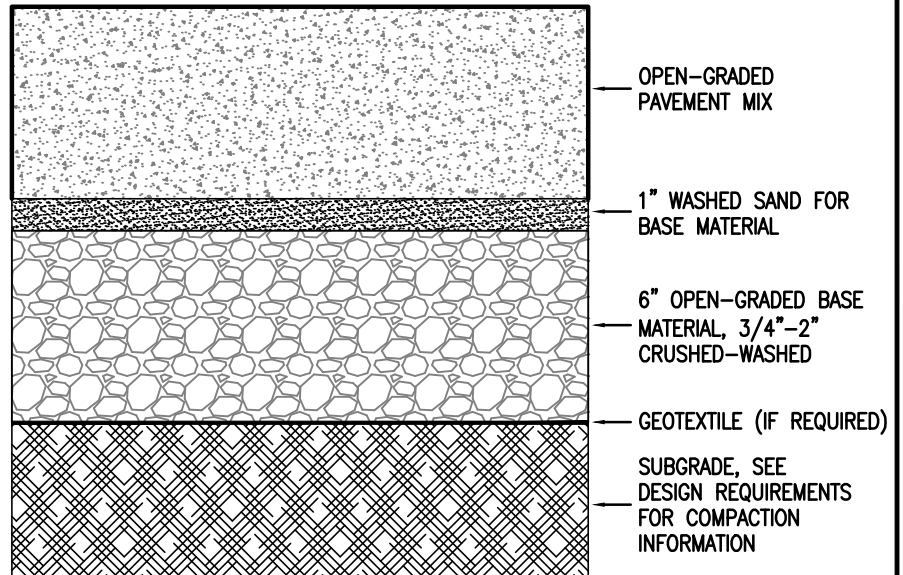


PERMEABLE CONCRETE BLOCK
OR "PAVER" SYSTEMS

	RESIDENTIAL DRIVEWAY OR PEDESTRIAN ONLY	PRIVATE STREET, PARKING LOT, OR FIRE LANE	PUBLIC STREET
CONCRETE	4"	4"	7"
ASPHALT	2 1/2"	3"	6"
PAVERS	2 3/8"	3 1/8"	3 1/8"
ENGINEERING REQ'D	NO	YES	YES
COMPACTION REQ'D	NO	YES	95%

EXHIBIT 2-8

PERVIOUS PAVEMENT REQUIREMENTS FOR TOP LIFT DEPTH, ENGINEERING, AND COMPACTION.



PERVIOUS (OPEN GRADED) CONCRETE
AND ASPHALT SYSTEMS

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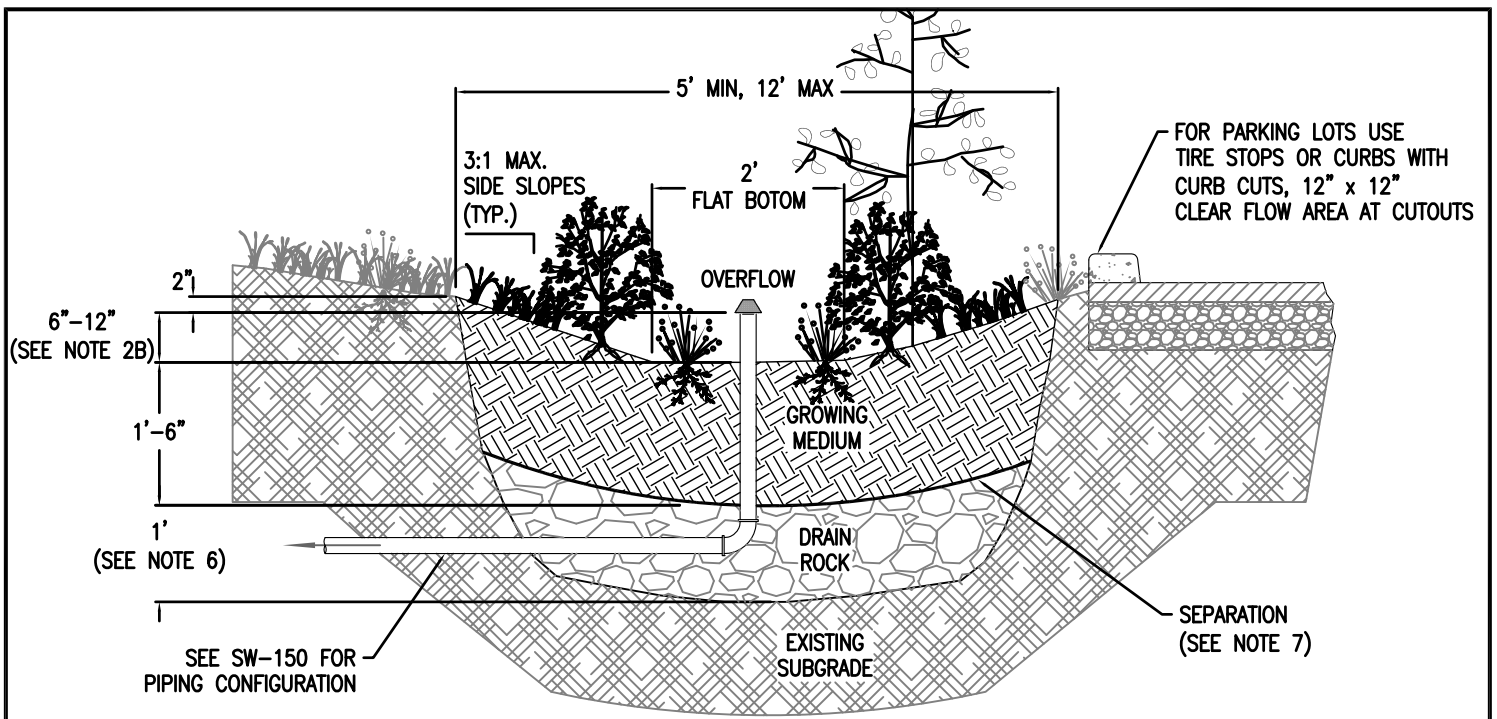
STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive / Performance Design Approach -
Pervious Pavement

NUMBER

SW-110





1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.
2. Dimensions:
 - a. Width of swale: 5' - 12'.
 - b. Depth of swale (from top of growing medium to overflow elevation); Simplified: 9", Presumptive: 6" - 12" .
 - c. Longitudinal slope of swale: 6.0% or less.
 - d. Flat bottom width: 2'.
 - e. Side slopes of swale: 3:1 maximum.
3. Setbacks (from centerline of facility):
 - a. Infiltration swales must be 10' from foundations and 5' from property lines.
 - b. Lined, flow-through swales must connect to approved discharge point according to SWMM Section 1.3.
4. Overflow:
 - a. Overflow required for Simplified Approach
 - b. Inlet elevation must allow for 2" of freeboard, minimum.
 - c. Protect from debris and sediment with strainer or grate.
5. Piping: shall be ABS Sch.40, cast iron, or PVC Sch.40. 3" pipe required for up to 1,500 sq ft of impervious area, otherwise 4" min. Piping must have 1% grade and follow the Uniform Plumbing Code.
6. Drain rock:
 - a. Size for infiltration swale: 1-1/2" - 3/4" washed
 - b. Size for lined, flow-through swale: 3/4" washed
 - c. Depth for Simplified: 12"
 - d. Depth for Presumptive: 0-48" , see calcs.
7. Separation between drain rock and growing medium: Use a gravel lens (3/4 - 1/4 inch washed, crushed rock 2 to 3 inches deep) or approved equivalent.
8. Growing medium:
 - a. 18" minimum
 - b. See Appendix F.3 for topsoil specification or use sand/loam/compost 3-way mix.
9. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Appendix F. Minimum container size is 1 gallon. # of plantings per 100sf of facility area:
 - a. Zone A (wet): 115 herbaceous plants OR 100 herbaceous plants and 4 small shrubs.
 - b. Zone B (moderate to dry): 1 tree AND 3 large shrubs/small trees AND 4 small shrubs AND 140 groundcover plants. The delineation between Zone A and B shall be either at the outlet elevation or the check dam elevation, whichever is lowest.
10. Waterproof liner: Shall be 30 mil PVC or equivalent when lining is required.
11. Install washed pea gravel or river rock to transition from inlets and splash pad to growing medium.
12. Check dams: Shall be placed according to facility design. Refer to SW-340 for profile and spacing.
13. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, for appropriate inspections.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive Design Approach -
Swale

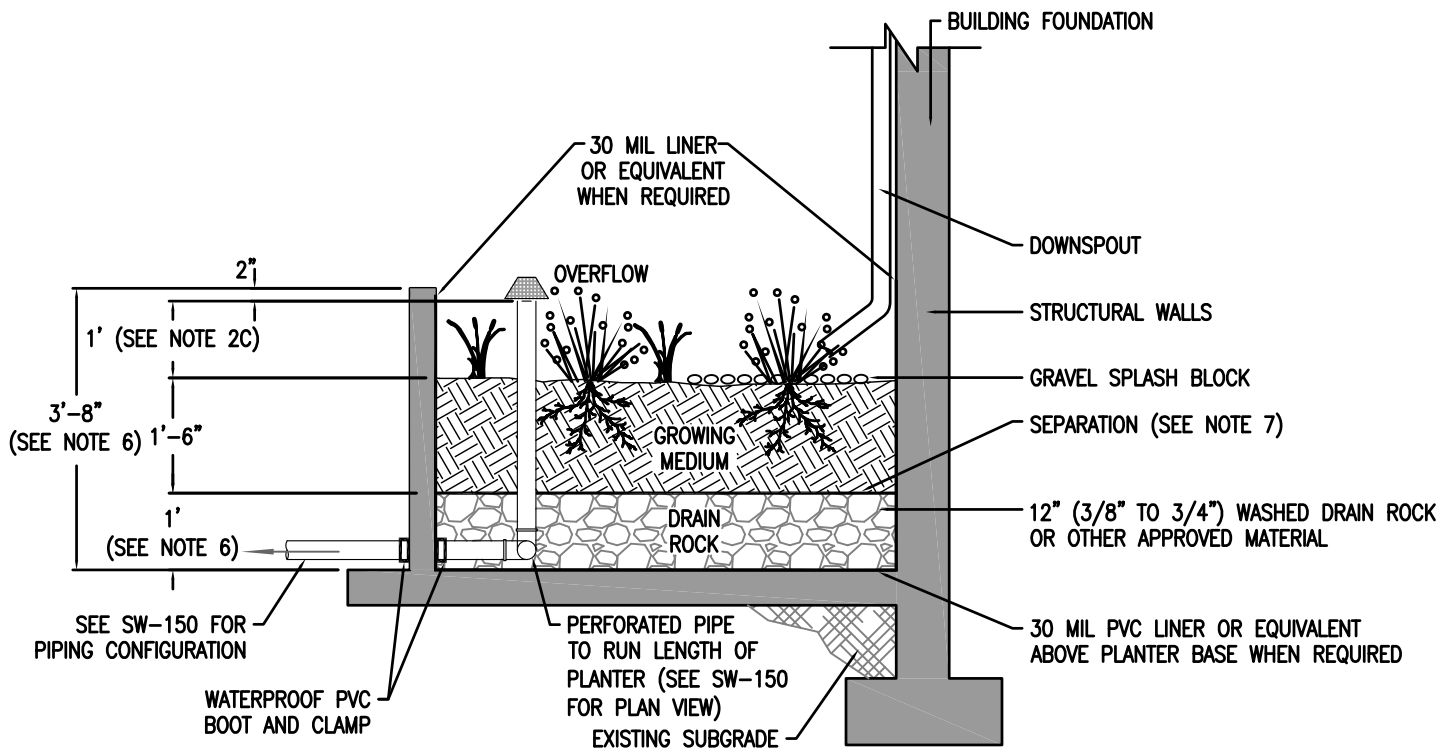
NUMBER

SW-120



Bureau of Environmental Services





1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.
2. Dimensions:
 - a. Width of flow-through planter: 18" minimum.
 - b. Width of infiltration planter: 30" minimum.
 - c. Depth of planter (from top of growing medium to overflow elevation); Simplified: 12", Presumptive: 6" - 18".
 - d. Longitudinal slope of planter: 0.5% or less.
3. Setbacks (from centerline of facility):
 - a. Infiltration planters must be 10' from foundations and 5' from property lines.
 - b. Flow-through planters must be less than 30" in height above surrounding area if within 5-feet of property line.
4. Overflow:
 - a. Overflow required for Simplified Approach
 - b. Inlet elevation must allow for 2" of freeboard, minimum.
 - c. Protect from debris and sediment with strainer or grate.
5. Piping: shall be ABS Sch.40, cast iron, or PVC Sch.40. 3" pipe required for up to 1,500 sq ft of impervious area, otherwise 4" min. Piping must have 1% grade and follow the Uniform Plumbing Code.
6. Drain rock:
 - a. Size for infiltration planter: 1-1/2" - 3/4" washed
 - b. Size for lined, flow-through planter: 3/4" washed
 - c. Depth for Simplified: 12"
 - d. Depth for Presumptive: 0-48", see calcs.
7. Separation between drain rock and growing medium: Use filter fabric (see SWMM Exhibit 2-4 Geotextile table) or a gravel lens (3/4 - 1/4 inch washed, crushed rock 2 to 3 inches deep).
8. Growing medium:
 - a. 18" minimum
 - b. See Appendix F.3 for topsoil specification or use sand/loam/compost 3-way mix.
9. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Appendix F. Minimum container size is 1 gallon. # of plantings per 100sf of facility area:
 - Zone A (wet):
 - a. 115 herbaceous plants OR;
 - b. 100 herbaceous plants and 4 small shrubs.
10. Planter walls:
 - a. Material shall be stone, brick, concrete, wood or other durable material (no chemically treated wood).
 - b. Concrete, brick, or stone walls shall be included on foundation plans.
11. Waterproof liner: Shall be 30 mil PVC or equivalent for flow-through facilities.
12. Install washed pea gravel or river rock to transition from inlets and splash pad to growing medium.
13. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, for appropriate inspections.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive Design Approach -
Planter

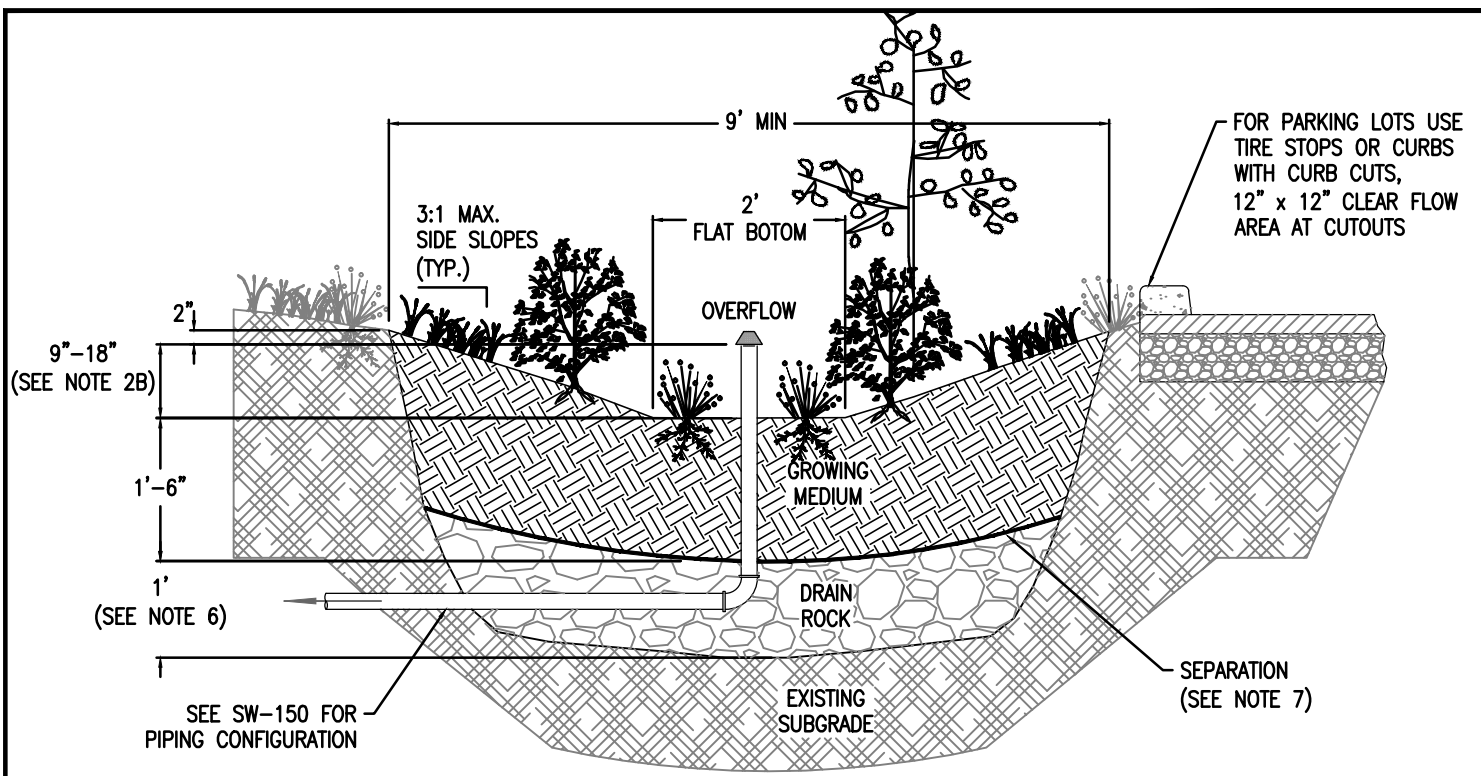
NUMBER

SW-130



Bureau of Environmental Services





1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.
2. Dimensions:
 - a. Width of basin: 9' minimum.
 - b. Depth of basin (from top of growing medium to overflow elevation); Simplified: 12", Presumptive: 9"-18".
 - c. Flat bottom width: 2' min.
 - d. Side slopes of basin: 3:1 maximum.
3. Setbacks (from midpoint of facility):
 - a. Infiltration basins must be 10' from foundations and 5' from property lines.
 - b. Flow-through swales must connect to approved discharge point according to SWMM Section 1.3.
4. Overflow:
 - a. Overflow required for Simplified Approach.
 - b. Inlet elevation must allow for 2" of freeboard, minimum.
 - c. Protect from debris and sediment with strainer or grate.
5. Piping: shall be ABS Sch.40, cast iron, or PVC Sch.40. 3" pipe required for up to 1,500 sq ft of impervious area, otherwise 4" min. Piping must have 1% grade and follow the Uniform Plumbing Code.
6. Drain rock:
 - a. Size for infiltration basin: 1-1/2" - 3/4" washed
 - b. Size for flow-through basin: 3/4" washed
 - c. Depth for Simplified: 12"
 - d. Depth for Presumptive: 0-48", see calcs.
7. Separation between drain rock and growing medium: Use a gravel lens (3/4" - 1/4" washed, crushed rock 2 to 3 inches deep) or approved equivalent.
8. Growing medium:
 - a. 18" minimum
 - b. See Appendix F.3 for topsoil specification or use sand/loam/compost 3-way mix.
9. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Appendix F. Minimum container size is 1 gallon. Number of plantings per 100sf of facility area:
 - a. Zone A (wet): 115 herbaceous plants OR 100 herbaceous plants and 4 shrubs
 - b. Zone B (moderate to dry): 1 tree AND 3 large shrubs AND 4 medium to small shrubs.
 The delineation between Zone A and B shall be either at the outlet elevation or the check dam elevation, whichever is lowest.
10. Install washed pea gravel or river rock to transition from inlets and splash pad to growing medium.
11. Inspections: Call BDS IVR Inspection Line, (503) 823-7000 for appropriate inspections.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive Design Approach -
Basin

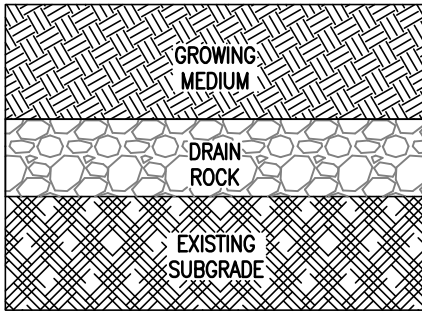
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SW-140

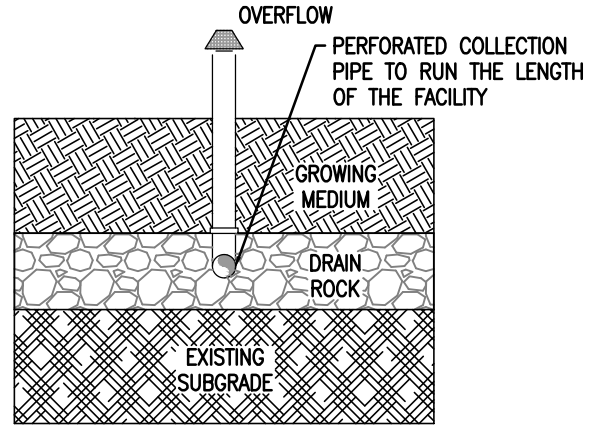


Bureau of Environmental Services

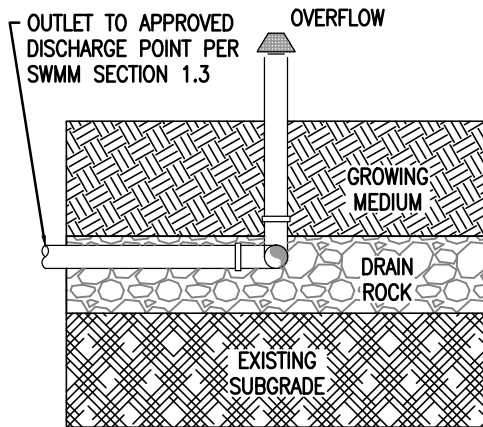




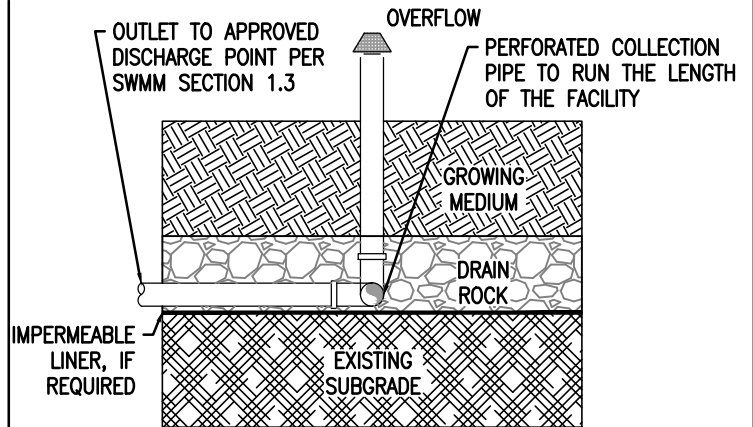
INFILTRATION
STORMWATER HIERARCHY CATEGORY 1



HYBRID
STORMWATER HIERARCHY CATEGORY 2
OVERFLOW DIRECTED TO DRAIN ROCK. (SEE SW-151 AND SW-152 FOR MORE INFORMATION)

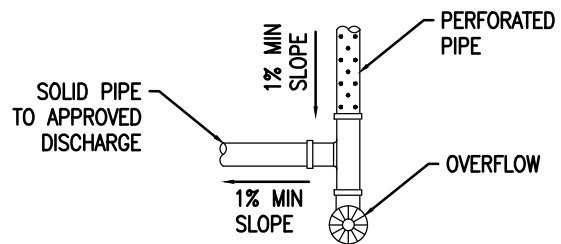


PARTIAL INFILTRATION
STORMWATER HIERARCHY CATEGORY 3 or 4
OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN WITHIN DRAIN ROCK



FLOW-THROUGH
STORMWATER HIERARCHY CATEGORY 3 or 4
OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN AT BASE OF DRAIN ROCK LINER.

NOTE:
HYBRID FACILITIES MUST BE REGISTERED AS A UIC DESIGNED UNDER THE PRESUMPTIVE APPROACH.



PLAN VIEW

PIPE W/ UNDERDRAIN & DISCHARGE POINT

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive Design Approach -
Facility Overflow Configurations

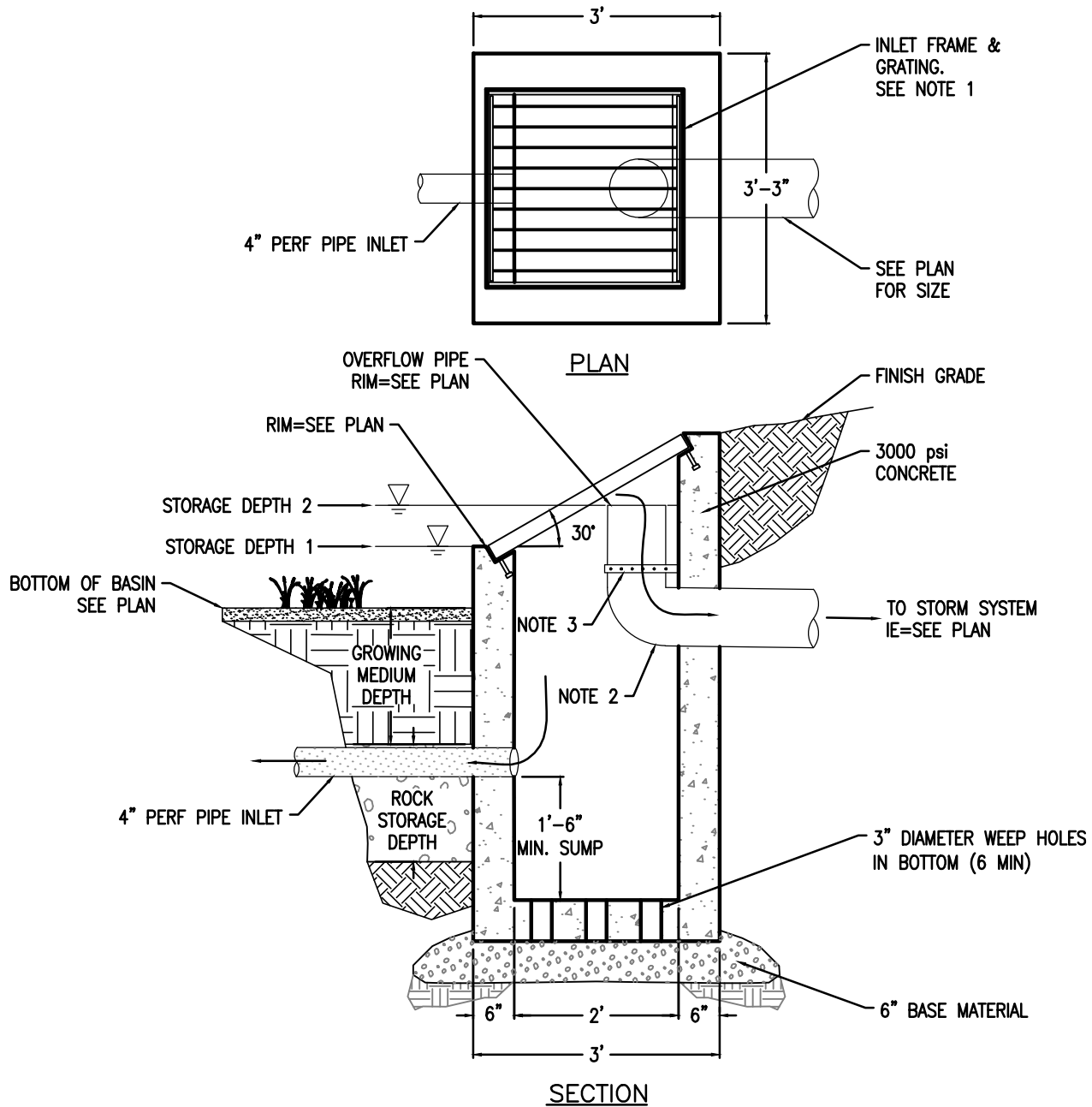


Bureau of Environmental Services



NUMBER

SW-150



NOTE:

1. GRATING AND FRAME SHALL BE GALVANIZED STEEL MEDIUM DUTY.
2. 8" DIA. OUTLET PIPE WITH UPTURNED ELBOW,
3. SECURE OUTLET PIPE WITH S/S BAND EMBEDDED 2" IN WALL.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Presumptive Design Approach -
Hybrid Configuration E

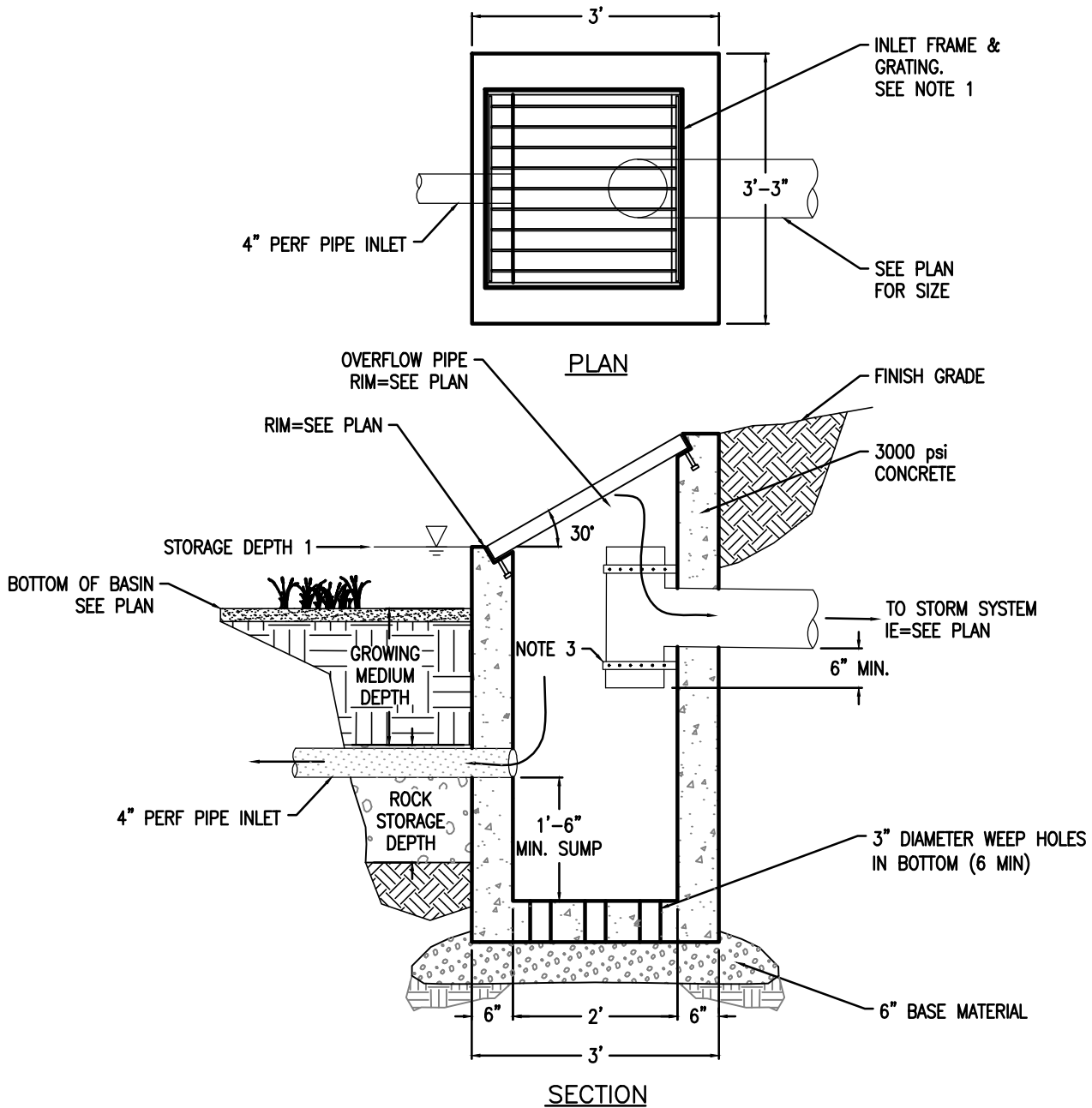
NUMBER

SW-151



Bureau of Environmental Services





NOTE:

1. GRATING AND FRAME SHALL BE GALVANIZED STEEL MEDIUM DUTY
2. 8" DIA. OUTLET PIPE WITH UPTURNED ELBOW
3. SECURE OUTLET PIPE WITH S/S BAND EMBEDDED 2" IN WALL

- DRAWING NOT TO SCALE -

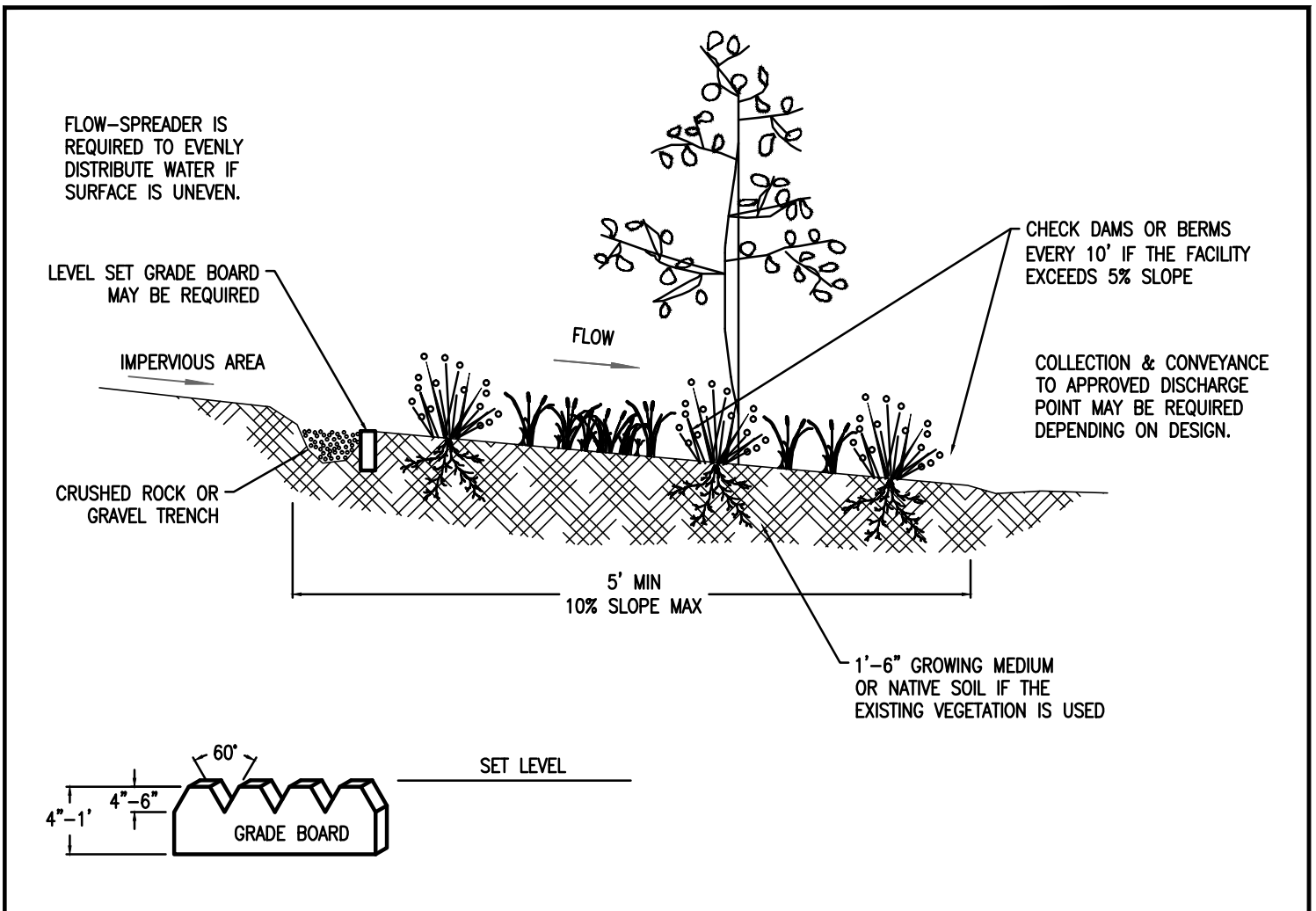
STORMWATER MANAGEMENT TYPICAL DETAILS

- Presumptive Design Approach -
Hybrid Configuration F

NUMBER

SW-152





1. Provide protection from all vehicle traffic, equipment staging, as well as foot traffic for proposed infiltration areas prior to and during construction.
2. Dimensions:
 - a. Flow line length: 5' minimum.
 - b. Slopes: 0.5 - 10%
3. Setbacks (from beginning of facility):
 - a. 5' from property line
 - b. 10ft from buildings
 - c. 50ft from wetlands, rivers, streams, and creeks where required.
4. Overflow: Collection from filter strip shall be specified on plans to approved discharge point according to SWMM Section 1.3.
5. Growing medium: Unless existing vegetated areas are used for the filter strip, growing medium shall be used within the top 18" (See Appendix F.3 for topsoil specifications or use sand/loam/compost 3-way mix).
6. Vegetation: The entire filter strip must have 100% coverage by native grasses, native wildflower blends, native ground covers, or any combination thereof.
7. Level Spreaders: A grade board or sand/gravel trench may be required to disperse the runoff evenly across the filter strip to prevent a point of discharge. The top of the level spreader must be horizontal and at an appropriate height to provide sheetflow directly to the soil without scour. Level spreaders shall not hold a permanent volume of runoff. Grade boards can be made of any material that will withstand weather and solar degradation. Trenches used as level spreaders can be filled with washed crushed rock, pea gravel, or sand
8. Check dams: shall be placed according to facility design otherwise:
 - a. 12" in length
 - b. Equal to the width of the filter
 - c. 3 to 5" in height
 - d. Every 10' where slope exceeds 5%.
9. Inspections: call BDS IVR Inspection Line, (503) 823-7000, for appropriate inspections.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive / Performance Design Approach -
Filter Strip

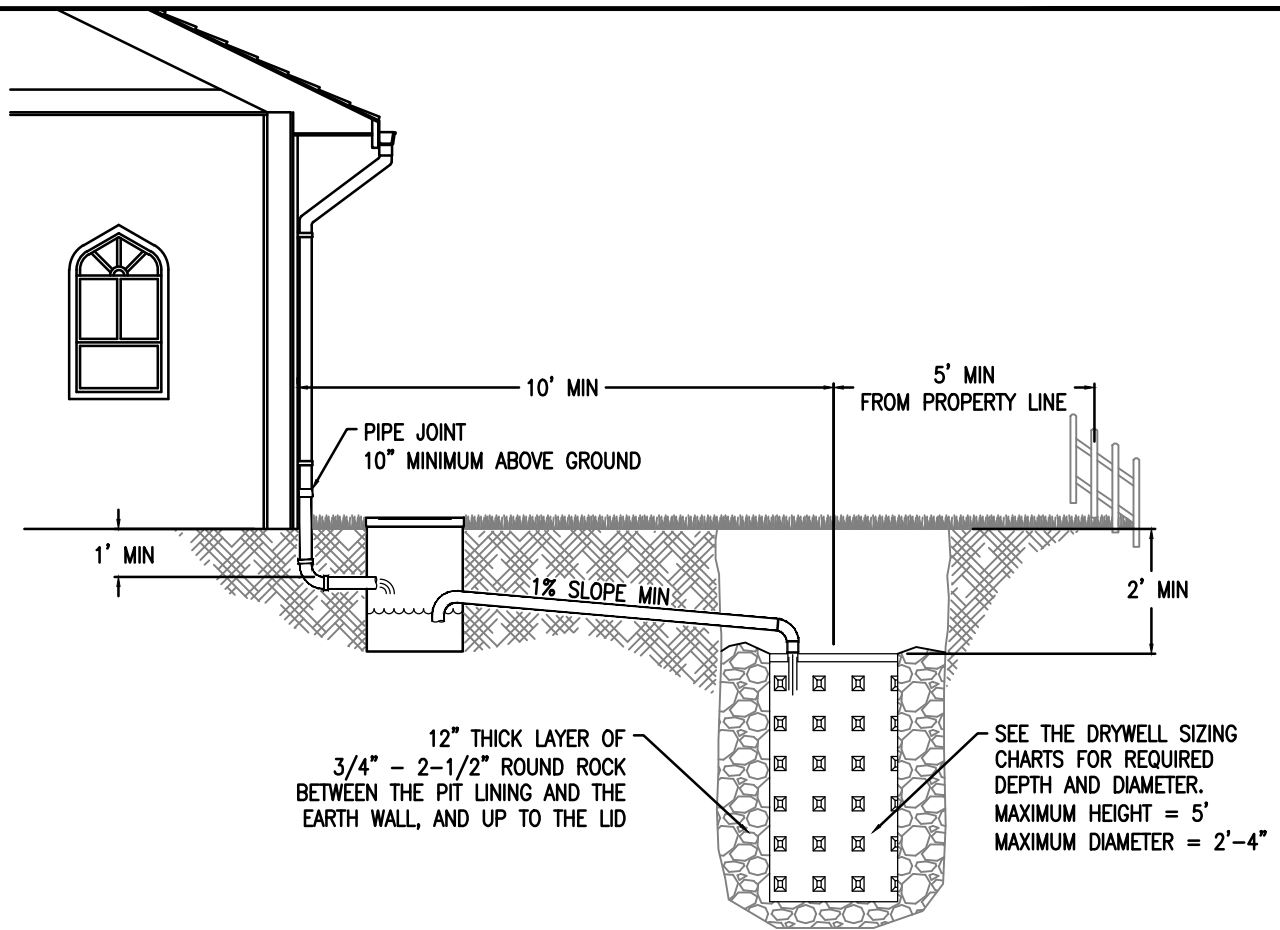


Bureau of Environmental Services



NUMBER

SW-160



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.
2. Siting criteria: Gravelly sand, gravelly loamy sand, or other equally porous material must occur in a continuous 5' deep stratum within 12' of the ground surface.
3. Sizing: Exhibit 2-36 is used to appropriately size the drywell(s) based on the amount of impervious area that each drywell is designed to manage. This chart shall be used as guidance, is based on field experience, and should be used as minimums only.
4. Drywell shall not be installed where base of facility has less than 5' of separation to water table.
5. Top of drywell must be below lowest finished floor.
6. Setbacks (from center of facility):
 - a. 10' from foundations
 - b. 5' from property lines
 - c. 20' from cesspools.
7. Piping shall be ABS SCH40, cast iron, or PVC SCH40. 3" pipe must be used for up to 1500sf of impervious area, otherwise 4" minimum. Piping must have 1% grade and must follow current Uniform Plumbing Code.

Exhibit 2-36: Drywell Sizing Table

Once approval has been given by BeS for onsite infiltration of stormwater, the following chart shall be used to select the number and size of drywells. Gray boxes are acceptable.

IMPERVIOUS Area (sq-ft)	28" Diameter				48" Diameter			
	Drywell Depth							
	5'	10'	15'	20'	5'	10'	15'	20'
1000								
2000								
3000								
4000								
5000								
6000								
7000								
8000								
9000								
10000								

- DRAWING NOT TO SCALE -

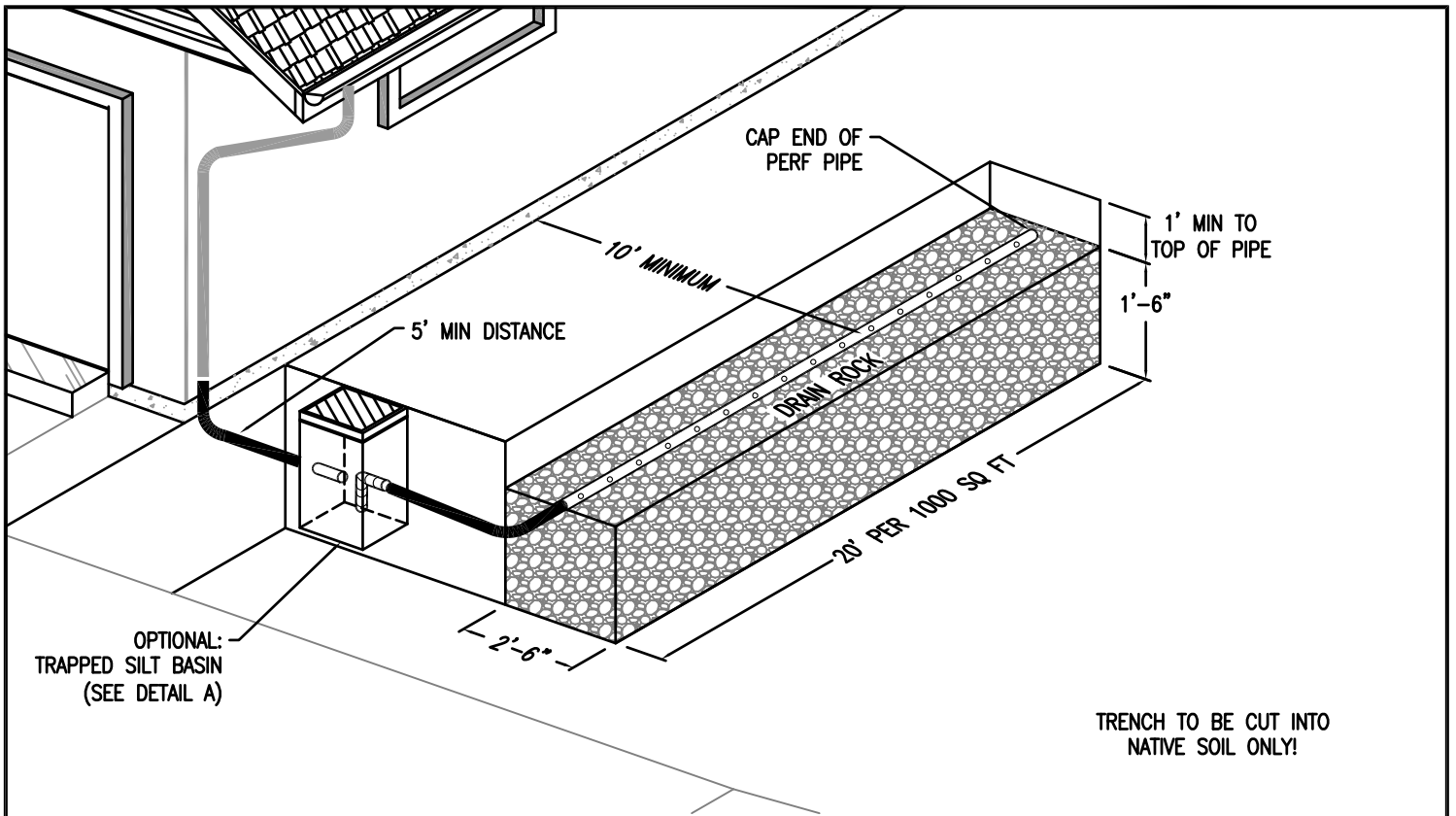
STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive Design Approach -
Drywell

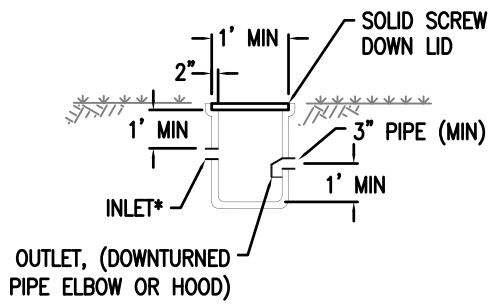
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SW-170



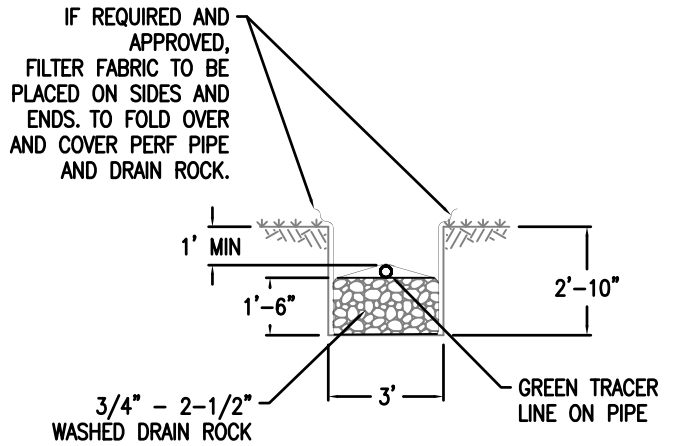


DETAIL A: OPTIONAL TRAPPED SILT BASIN DETAIL



* THE BOTTOM OF THE INLET PIPE MUST NOT BE LOWER THAN THE TOP OF THE OUTLET PIPE.

DETAIL B: SOAKAGE TRENCH CONSTRUCTION



IF REQUIRED AND APPROVED, LINE TRENCH SIDES WITH FILTER FABRIC AS SHOWN, ADD 18" OF DRAIN ROCK. PLACE PERF. PIPE AND COVER ALL.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive Design Approach -
Soakage Trench
 East Side

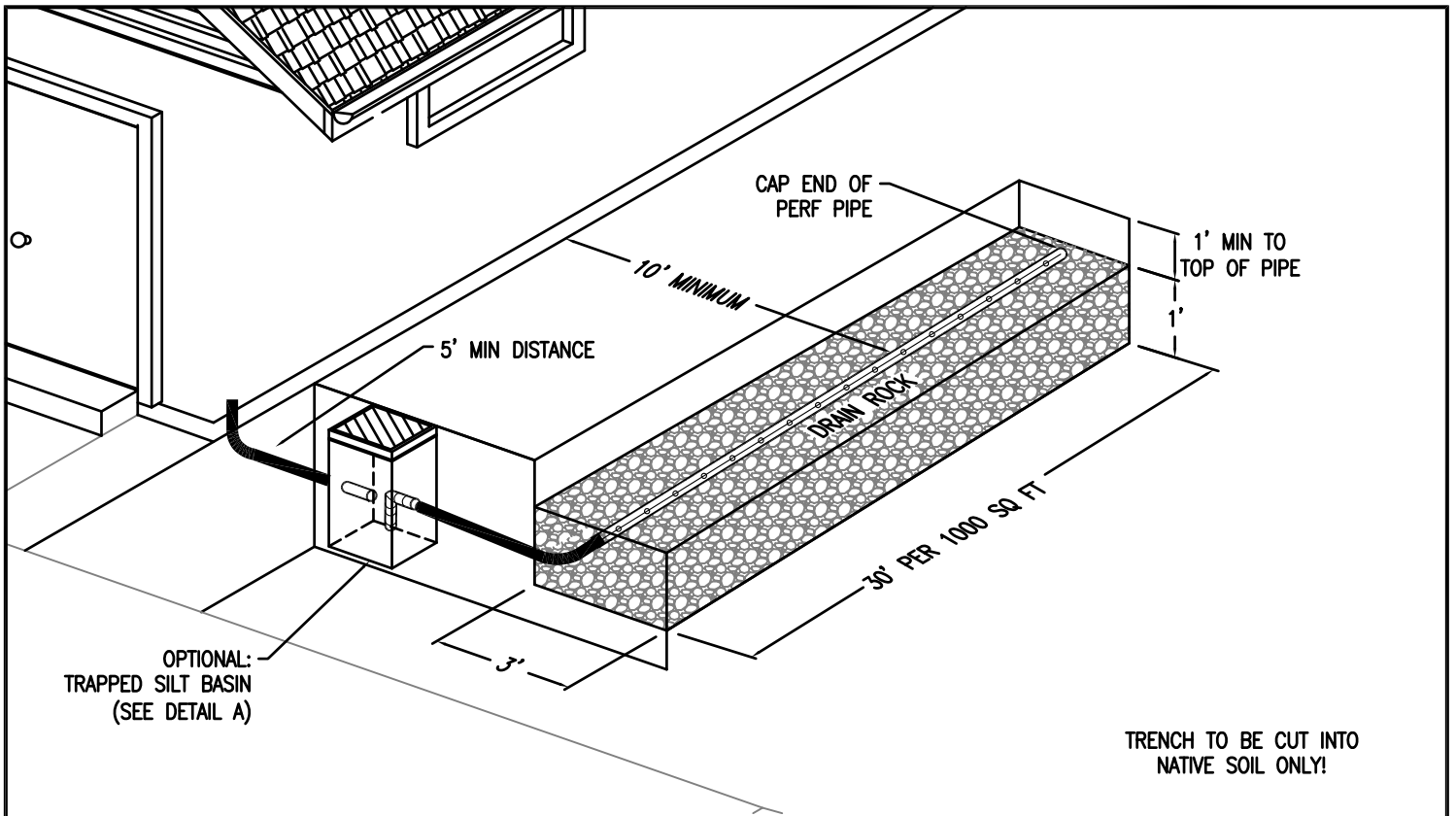


Bureau of Environmental Services



NUMBER

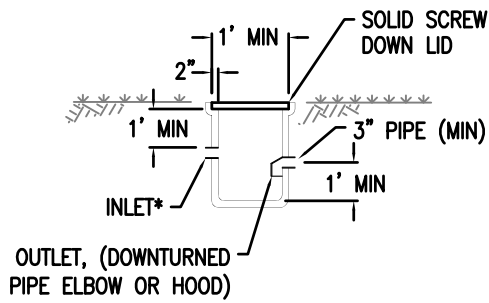
SW-180



OPTIONAL:
TRAPPED SILT BASIN
(SEE DETAIL A)

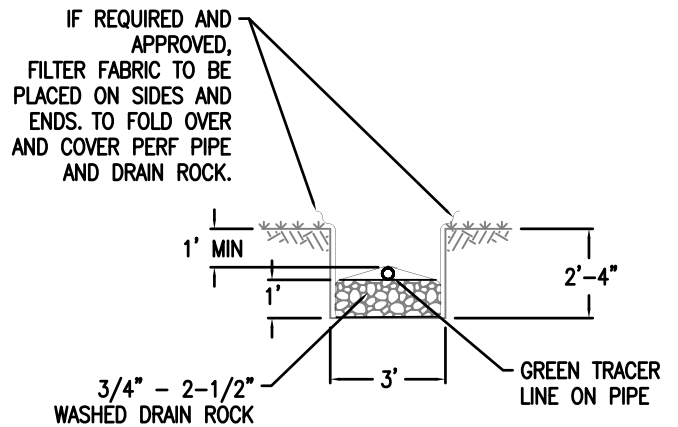
TRENCH TO BE CUT INTO
NATIVE SOIL ONLY!

**DETAIL A: OPTIONAL TRAPPED
SILT BASIN DETAIL**



* THE BOTTOM OF THE
INLET PIPE MUST NOT BE
LOWER THAN THE TOP OF
THE OUTLET PIPE.

**DETAIL B: SOAKAGE TRENCH
CONSTRUCTION**



IF REQUIRED AND APPROVED,
LINE TRENCH SIDES WITH
FILTER FABRIC AS SHOWN,
ADD 18" OF DRAIN ROCK.
PLACE PERF. PIPE AND
COVER ALL.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified / Presumptive Design Approach -

Soakage Trench

West Side



Bureau of Environmental Services



NUMBER

SW-181

Appendix G.2 Table of Contents

SW-220: Sand Filter – Infiltration

SW-221: Sand Filter – Sub-Surface

SW-230: Pond Setback Details

SW-231: Pond – Secondary Riser Stack

SW-232: Pond – Emergency Overflow Spillway Weir

SW-233: Pond – Inlet / Outlet Anti-Seepage Collar

SW-234: Pond – Inflow Riser Manhole with Grate Cover

SW-250: Rainwater Harvesting

SW-260: Detention Tank Facility

SW-261: Access Riser Detail

SW-262: Detention Vault Facility

SW-263: Orifice Location Tee Riser

SW-264: Orifice Location Baffle Riser

SW-265: Orifice Structure

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Performance Facilities –
Table of Contents

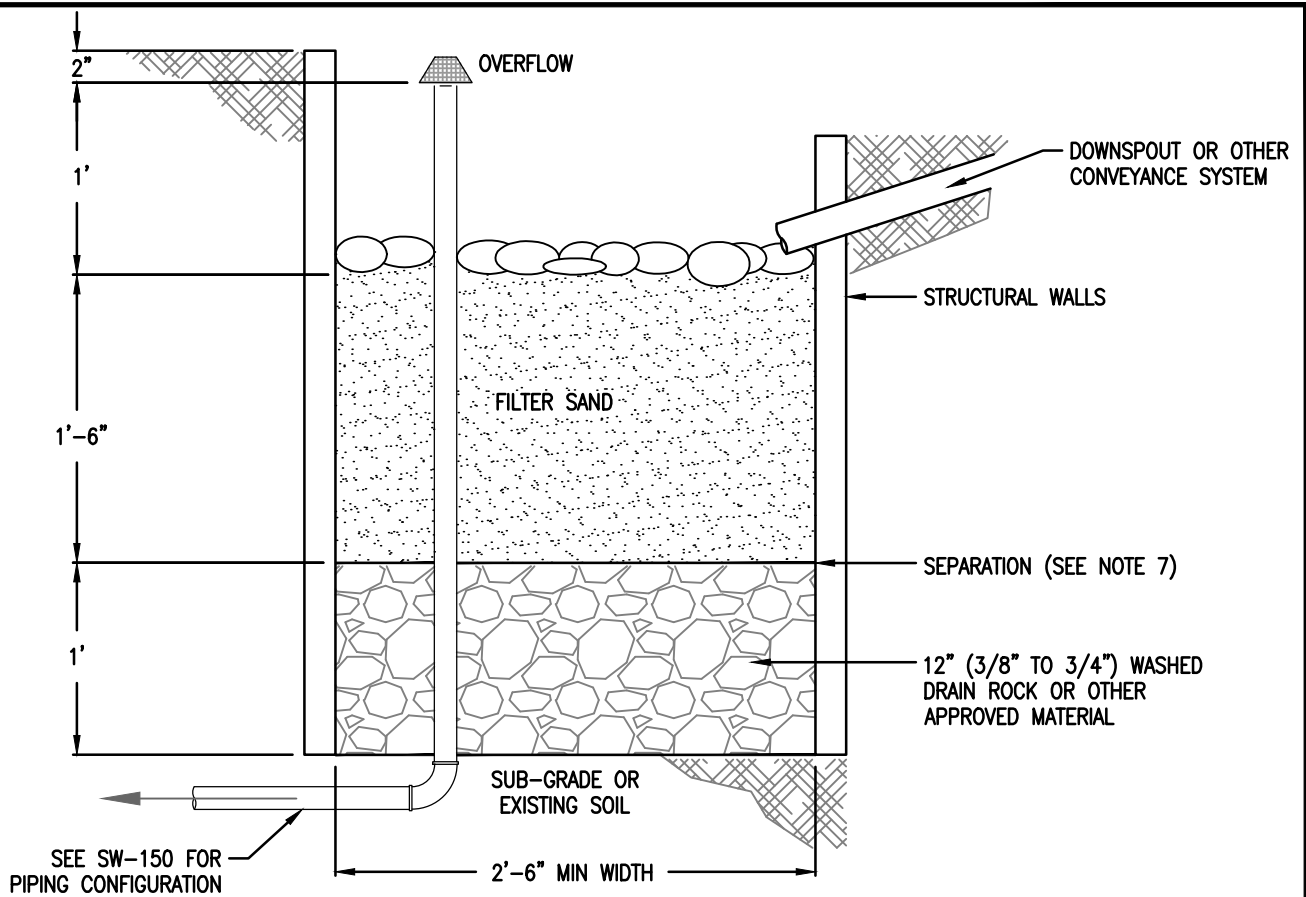


Bureau of Environmental Services



NUMBER

TOC



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.
2. Dimensions:
 - a. Width of sand filter: 18" minimum.
 - b. Depth of sand filter (from top of sand to overflow elevation). Simplified: 12"; Presumptive: 6" - 18".
 - c. Slope of sand filter: 0.5% or less.
3. Setbacks (from centerline of facility):
 - a. Infiltration sand filters must be 10' from foundations and 5' from property lines.
 - b. Flow-through sand filters must be less than 30" in height above surrounding area if within 5 feet of property line.
4. Overflow (where required):
 - a. Overflow required for Simplified Approach.
 - b. Inlet elevation must allow for 2" of freeboard, minimum.
 - c. Protect from debris, sand, and sediment with strainer or grate.
5. Piping: shall be ABS Sch.40, cast iron, or PVS Sch.40. 3" pipe required for up to 1,500 sq ft of impervious area, otherwise 4" min. Piping must have 1% grade and follow the Uniform Plumbing Code.
6. Drain rock (minimum):
 - a. Infiltration sand filter: 12" of 1-1/2" - 3/4" washed.
 - b. Flow-through sand filter: 8" of 3/4" washed.
7. Separation between drain rock and sand: Use a gravel lens (3/4 - 1/4 inch washed, crushed rock 2 to 3 inches deep) or approved equivalent.
8. Filter sand:
 - a. 18" minimum.
 - b. See sand spec in SWMM Exhibit 2-4.
9. Sand filter walls:
 - a. Material shall be stone, brick, concrete, wood, or other durable material (no chemically treated wood).
 - b. Concrete, brick, or stone walls shall be included on foundation plans.
10. Waterproof liner: Shall be 30 mil PVC or equivalent when lining is required.
11. Install washed pea gravel or river rock to transition from inlet or splash pad to growing medium.
12. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, for appropriate inspections.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -
Sand Filter

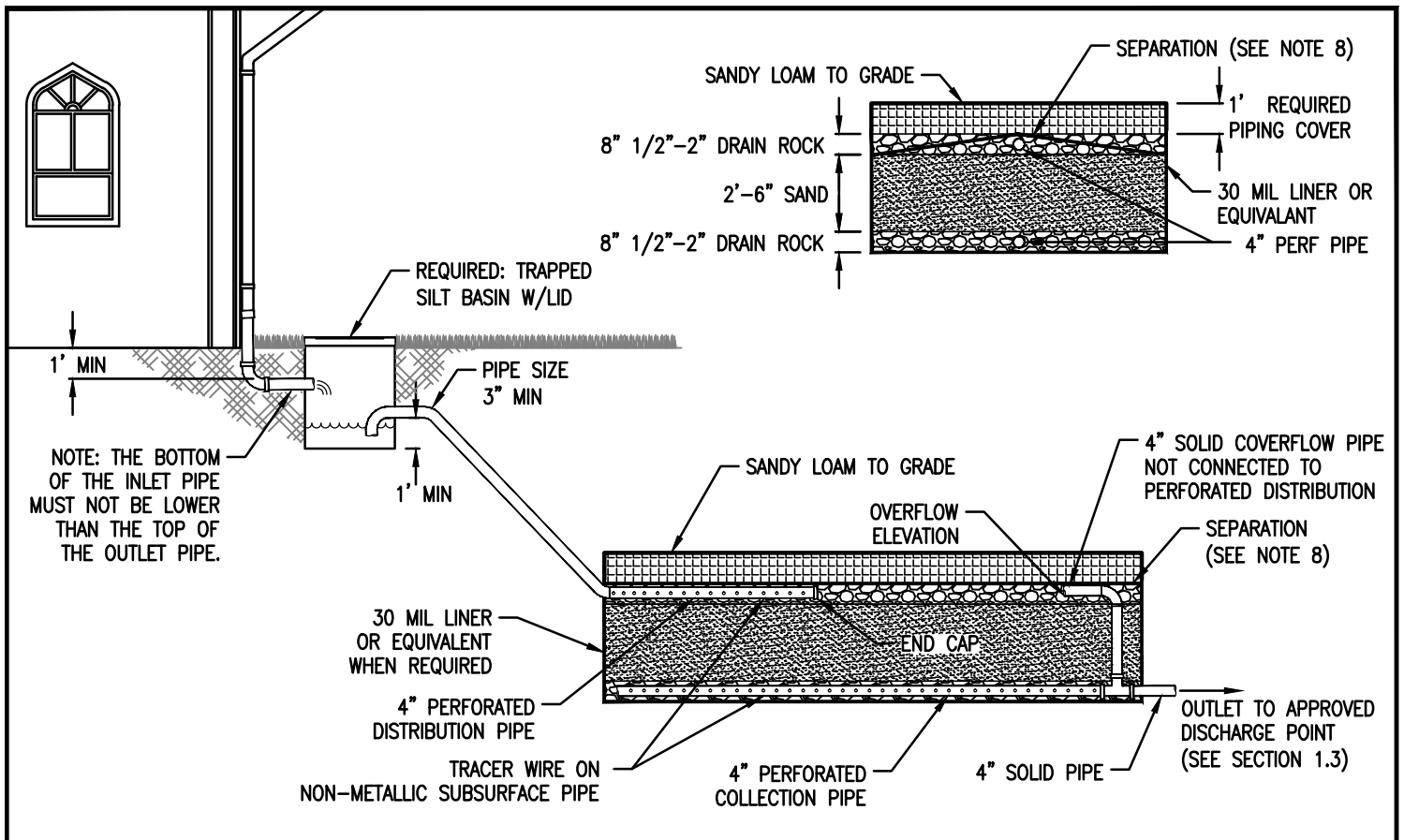
NUMBER

SW-220



Bureau of Environmental Services





1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to and during construction.
2. Dimensions:
 - a. Height of subsurface sandfilter: 46" from base.
 - b. Depth of excavation: 58" Min. (to accommodate 12" of cover).
3. Setbacks (from centerline of facility):
 - a. Infiltration facilities must be 10' from foundations and 5' from property lines.
 - b. Flow-through facilities may be within 10' of foundation and within 5' of property line if properly lined.
4. Trapped silt basin required prior to inlet to subsurface sand filter.
5. Overflow: perforated collection pipe within top gravel layer connected to approved discharge point according to Section 1.3.
6. Piping shall be ABS SCH40, cast iron, or PVC SCH40. 3" pipe must be used for up to 1500sf of impervious area, otherwise 4" minimum. Piping must have 1% grade and must follow current Uniform Plumbing Code.
 - a. Underdrain piping system shall consist of minimum 4" diameter collector manifold with perforated lateral branch lines.
7. Drain rock and sand depth:
 - a. 8" of 3/4" washed drain rock as base.
 - b. 30" of washed sand (See sand spec in SWMM Section 2.3.3).
 - c. 8" top layer of 3/4" washed drain rock over sand.
8. Separation between drain rock and sand: Use filter fabric (see SWMM Exhibit 2-4 Geotextile table) or a gravel lens (3/4 - 1/4 inch washed, crushed rock 2 to 3 inches deep) or approved equivalent.
9. Waterproof liner: Shall be 30 mil PVC or equivalent for flow-through facilities when lining is required.
10. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, for appropriate inspections.
- b. Underdrain laterals shall be placed with minimum 1% positive gravity drainage to the collector manifold.
- c. The collector manifold shall have a minimum 1% grade toward the discharge joint.
- d. Lateral spacing of collection or distribution pipes shall not exceed 10'.
- e. All laterals and collector manifolds shall have cleanouts installed, accessible from the surface without removing or disturbing filter media.
- f. Outlet to approved discharge point shall be protected from soil, gravel, or sand displacement with filter fabric or equivalent.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -
Subsurface Sand Filter

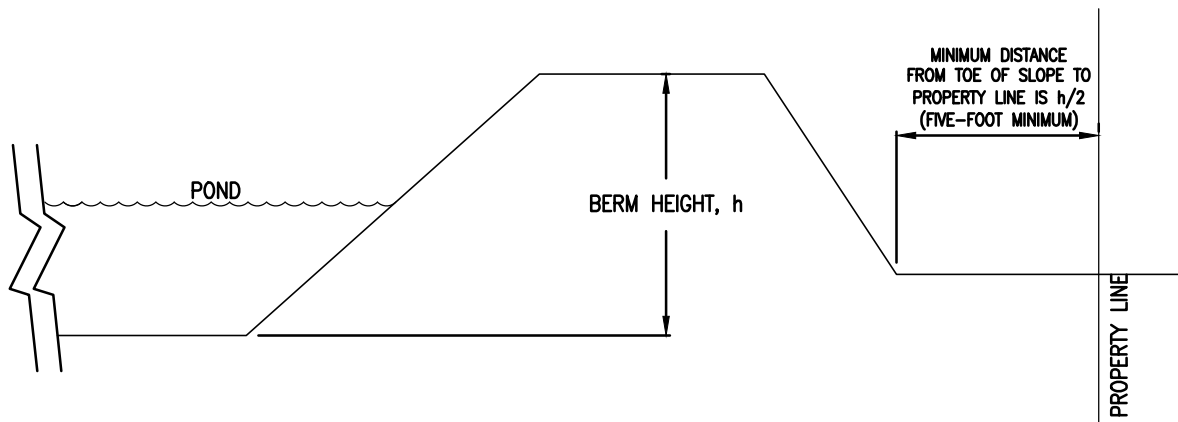
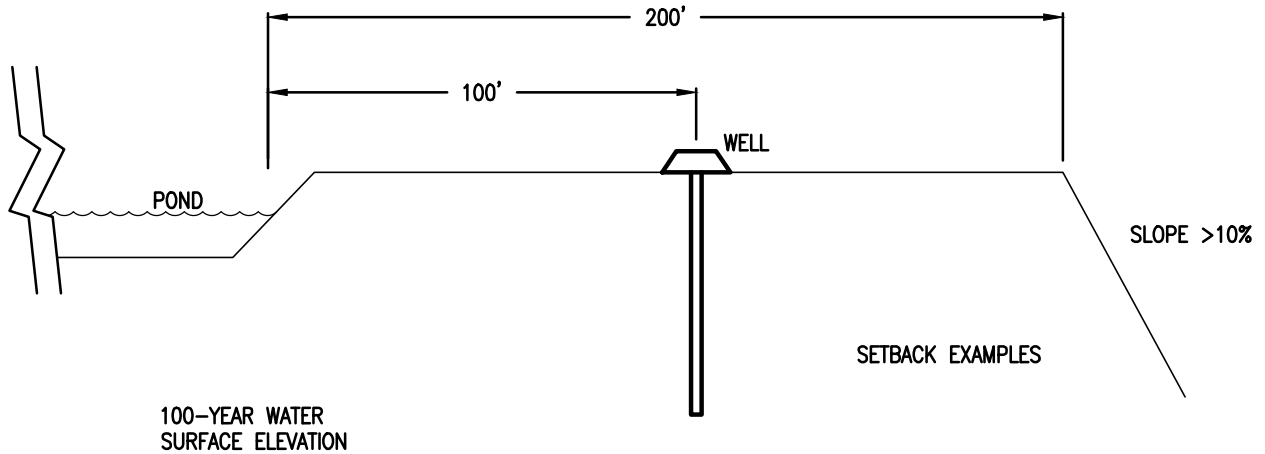


Bureau of Environmental Services



NUMBER

SW-221



- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -

Pond
Setback Details

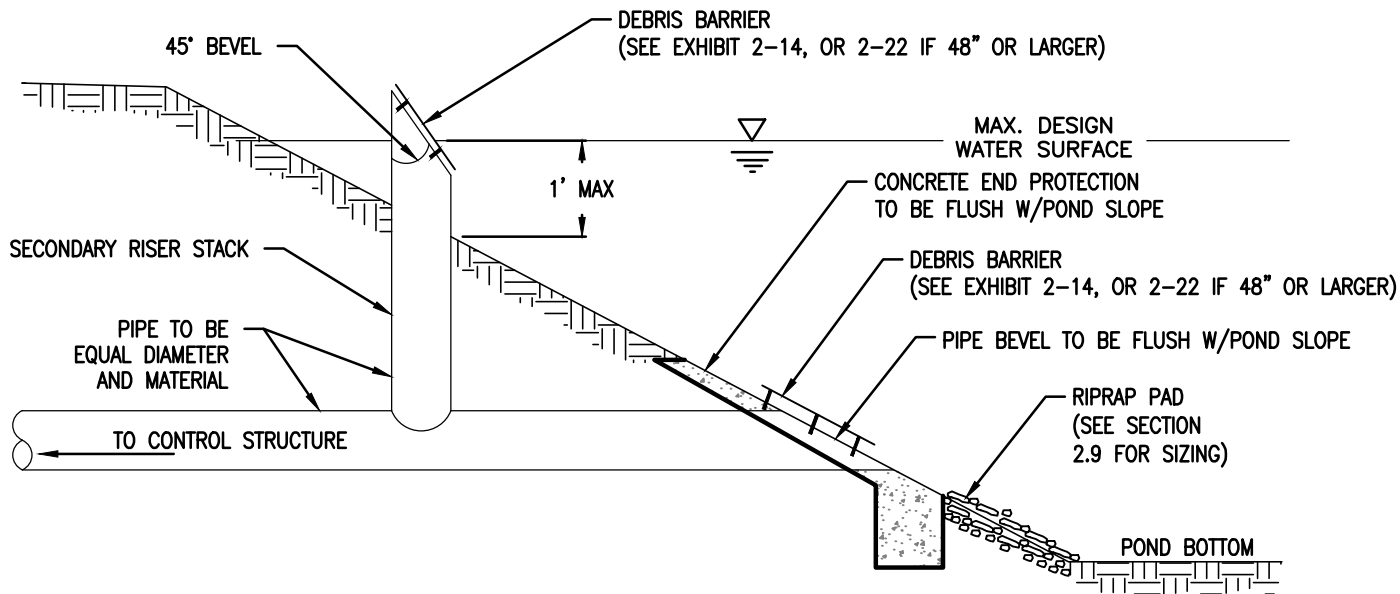
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SW- 230



Bureau of Environmental Services





- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -

Pond
Secondary Riser Stack

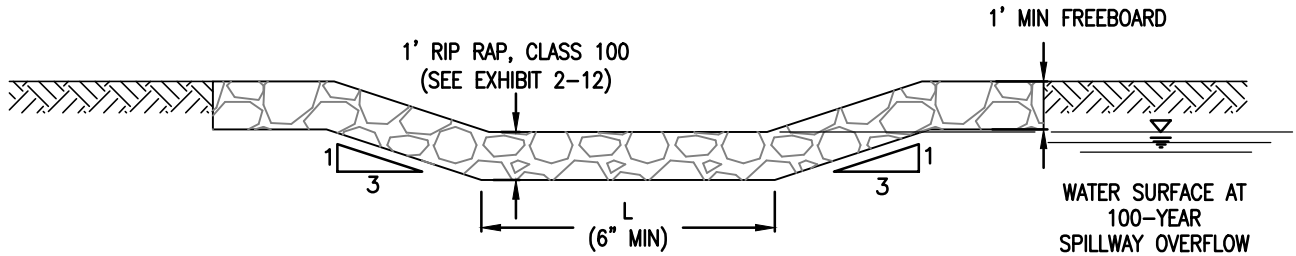
NUMBER

SW- 231



Bureau of Environmental Services





- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -

Pond
Emergency Overflow Spillway Weir

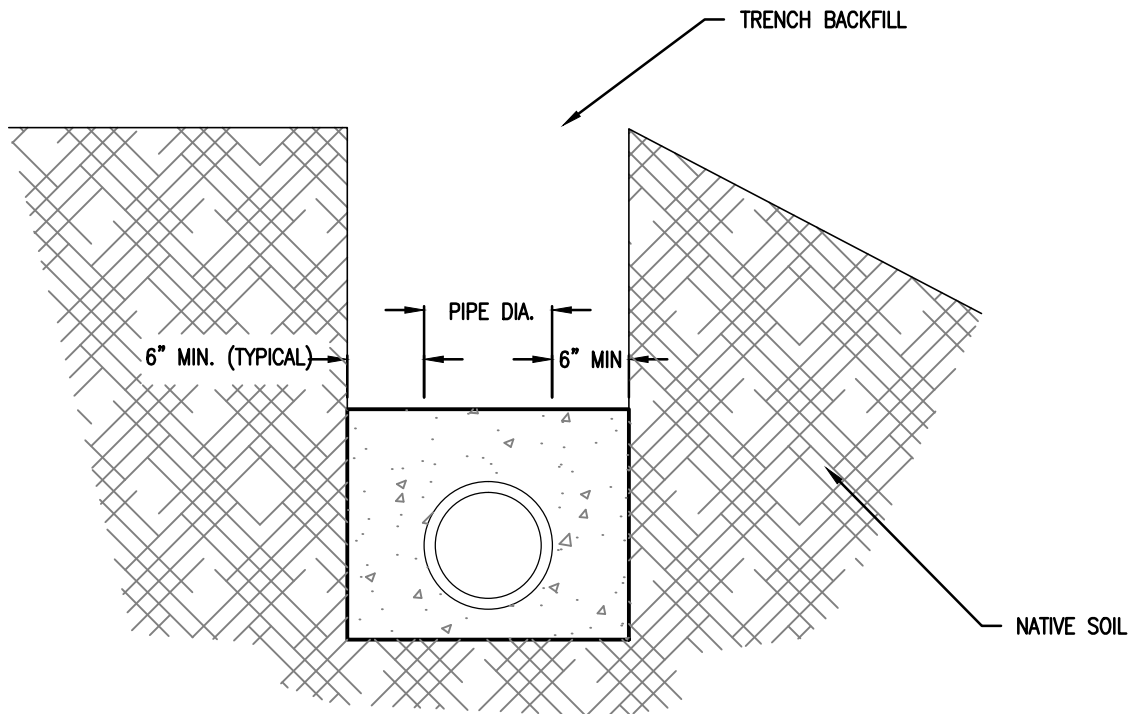
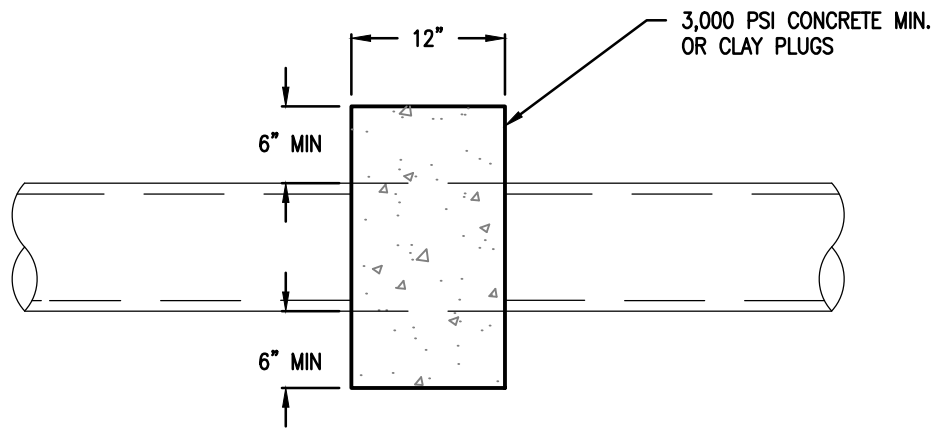
NUMBER

SW- 232



Bureau of Environmental Services





- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -

Pond

Inlet/Outlet Anti-Seepage Collar

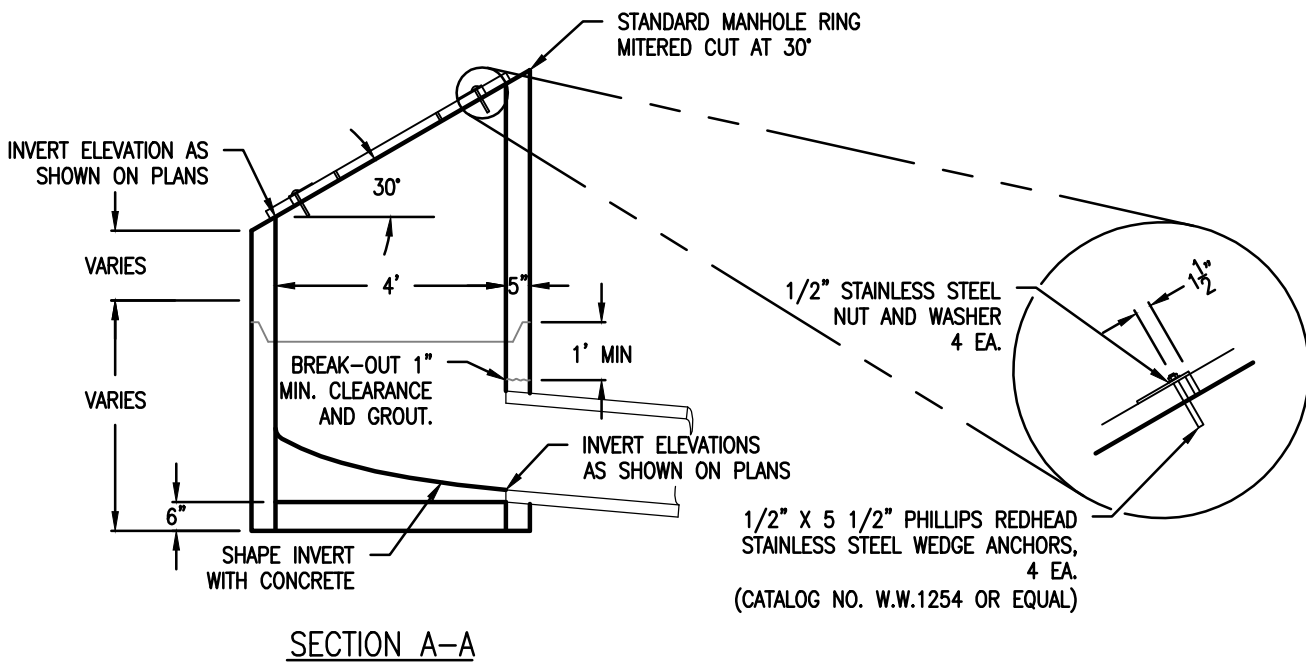
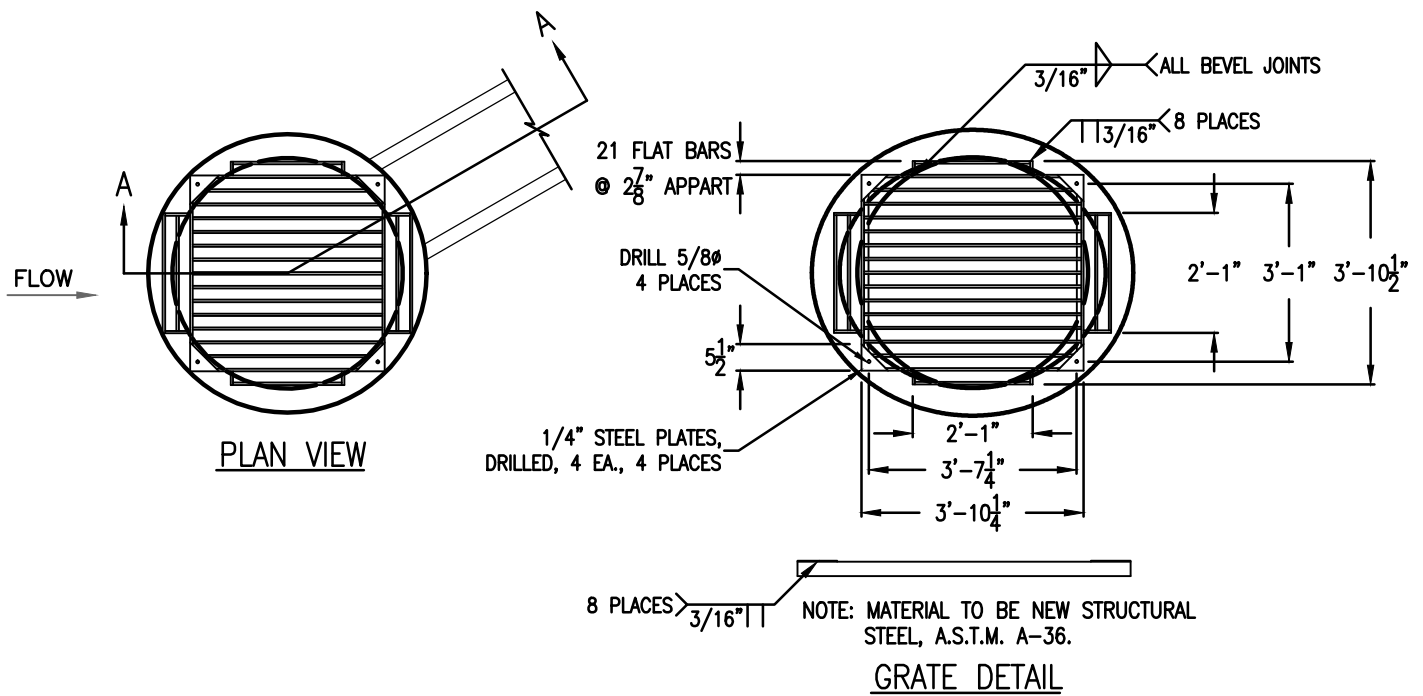
NUMBER

SW- 233



Bureau of Environmental Services





NOTE: ALL PRECAST SECTIONS SHALL CONFORM TO REQUIREMENTS OF A.S.T.M. C-478.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -

Pond

Inflow Riser Manhole w/ Grate Cover

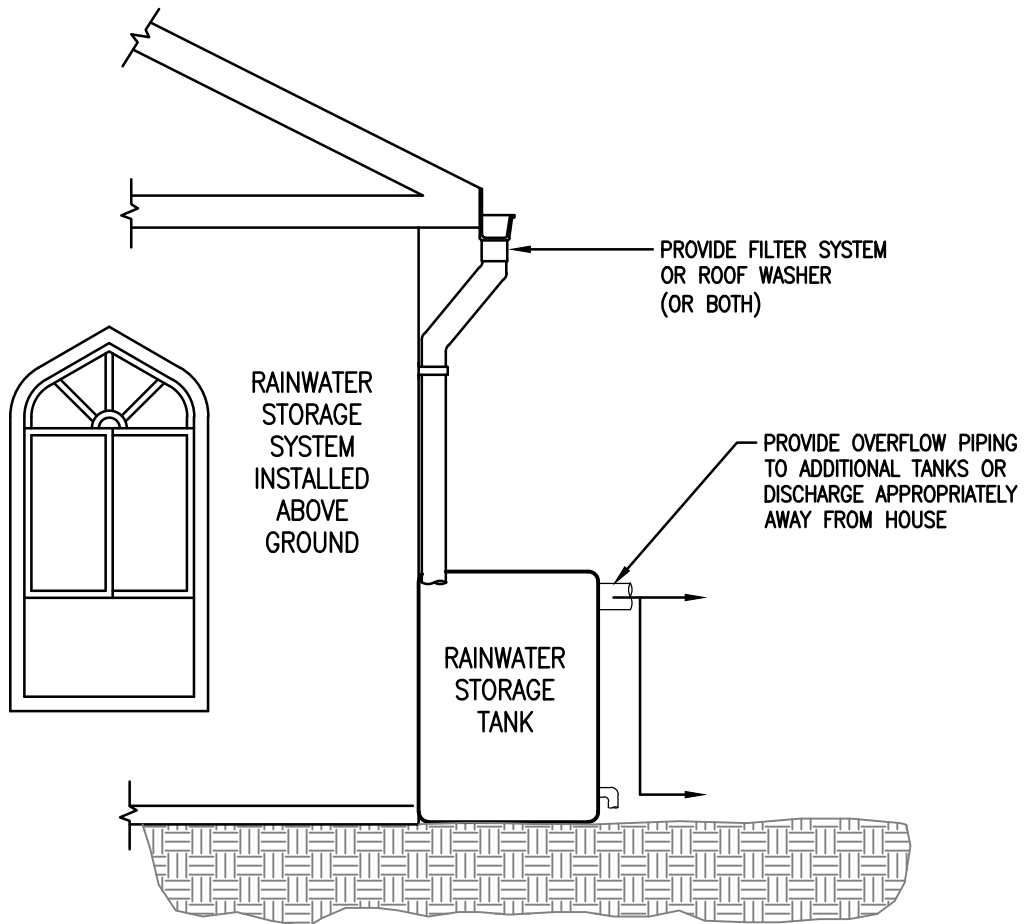
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SW- 234



Bureau of Environmental Services





- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Design Approach -
Rainwater Harvesting

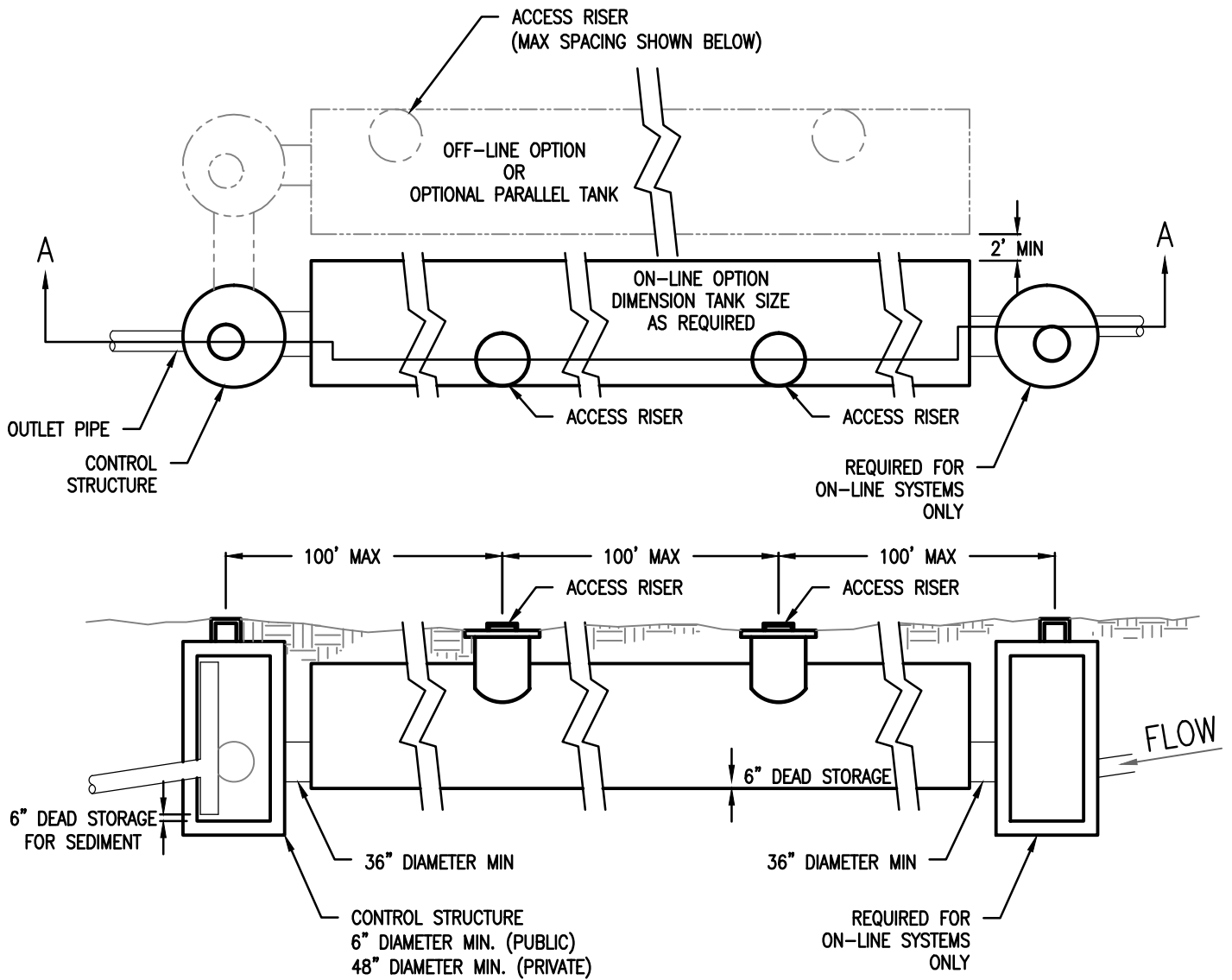
NUMBER

SW- 250



Bureau of Environmental Services





SECTION A-A

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -
Detention Tank

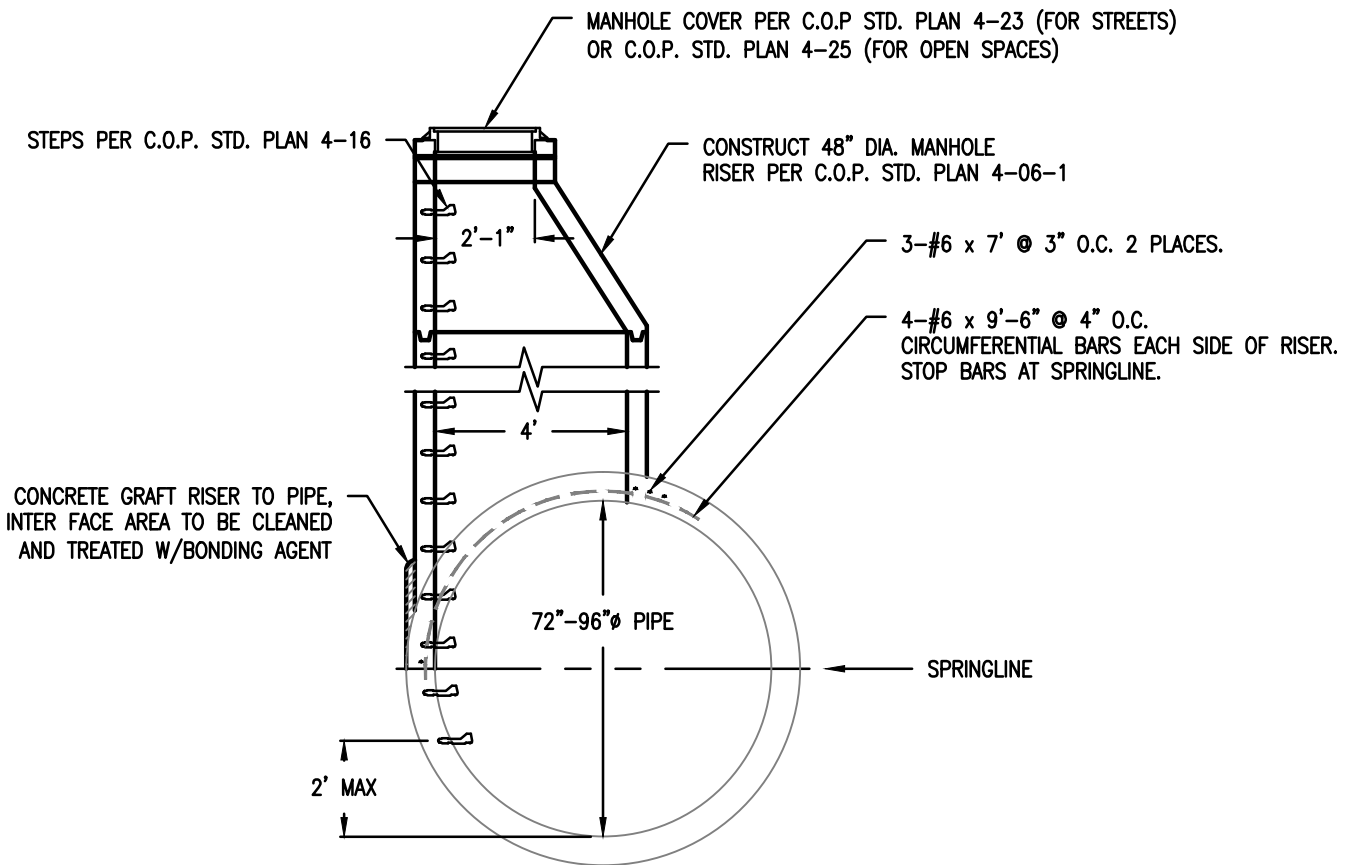
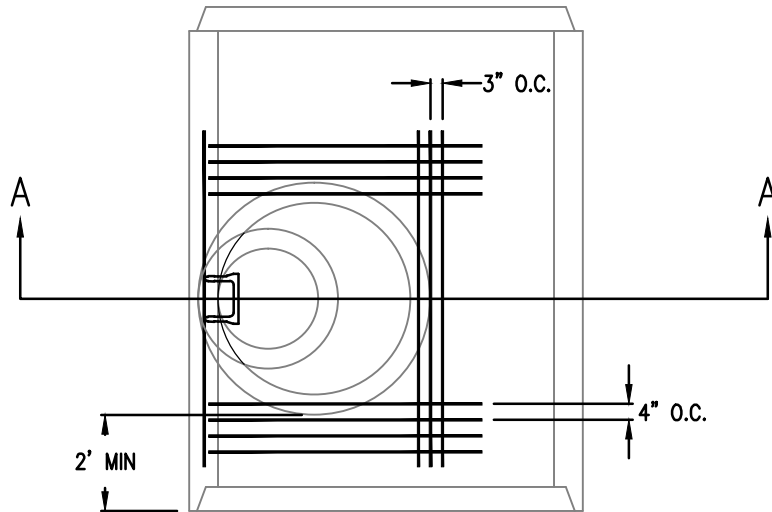
NUMBER

SW- 260



Bureau of Environmental Services





- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -
Access Riser

NUMBER

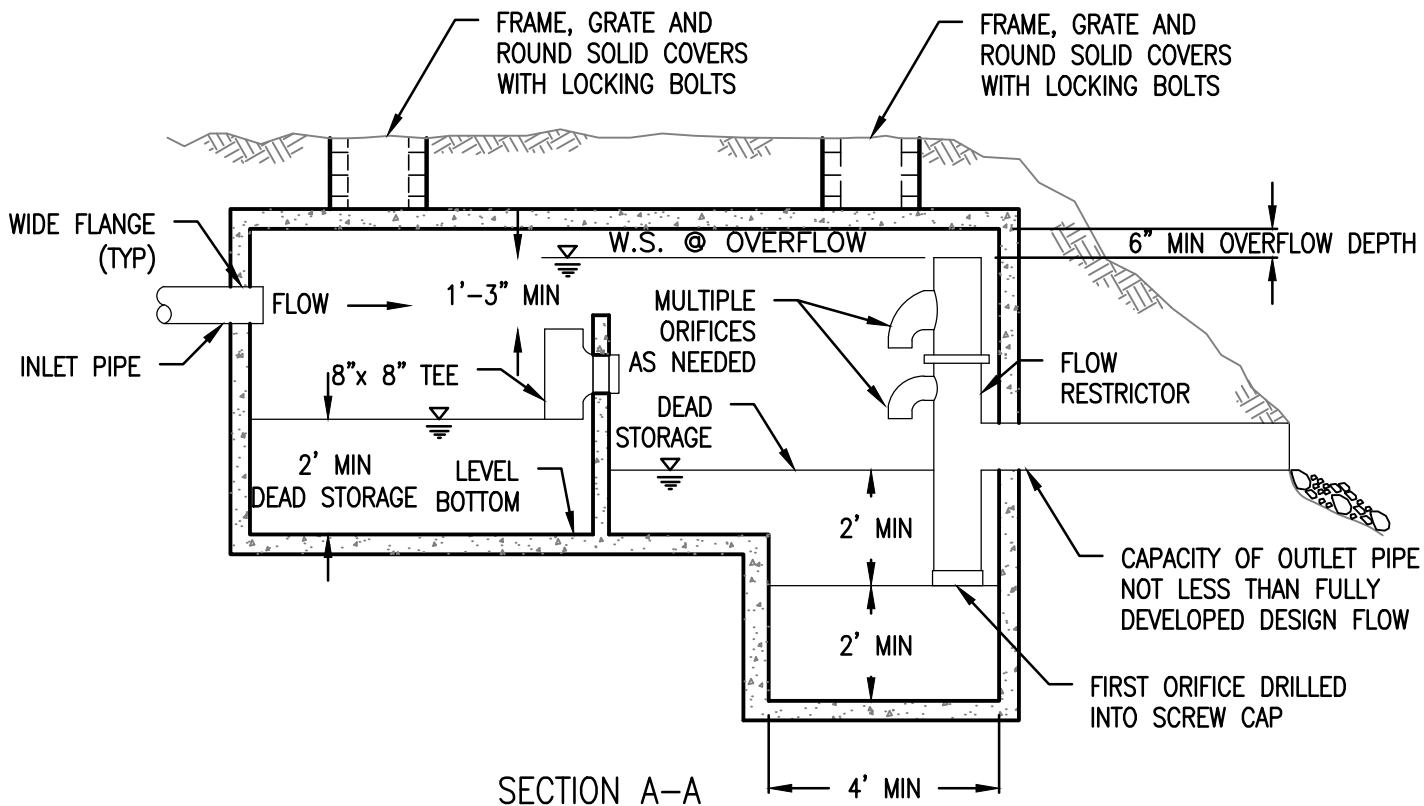
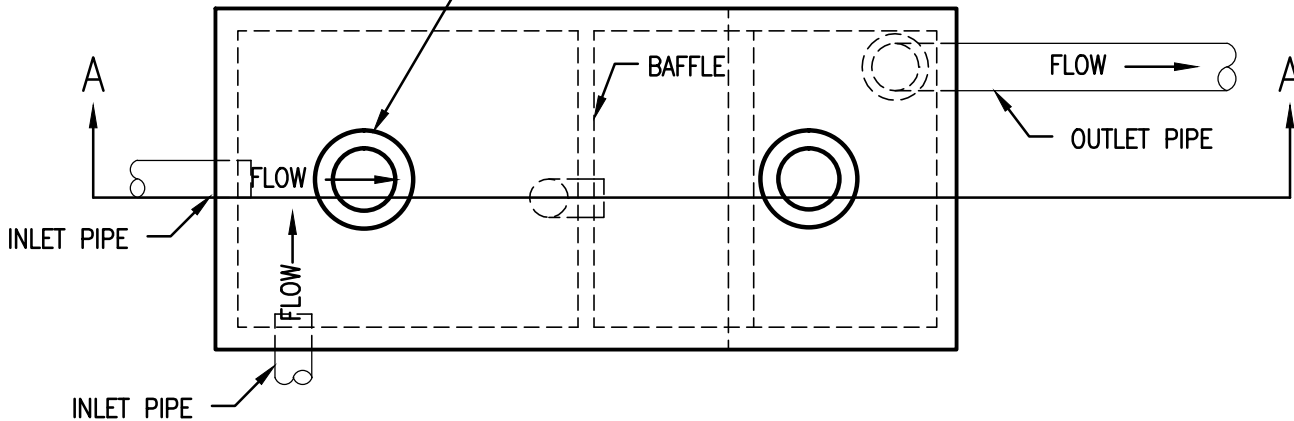
SW- 261



Bureau of Environmental Services



SECOND ACCESS REQUIRED ONLY IF LENGTH OF DETENTION CHAMBER IS > 50' OR ONE PER CELL FOR MULTI-CELLED VAULTS. PROVIDE PARTITIONS AS REQUIRED WITH ADEQUATE FLOW-THROUGH AT BOTTOM (LEAVING 0.5' DEAD STORAGE) AND AIR VENT AT TOP.



- DRAWING NOT TO SCALE -

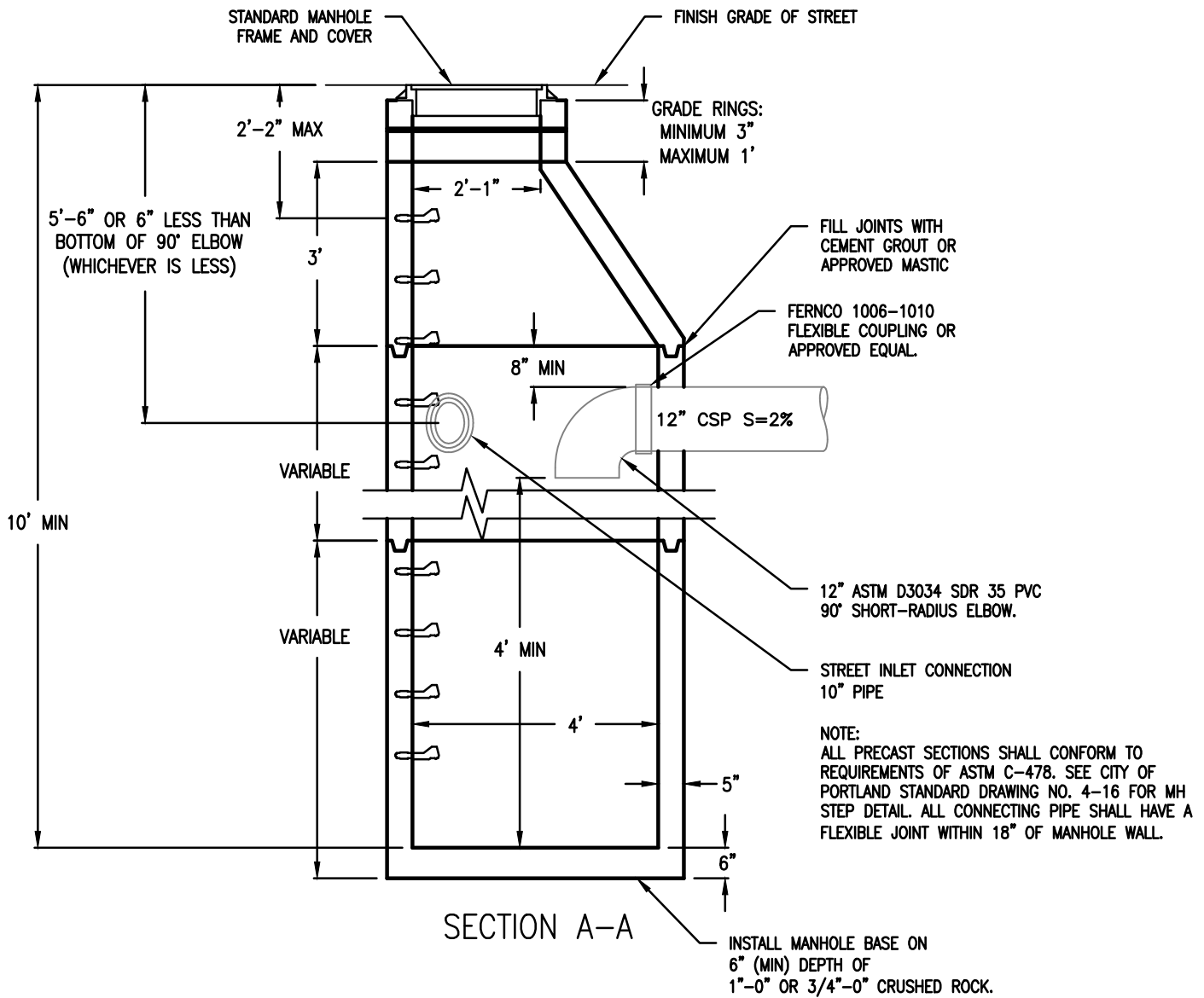
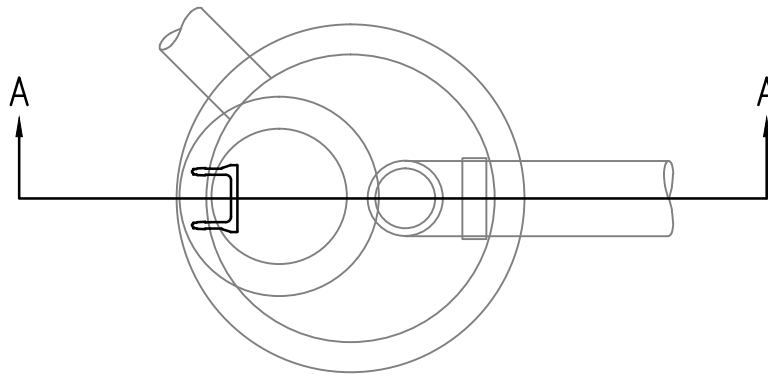
STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -
Detention Vault

NUMBER

SW- 262





- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -
Orifice Location Tee Riser

NUMBER

SW- 263

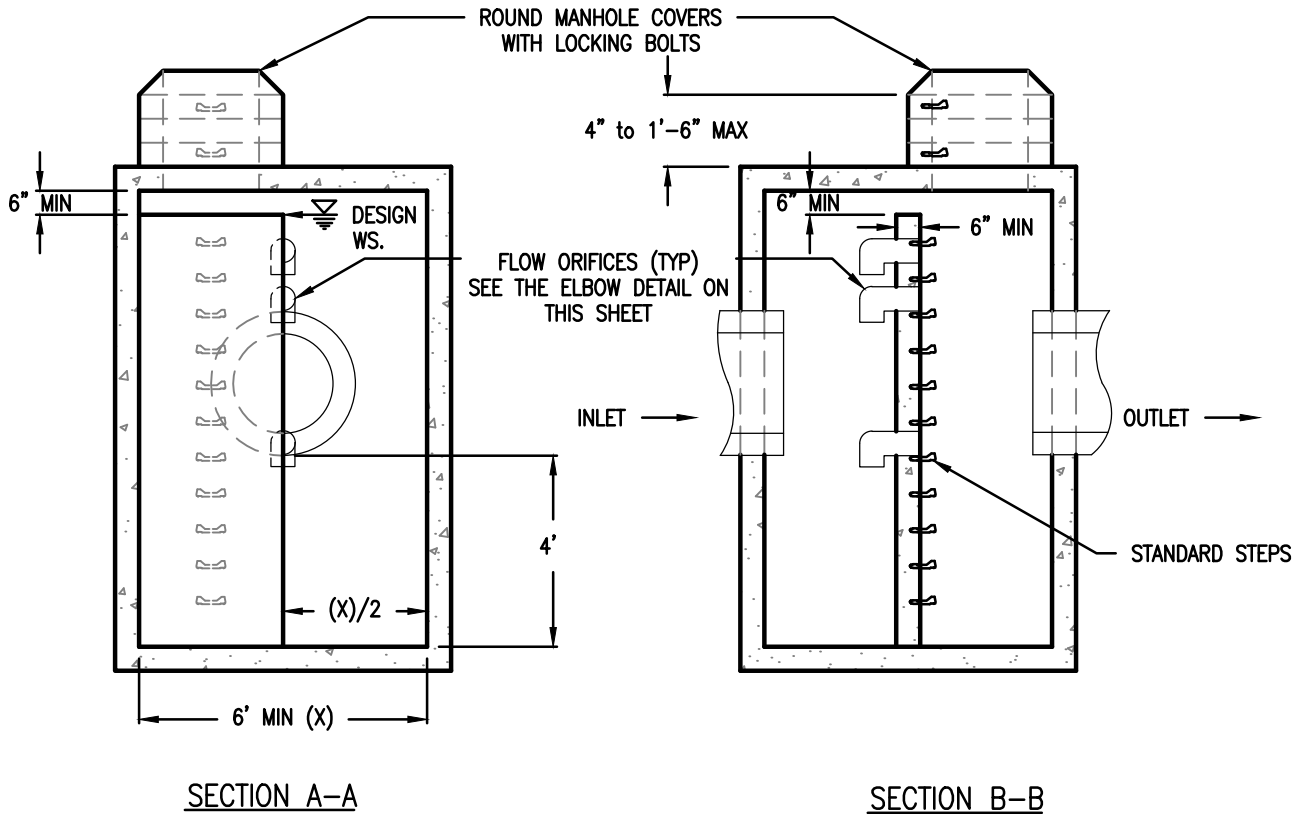
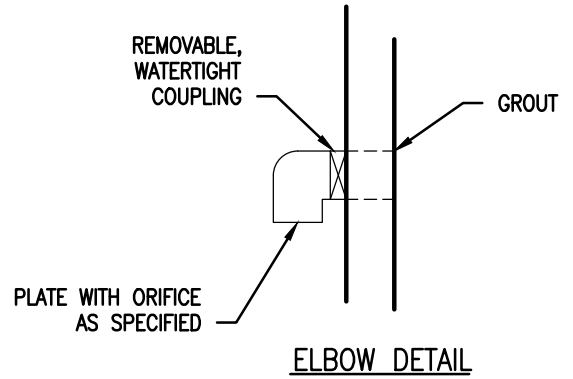
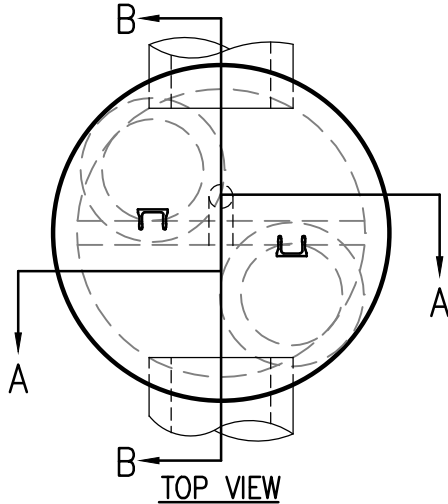


Bureau of Environmental Services



NOTES:

1. EXCEPT AS SHOWN OR NOTED, UNIT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE REQUIREMENTS FOR LARGE PRE CAST CONCRETE MANHOLES. SEE C.O.P. STANDARD PLAN No. 4-08-1. 72", 84" & 96" DIAMETER.
2. FOR DETAILS SHOWING GRADE RINGS, STEPS, AND TOP SLABS, ALSO SEE STANDARD PLAN No. 4-08-1.
3. SEE PROJECT PLANS FOR SIZE AND LOCATION OF ORIFICES.
4. PIPE SIZES, SLOPES AND ALL ELEVATIONS AS SHOWN IN THE PLANS.
5. BAFFLE WALL SHALL HAVE #4 BAR AT 12" SPACING EACH WAY.
6. PRE-CAST BAFFLE WALL SHALL BE KEYED AND GROUTED IN PLACE.
7. ORIFICE PLATES TO BE 1/4" THICK MIN. HDPE OR APPROVED EQUAL AND ATTACHED WITH 1/2" STAINLESS STEEL BOLTS.



- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -
Orifice Location Baffle Riser

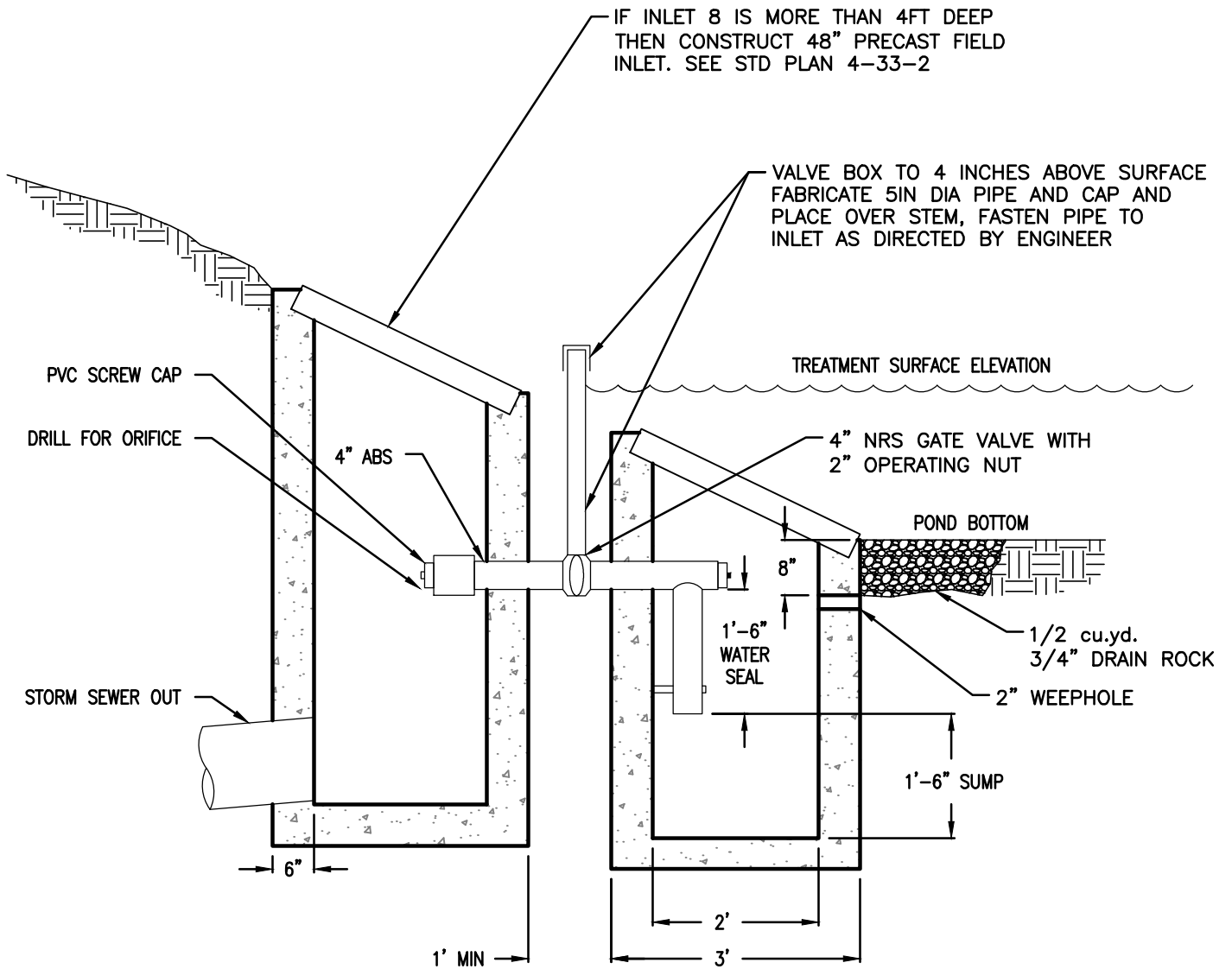
NUMBER

SW- 264



Bureau of Environmental Services





- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Performance Approach -
Orifice Structure

NUMBER

SW- 265



Bureau of Environmental Services



Appendix G.3 Table of Contents

SWALES

- SW-300 – Plan View
- SW-301 – Section Views
- SW-302 – Street Tree Detail
- SW-303 – Landscape Planting Templates
- SW-304 – Meter & Hydrant Locations

PLANTERS

- SW-310 – Plan View without Parking
- SW-311 – Plan View with Parking
- SW-312 – Section Views
- SW-313 – Planter Wall Details
- SW-314 – Street Tree Detail
- SW-315 – Landscape Planting Templates
- SW-316 – Meter & Hydrant Locations

CURB EXTENSIONS

- SW-320 – In-Street Plan View
- SW-321 – In-Planting-Strip Plan View
- SW-322 – Section Views
- SW-323 – Landscape Planting Templates
- SW-324 – Meter & Hydrant Locations

CURB INLETS

- SW-330 – Concrete Inlet with Wingwalls
- SW-331 – Concrete Inlet
- SW-332 – Metal Inlet Splash Pad Alternatives
- SW-333 – Inlet & Outlet for Curb Extensions
- SW-334 – Modified Metal Inlet Assembly
- SW-335 – Channel & Grate Details
- SW-336 – Grate & Frame Details

CHECK DAMS

- SW-340 – Rock Check Dam for Swales
- SW-341 – Wooden Check Dam for Swales
- SW-342 – Wooden Check Dam for Planters
- SW-343 – Concrete Check Dam for Planters

OVERFLOW INLETS

- SW-350 – Atrium Grate
- SW-351 – Overflow Drain

MISCELLANEOUS

- SW-360 – Liner Attachment & Pipe Boot Details

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

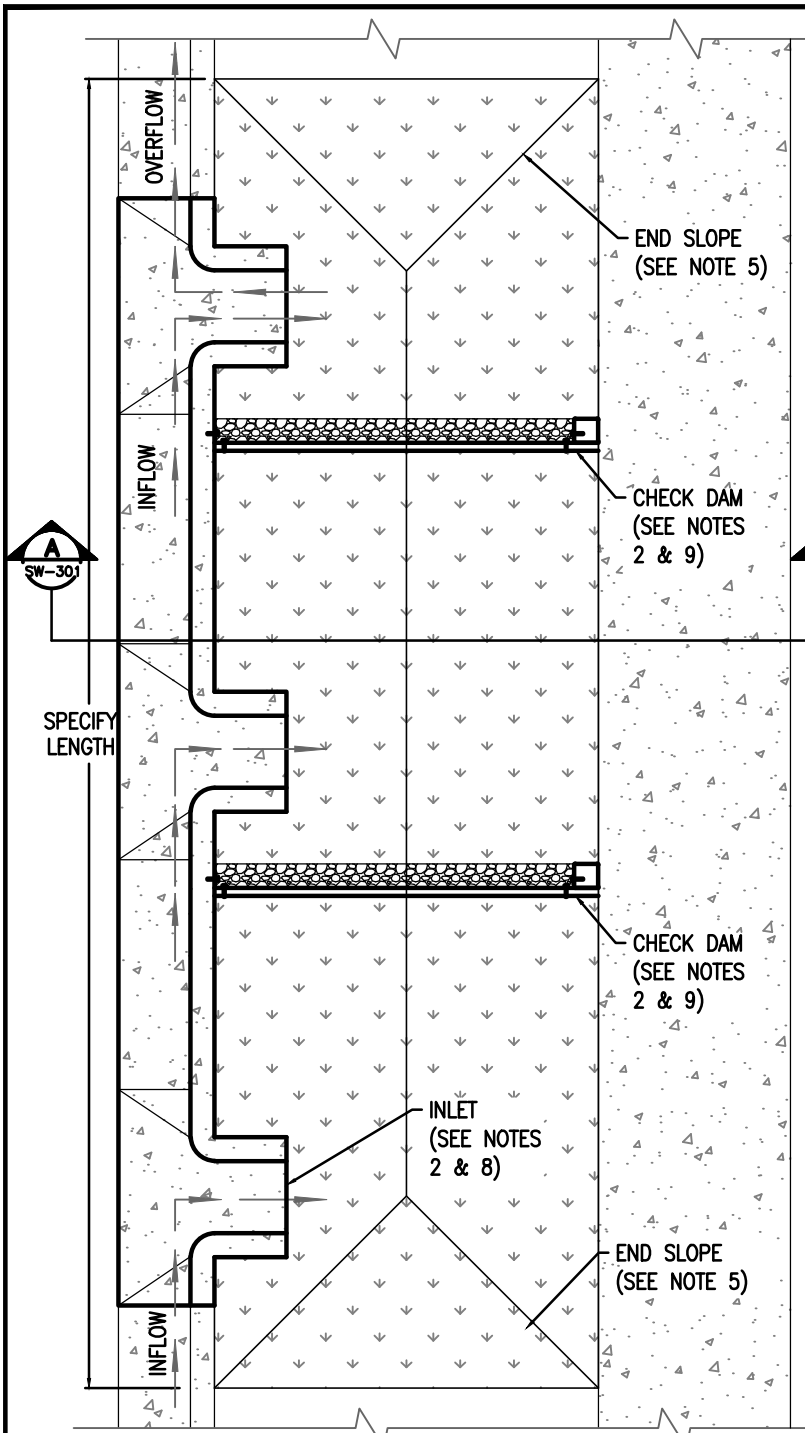
– Green Streets –
Table of Contents



Bureau of Environmental Services



NUMBER
TOC



PLAN VIEW

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet and check dam.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Existing utility lines must be sleeved or relocated. Proposed utility lines to be located out of facility.
5. End slopes 1:4. See swale sections on SW-301 for side slopes.
6. Longitudinal slope of swale matches the road.
7. Area and Depth of facility are based upon engineering calculations and right-of-way constraints. See chapter 2 of the City of Portland Stormwater Management Manual (SWMM).

RELATED DETAILS AND RESOURCES:

8. Concrete Inlet detail SW-300
9. Check Dam details SW-340 and SW-341
10. Special requirements for water lines, meters, and fire hydrants (see SW-304)
11. Swale Planting Template (see SW-303)
12. Thickened Curb and Gutter per PBOT standard drawing P-540
13. Stormwater facility construction and topsoil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

For more information contact:

PBOT (503) 823-7884	BES (503) 823-7761
PWB (503) 823-7368	Urban Forestry (503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Plan View
Swales



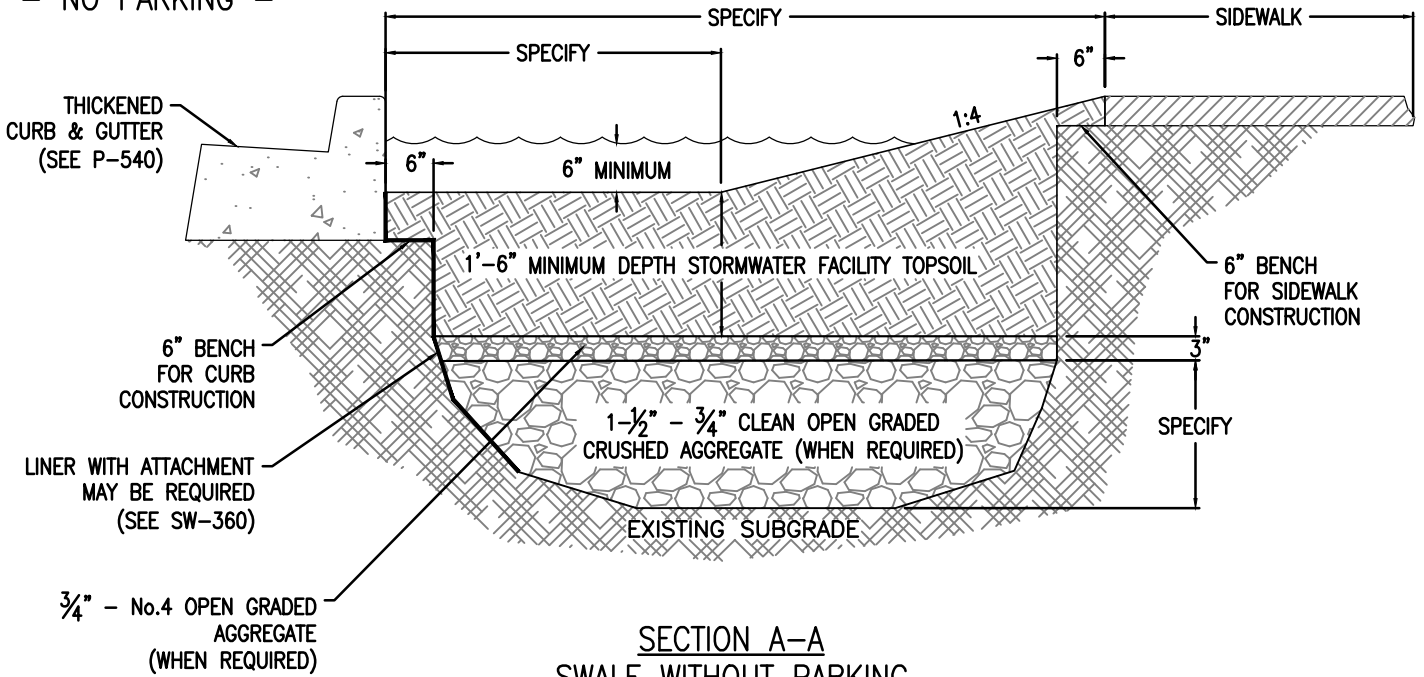
Bureau of Environmental Services



NUMBER

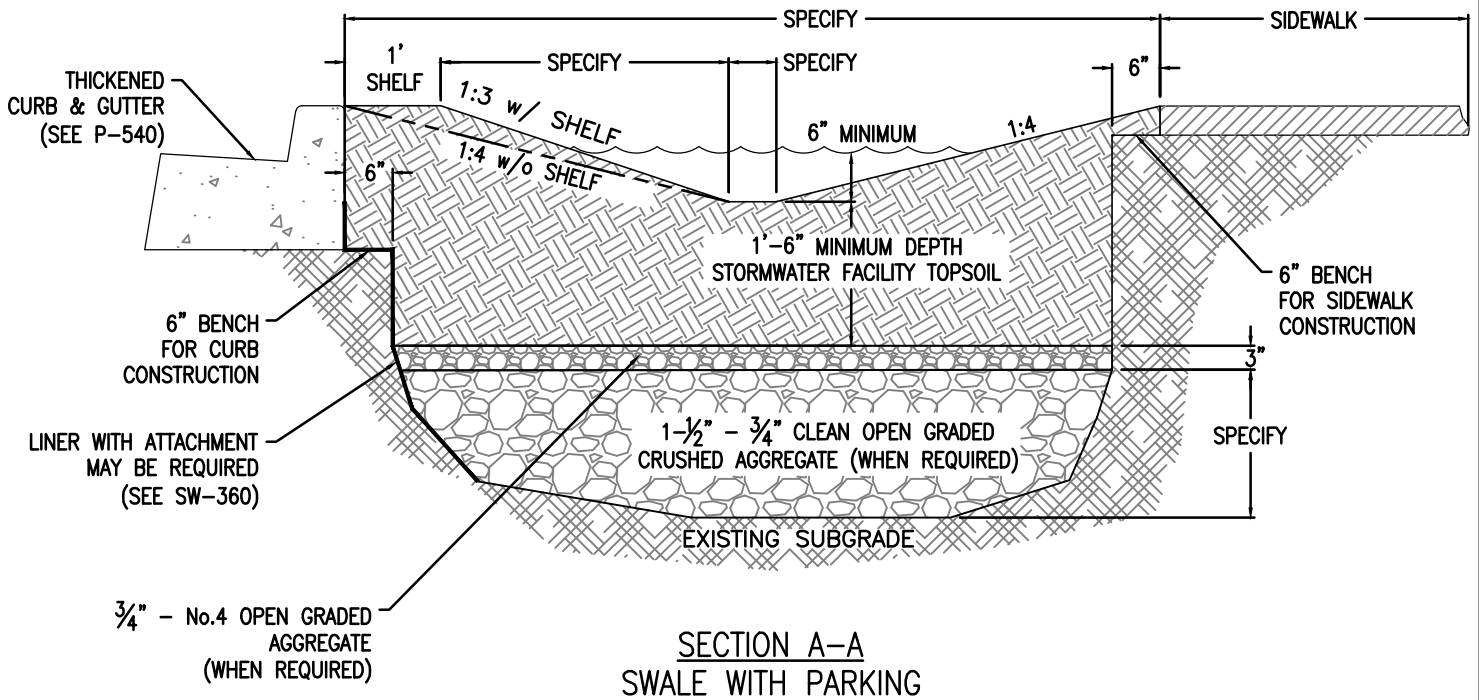
SW-300

- NO PARKING -



SECTION A-A
SWALE WITHOUT PARKING

- PARKING -



SECTION A-A
SWALE WITH PARKING

DESIGNER INFORMATION:

See SW-300 for Inlet

CONSTRUCTION NOTE:

Scarify the native soil following the initial excavation and before installing topsoil or rock.

- DRAWING NOT TO SCALE -

FOR PLAN VIEW
SEE SW-310

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Section Views
Swales



Bureau of Environmental Services



NUMBER

SW-301

STREET TREES	
Botanical Name	Common Name
<i>WITH power lines</i>	
Carpinus caroliniana	American Hornbeam
Fraxinus pennsylvanica 'Johnson'	Leprechaun Ash
Gleditsia triacanthos 'Impcole'	Imperial Honeylocust
Koelreuteria paniculata	Goldenrain Tree
Prunus virginiana "Canada Red"	Canada Red Chokecherry
<i>WITHOUT power lines</i>	
Nyssa sylvatica	Black Tupelo
Celtis occidentalis	Hackberry
Quercus shumardii	Shumard Oak
Betula jacquemontii	Jacquemontii Birch
Acer campestre 'Evelyn'	Queen Elizabeth Hedge Maple
Gleditsia triacanthos 'Skycole'	Skyline Honeylocust

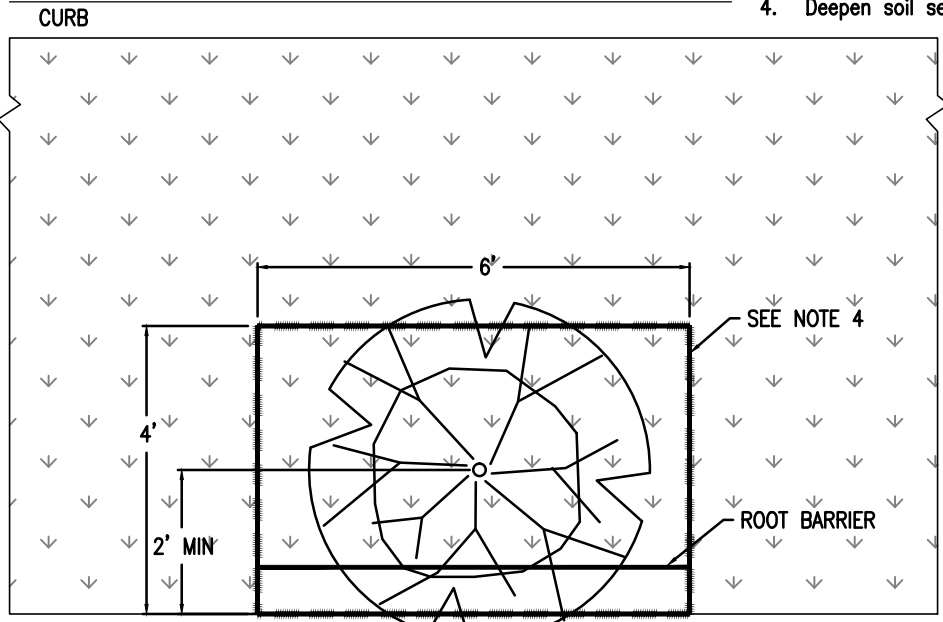
TABLE 1

DESIGNER INFORMATION:

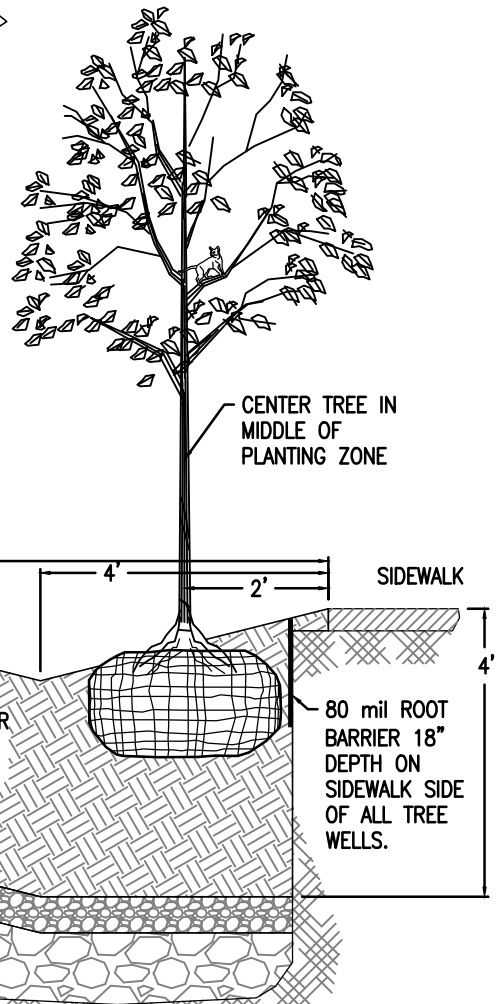
1. Distance between trees varies: 20ft–30ft on center.
2. Stormwater facility construction and topsoil requirements, see City of Portland Standard Construction Specifications sections 00415 and 01040.14(d).
3. Street Tree list provided for reference do not include on plans. Use of tree species not on list must be approved by Urban Forestry 503–823–4489.
4. Include Tree Well and Street Tree views on plans.
5. Dimension topsoil and rock layers on non–tree side to correspond to Swale Section.
6. Include liner and call–out if used, see Swale Section SW–301.

CONSTRUCTION NOTES:

1. Contact Urban Forestry for tree installation assistance and permitting at (503) 823–4489.
2. Remove wire and burlap from root ball prior to backfilling.
3. Set top of root ball 1" –2" above topsoil surface.
4. Deepen soil section minimum; 4ft wide, 6ft long, 4ft deep.



TREE WELL PLAN VIEW



STREET TREE IN SWALE

IMPORTANT: Location of trees must meet clearance requirements established by the City of Portland. Utility conflicts and existing conditions can effect tree placement. Locate utilities prior to installing trees.

For specific clearance requirements contact:
 PBOT (503) 823–7884
 PWB (503) 823–7368
 BES (503) 823–7761
 Urban Forestry (503) 823–4489

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –
 Street Tree Detail
 Swales

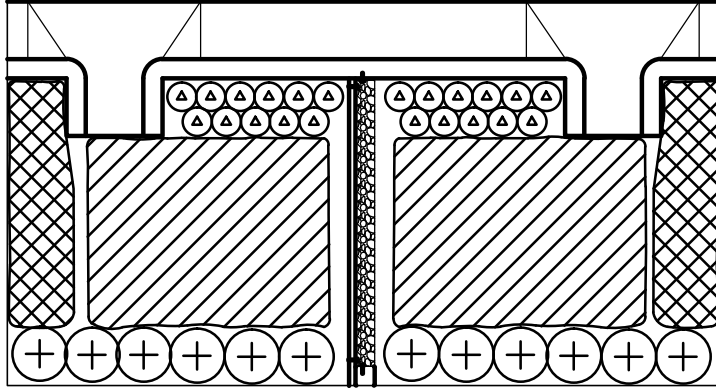


Bureau of Environmental Services



NUMBER
 SW–302

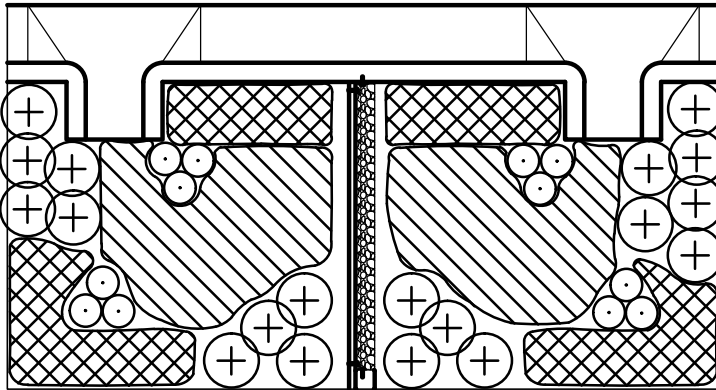
TEMPLATE 1



PLANT LEGEND 1

Symbol	Botanical Name	Common Name
ZONE A		
	<i>Juncus patens</i>	Spreading rush
	<i>w/Camassia leichtlinii</i>	Great camas- interspersed for accent
ZONE B		
	<i>Mahonia repens</i>	Creeping oregon grape
	<i>Spiraea x bumalda 'Goldflame'</i>	Goldflame spirea
	<i>Arcostaphylos uva-ursi</i>	Kinnickinnick

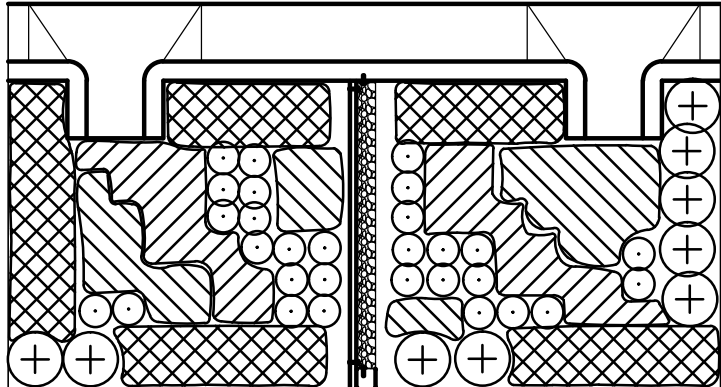
TEMPLATE 2



PLANT LEGEND 2

Symbol	Botanical Name	Common Name
ZONE A		
	<i>Carex obnupta</i>	Slough sedge
	<i>Deschampsia cespitosa</i>	Tufted hair grass
	<i>w/Camassia leichtlinii</i>	Great camas- interspersed for accent
ZONE B		
	<i>Fragaria chiloensis</i>	Coastal strawberry
	<i>Cornus sericea 'Kelsey'</i>	Kelsey dogwood

TEMPLATE 3



PLANT LEGEND 3

Symbol	Botanical Name	Common Name
ZONE A		
	<i>Juncus patens</i>	Spreading rush
	<i>Carex obnupta</i>	Slough sedge
	<i>Deschampsia cespitosa</i>	Tufted hair grass
ZONE B		
	<i>Arcostaphylos uva-ursi</i>	Kinnickinnick
	<i>Spiraea densiflora</i>	Sub-alpine spiraea
	<i>w/Narcissus spp.</i>	Daffodils- interspersed for accent

INSTRUCTIONS

1. Choose a template and alter it to design. These are examples of approved planting templates. Other planting plans may be approved.
2. Plant lists and quantity requirements are found in Section 2.3.3 and Appendix F.4, respectively, of the City of Portland Stormwater Management Manual.
3. Planting table required. State plant species, spacing, and quantities per Zone A and Zone B and per swale. Include the square footage of Zone A and B.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS



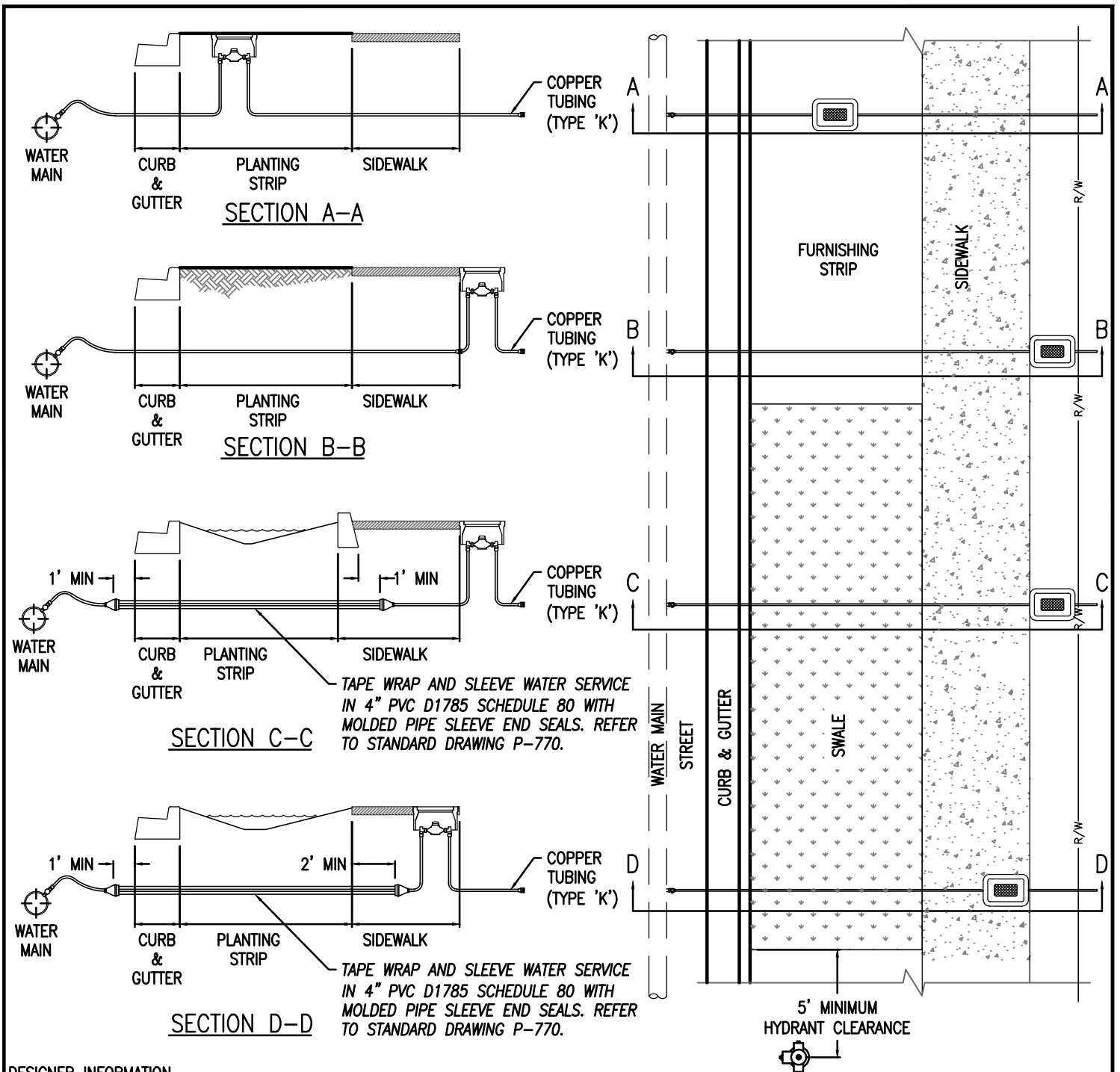
Bureau of Environmental Services

- Green Streets -
Landscape Planting Templates
Swales



NUMBER

SW-303



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P-700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A. Option B or C can be used only if the meter box is fully within the Right-of-Way. Option D can only be used for an existing service and when other options are infeasible.
3. Refer to 1" Service Assembly Standard Drawing P-780. For larger services or other appurtenances, contact PWB development services at (503) 823-7368. Water service line must be 2 ft min. from bottom of stormwater facility topsoil.
4. Maintain 2 ft skin-to-skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross-section views are not required on construction plans.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS



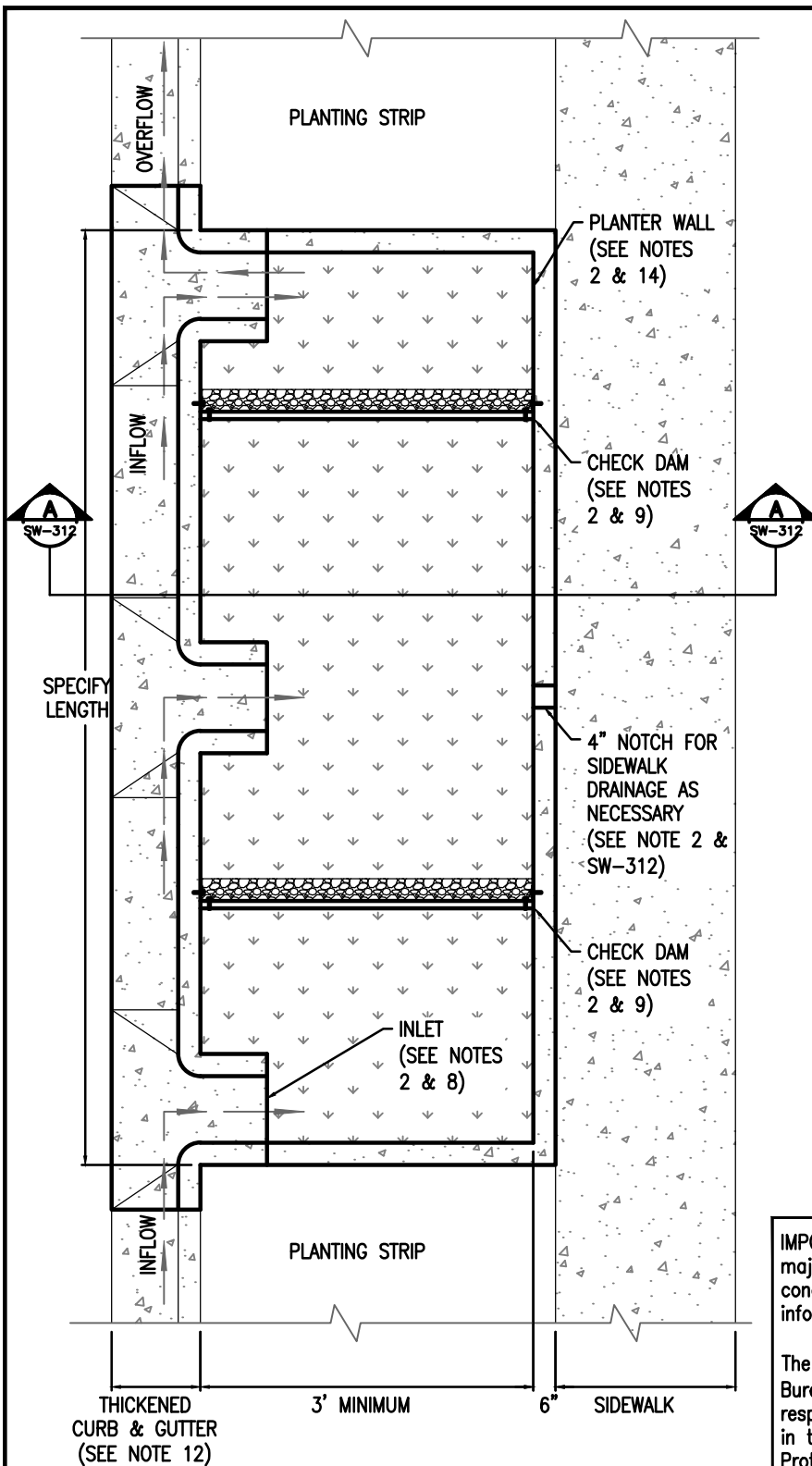
Bureau of Environmental Services

- Green Streets -
Meter & Hydrant Locations
Swales



NUMBER

SW-304



PLAN VIEW

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, planter corner and sidewalk notches.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Existing utility lines must be sleeved or relocated. Proposed utility lines to be located out of facility.
5. Longitudinal slope of planter matches the road.
6. Area and Depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWM).
7. Minimum interior planter width is 3 feet. A minimum of 4 feet is required for planters with street trees.

RELATED DETAILS AND RESOURCES:

8. Concrete Inlet details SW-331 and SW-332
9. Check Dam details SW-342 and SW-343
10. Special requirements for water lines, meters, and fire hydrants (see SW-316)
11. Planter Planting Template (see SW-315)
12. Thickened Curb and Gutter per PBOT standard drawing P-540
13. Stormwater facility construction and topsoil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
14. Planter wall detail (see SW-315)

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For more information contact:

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PWB	(503) 823-7368	Urban Forestry	(503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Plan View without Parking
Planters

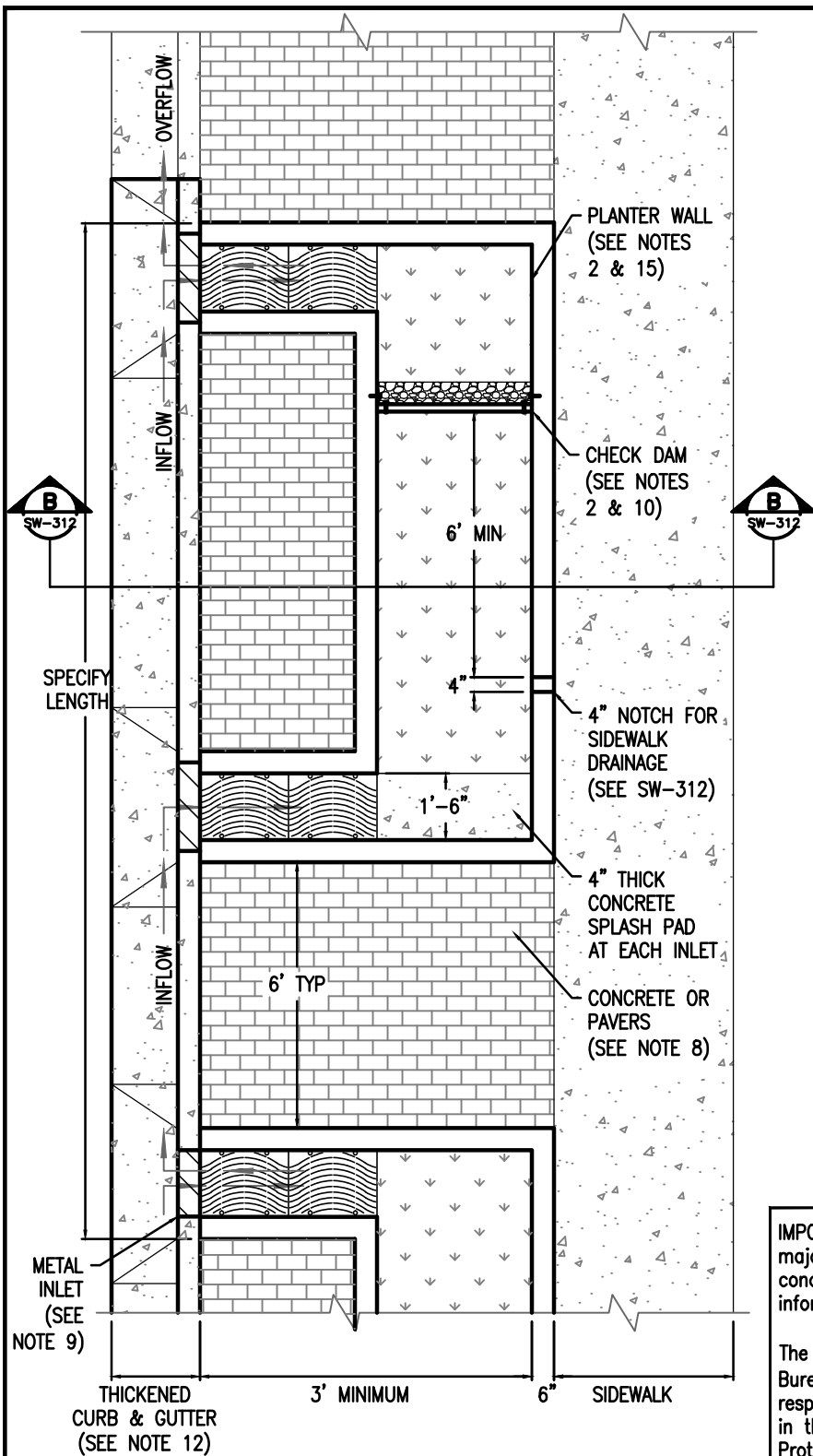
NUMBER

SW-310



Bureau of Environmental Services





PLAN VIEW

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, planter corner and sidewalk notches.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Existing utility lines must be sleeved or relocated. Proposed utility lines to be located out of facility.
5. Longitudinal slope of planter matches the road.
6. Area and Depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
7. Minimum interior planter width is 3 feet. A minimum of 4 feet is required for planters with street trees.
8. May use concrete or pavers per City Standards.

RELATED DETAILS AND RESOURCES:

9. Metal Inlet details SW-332, SW-335 and SW-336
10. Check Dam details SW-342 and SW-343
11. Special requirements for water lines, meters, and fire hydrants (see SW-316)
12. Planter Planting Template (see SW-315)
13. Thickened Curb and Gutter per PBOT standard drawing P-540
14. Stormwater facility construction and topsoil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
15. Planter wall detail (see SW-315)

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PWB	(503) 823-7368	Urban Forestry	(503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Plan View with Parking
Planters

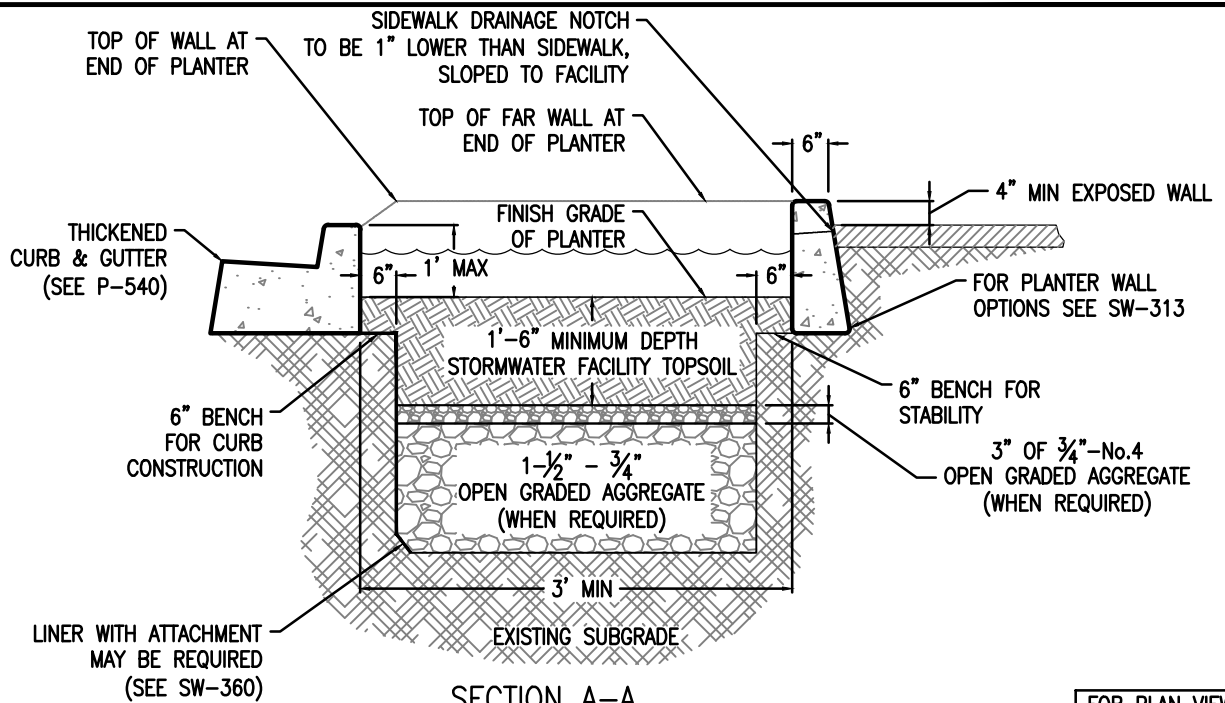


Bureau of Environmental Services



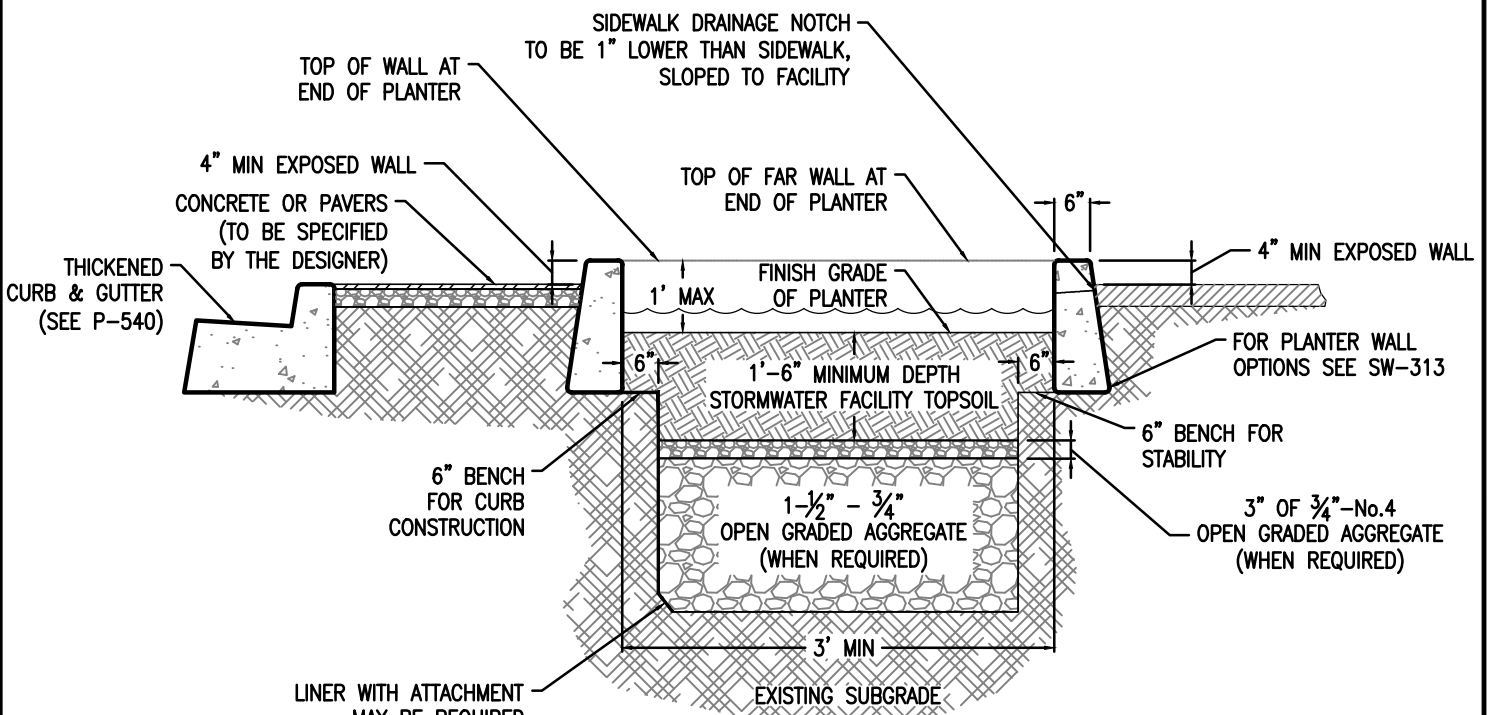
NUMBER

SW-311



SECTION A-A
PLANTER WITHOUT PARKING

FOR PLAN VIEW
SEE SW-310



SECTION B-B
PLANTER WITH PARKING

FOR PLAN VIEW
SEE SW-311

DESIGNER INFORMATION

See SW-335 and SW-336 for Channel and Grate details.

CONSTRUCTION NOTE

Scarify the native soil following the initial excavation and before installing topsoil of rock.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Section Views
Planters

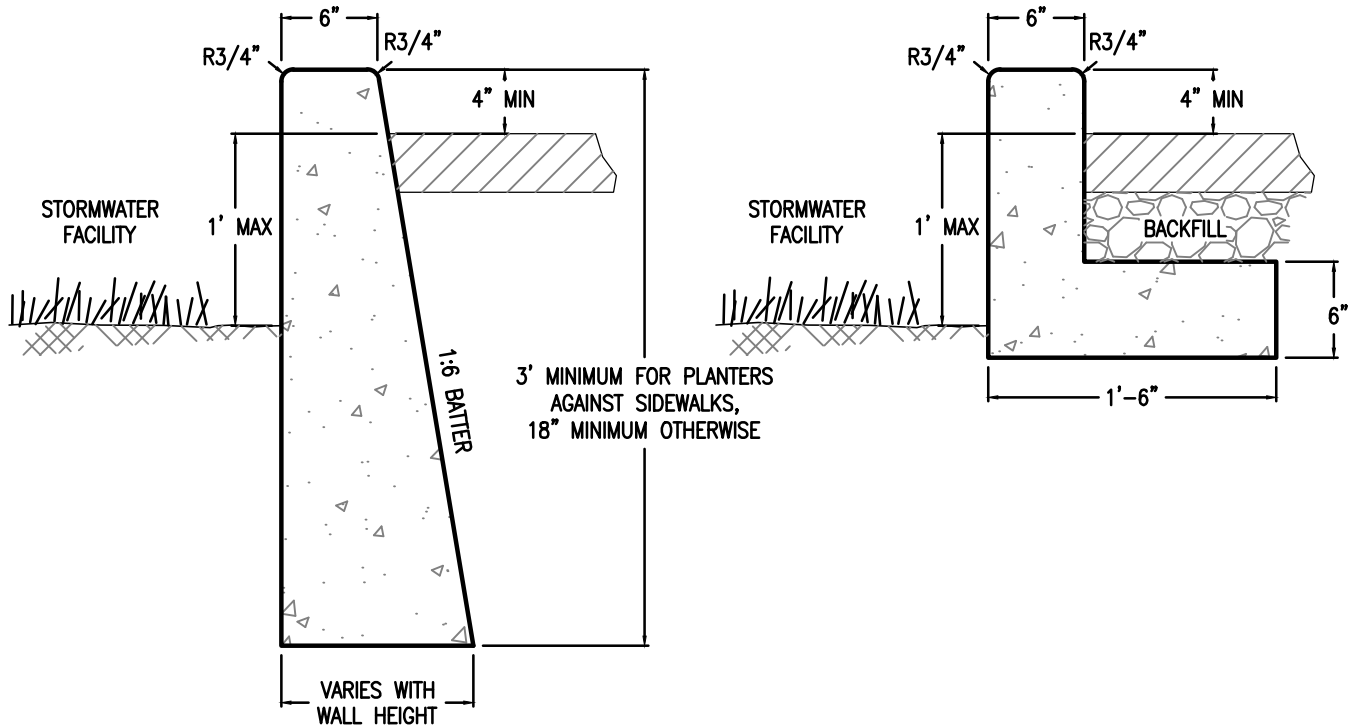


Bureau of Environmental Services



NUMBER

SW-312



DESIGNER INFORMATION

1. Special design considerations or structural review may be required for longer planter wall spans. Steel reinforcement or additional concrete check dams may be needed for stability.
2. Specify one of the above planter wall options based on site conditions.
3. Maintain 1:6 batter for walls and 4" minimum to top of curb
4. If a liner is used with an L-shaped wall, the wall height must be increased. Three inches of concrete is required on all side of the liner attachment (see SW-360)

CONSTRUCTION NOTE

Finish all exposed concrete surfaces.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Planter Wall Details
Planters



Bureau of Environmental Services



NUMBER

SW-313

STREET TREES	
Botanical Name	Common Name
<i>WITH power lines</i>	
<i>Carpinus caroliniana</i>	American Hornbeam
<i>Fraxinus pennsylvanica</i> 'Johnson'	Leprechaun Ash
<i>Gleditsia triacanthos</i> 'Impcole'	Imperial Honeylocust
<i>Koelreuteria paniculata</i>	Goldenrain Tree
<i>Prunus virginiana</i> "Canada Red"	Canada Red Chokecherry
<i>WITHOUT power lines</i>	
<i>Nyssa sylvatica</i>	Black Tupelo
<i>Celtis occidentalis</i>	Hackberry
<i>Quercus shumardii</i>	Shumard Oak
<i>Betula jacquemontii</i>	Jacquemontii Birch
<i>Acer campestre</i> 'Evelyn'	Queen Elizabeth Hedge Maple
<i>Gleditsia triacanthos</i> 'Skycole'	Skyline Honeylocust

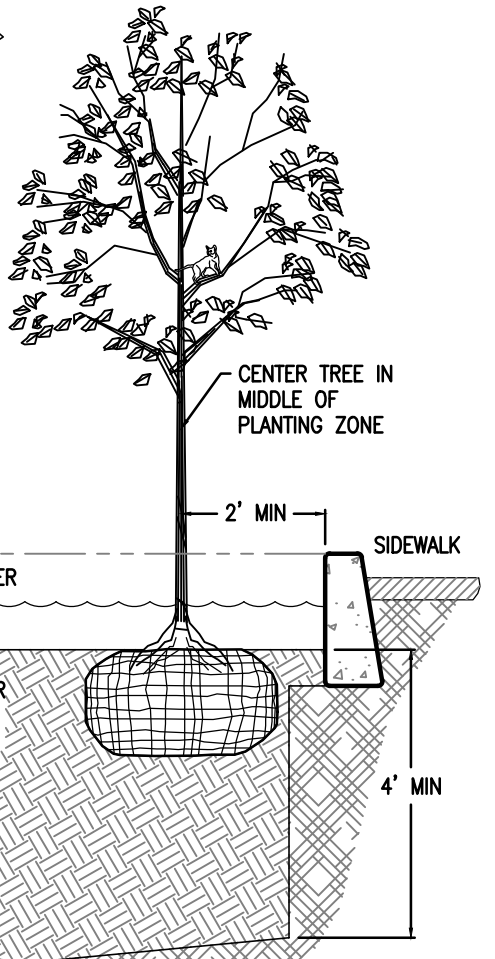
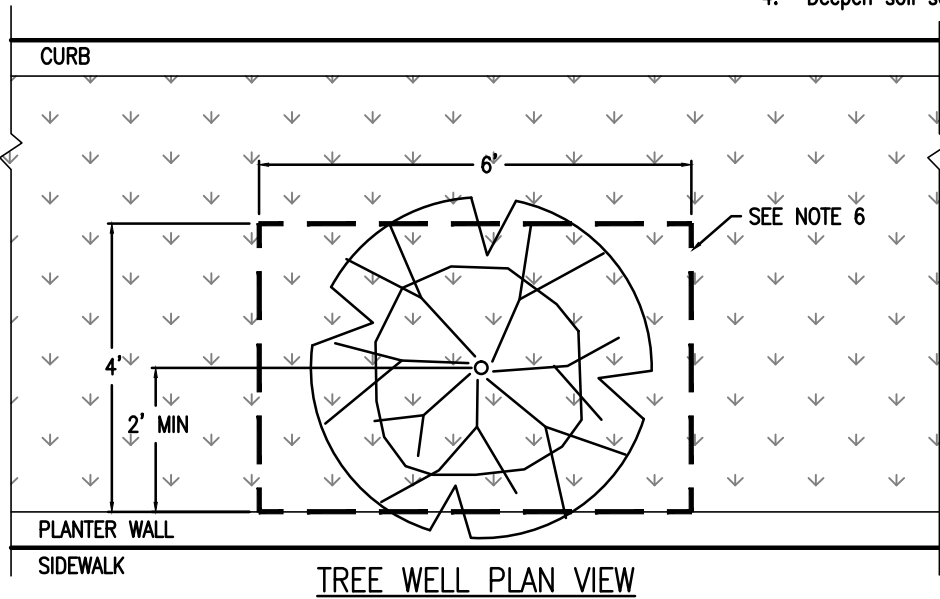
TABLE 1

DESIGNER INFORMATION:

1. Distance between trees varies: 20ft–30ft on center.
2. Stormwater facility construction and topsoil requirements, see City of Portland Standard Construction Specifications sections 00415 and 01040.14(d).
3. Street Tree list provided for reference do not include on plans. Use of tree species not on list must be approved by Urban Forestry 503–823–4489.
4. Include Tree Well and Street Tree views on plans.
5. Dimension topsoil and rock layers on non-tree side to correspond to Planter Section.
6. Include liner and call-out if used, see Planter Section SW–312.

CONSTRUCTION NOTES:

1. Contact Urban Forestry for tree installation assistance and permitting at (503) 823–4489.
2. Remove wire and burlap from root ball prior to backfilling.
3. Set top of root ball 1" –2" above topsoil surface.
4. Deepen soil section minimum; 4ft wide, 6ft long, 4ft deep.



IMPORTANT: Location of trees must meet clearance requirements established by the City of Portland. Utility conflicts and existing conditions can effect tree placement. Locate utilities prior to installing trees.

For specific clearance requirements contact:

PBOT (503) 823–7884
 PWB (503) 823–7368
 BES (503) 823–7761
 Urban Forestry (503) 823–4489

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
 Street Tree Detail
 Planters



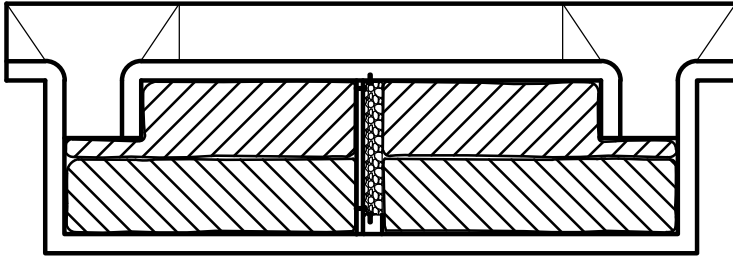
Bureau of Environmental Services



NUMBER

SW-314

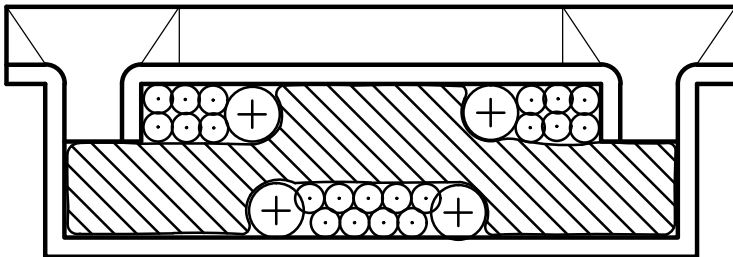
TEMPLATE 1



PLANT LEGEND 1

Symbol	Botanical Name	Common Name
	<i>Juncus patens</i>	Spreading rush w/ <i>Camassia leichtlinii</i> Great camas- interspersed for accent
	<i>Carex obnupta</i>	Slough sedge

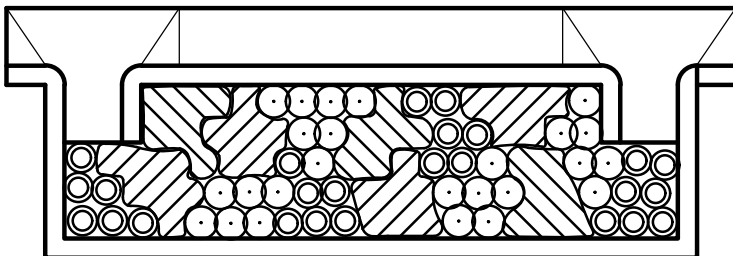
TEMPLATE 2



PLANT LEGEND 2

Symbol	Botanical Name	Common Name
	<i>Carex obnupta</i>	Slough sedge
	<i>Deschampsia cespitosa</i>	Tufted hair grass
	<i>Cornus sericea 'Kelsey'</i>	Kelsey dogwood w/ <i>Iris douglasii</i> Douglas' Iris- interspersed for accent

TEMPLATE 3



PLANT LEGEND 3

Symbol	Botanical Name	Common Name
	<i>Carex obnupta</i>	Slough sedge
	<i>Deschampsia cespitosa</i>	Tufted hair grass
	<i>Juncus patens</i>	Spreading rush
	<i>Carex morrowii 'Ice Dance'</i>	Ice Dance Sedge w/ <i>Camassia leichtlinii</i> Great camas- interspersed for accent

INSTRUCTIONS

1. Choose a template and alter it to design. These are examples of approved planting templates. Other planting plans may be approved.
2. Plant lists and quantity requirements are found in Section 2.3.3 and Appendix F.4, respectively, of the City of Portland Stormwater Management Manual.
3. Planting table required. State plant species, spacing, and quantities per planter. Include the square footage of planter.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Landscape Planting Templates
Planters

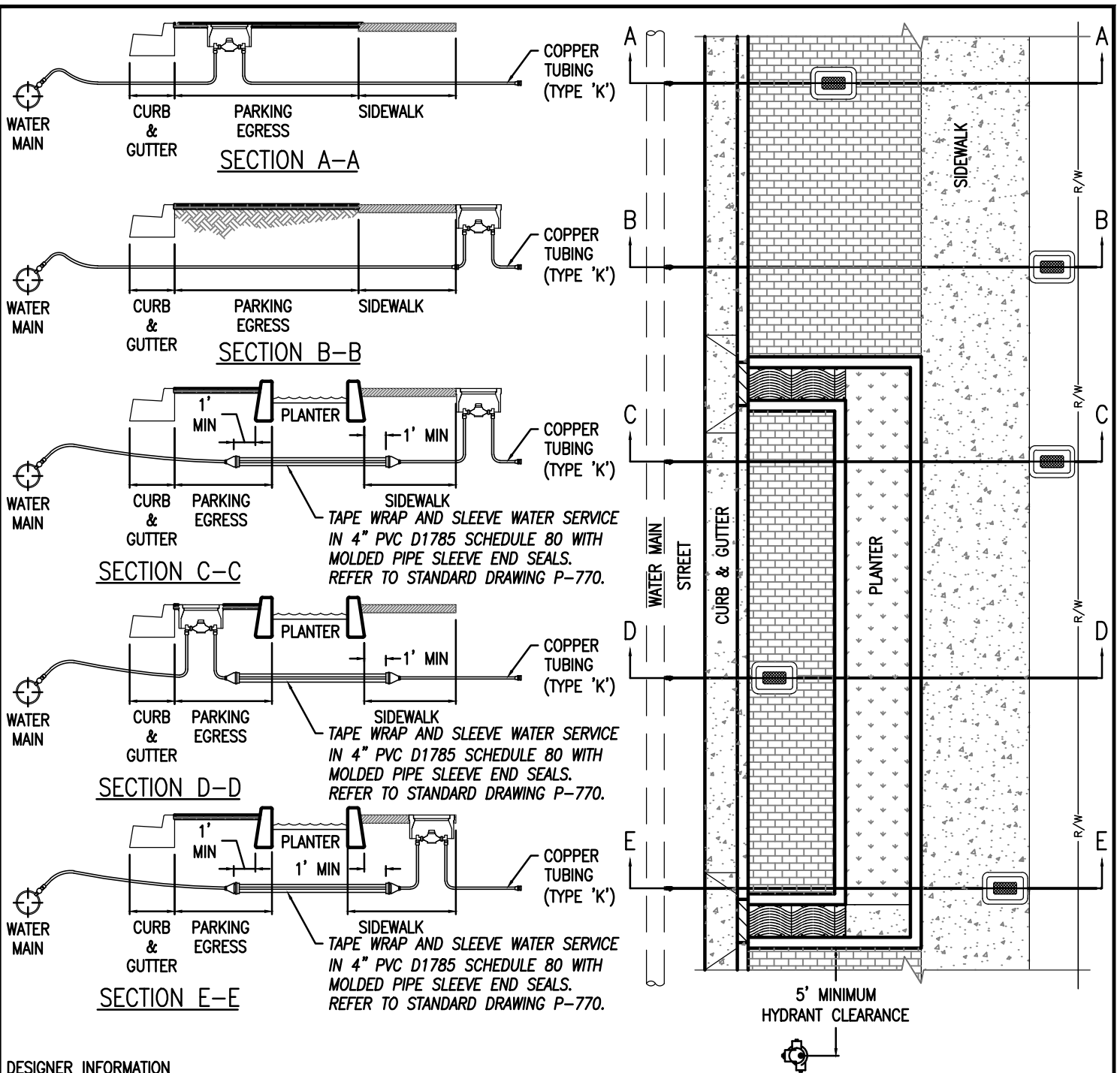


Bureau of Environmental Services



NUMBER

SW-315



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P-700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A. Option B or C can be used only if the meter box is fully within the Right-of-Way. Option D can only be used for an existing service and when other options are infeasible. Option E can only be used for an existing service and when other options are infeasible.
3. Refer to 1" Service Assembly Standard Drawing P-780. For larger services or other appurtenances, contact PWB development services at (503) 823-7368. Water service line must be 2 ft min. from bottom of stormwater facility topsoil.
4. Maintain 2 ft skin-to-skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross-section views are not required on construction plans.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS



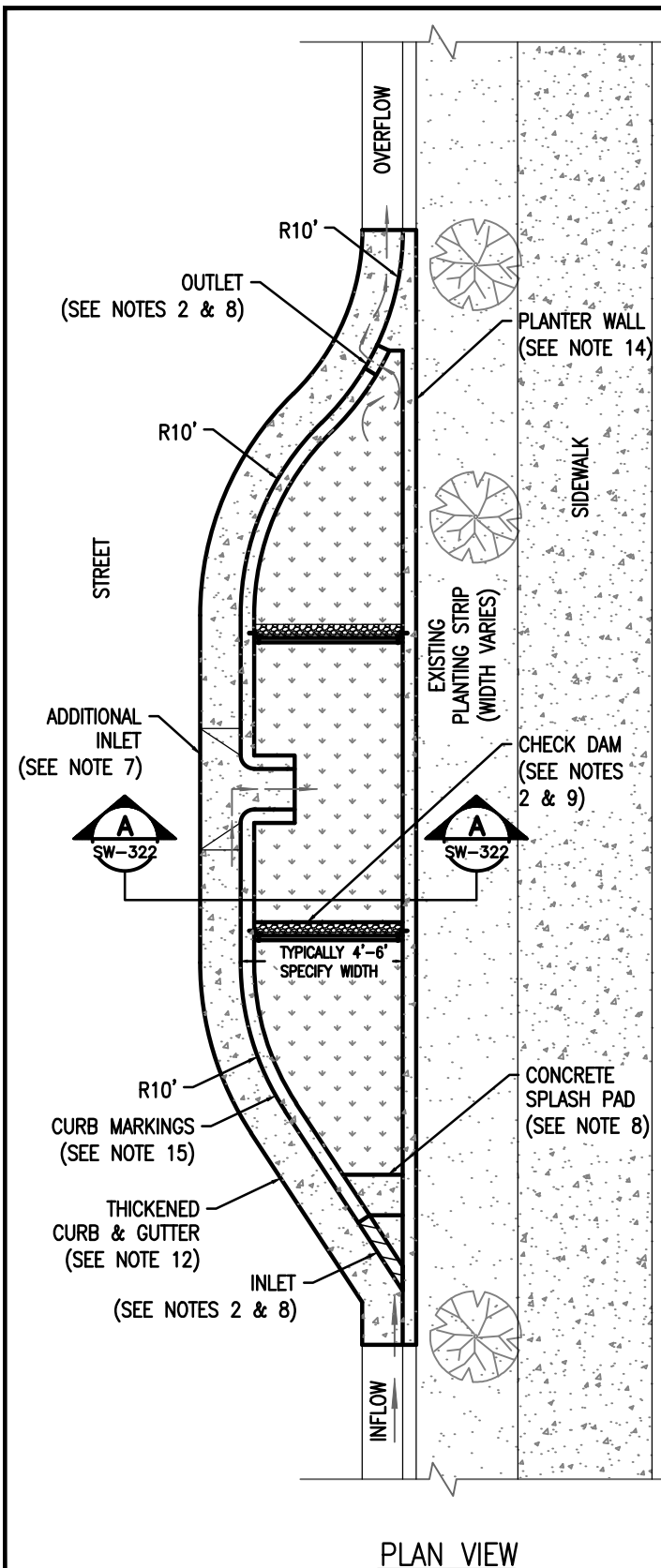
Bureau of Environmental Services

- Green Streets -
Meter & Hydrant Locations
Planters



NUMBER

SW-316



PLAN VIEW

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, planter corner and sidewalk notches.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Existing utility lines must be sleeved or relocated. Proposed utility lines to be located out of facility.
5. Longitudinal slope of planter matches the road.
6. Area and Depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
7. Additional inlets in facilities over 25 feet in length per BES requirements or site-specific requirements needs.

RELATED DETAILS AND RESOURCES:

8. Inlet and outlet details SW-333 and SW-334
9. Check Dam details SW-342 and SW-343
10. Special requirements for water lines, meters, and fire hydrants (see SW-316)
11. Planter Planting Template (see SW-315)
12. Thickened Curb and Gutter (see PBOT standard drawing P-540)
13. Stormwater facility construction and topsoil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
14. Planter wall detail (see SW-313)
15. Pavement markings see PBOT standard drawing P-434

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

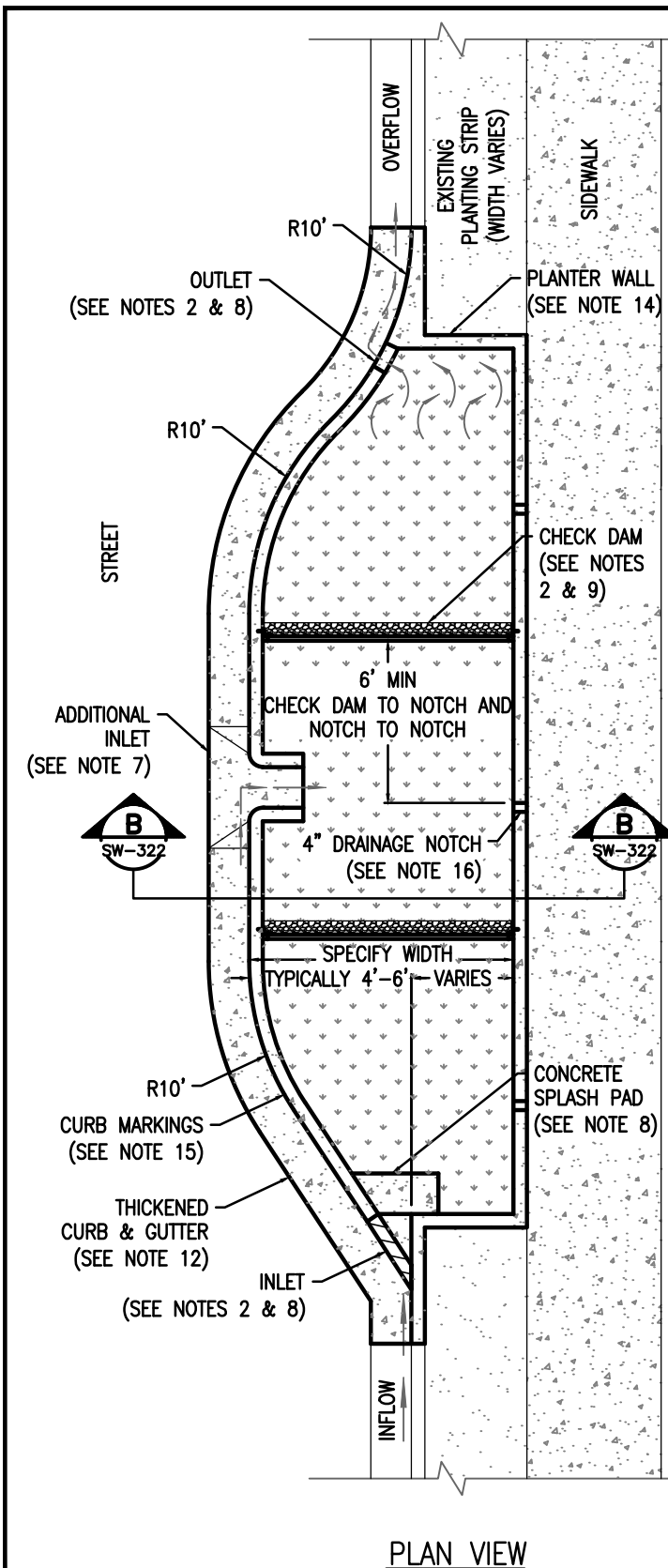
The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

For more information contact:

PBOT	(503) 823-7884	BES	(503) 823-7761
PWB	(503) 823-7368	Urban Forestry	(503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS





PLAN VIEW

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, planter corner and sidewalk notches.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Existing utility lines must be sleeved or relocated. Proposed utility lines to be located out of facility.
5. Longitudinal slope of planter matches the road.
6. Area and depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
7. Additional inlets in facilities over 25 feet in length per BES requirements or site-specific requirements needs.

RELATED DETAILS AND RESOURCES:

8. Inlet and outlet details SW-333 and SW-334
9. Check Dam details SW-342 and SW-343
10. Special requirements for water lines, meters, and fire hydrants (see SW-316)
11. Planter Planting Template (see SW-315)
12. Thickened Curb and Gutter per PBOT standard drawing P-540
13. Stormwater facility construction and topsoil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
14. Planter wall detail (see SW-313)
15. Pavement markings (see PBOT standard drawing P-434)
16. 4" Sidewalk-drainage notch (see SW-322)

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

For more information contact:

PBOT (503) 823-7884	BES (503) 823-7761
PWB (503) 823-7368	Urban Forestry (503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

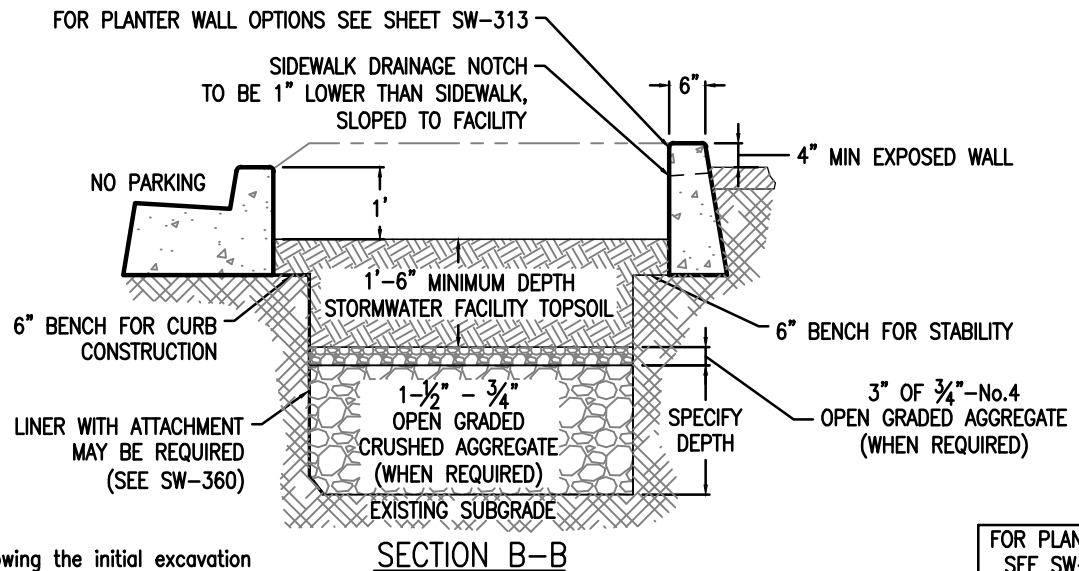
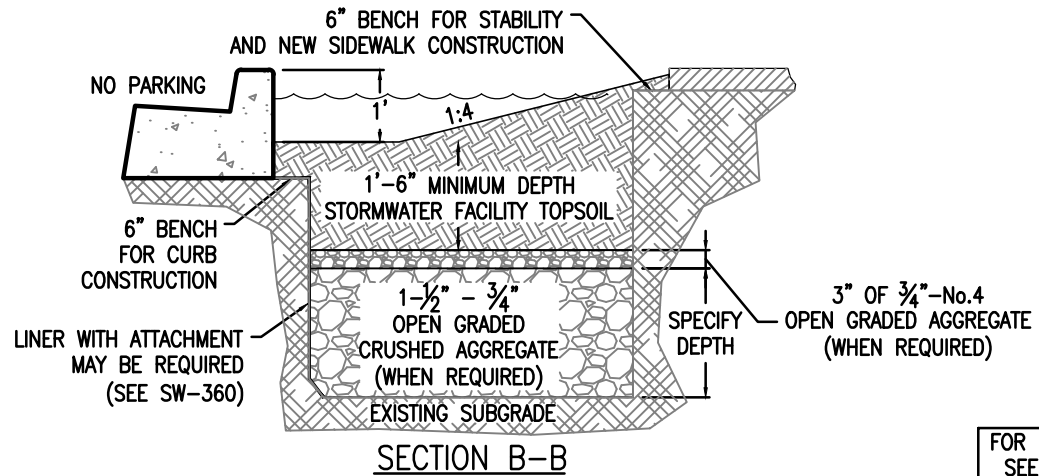
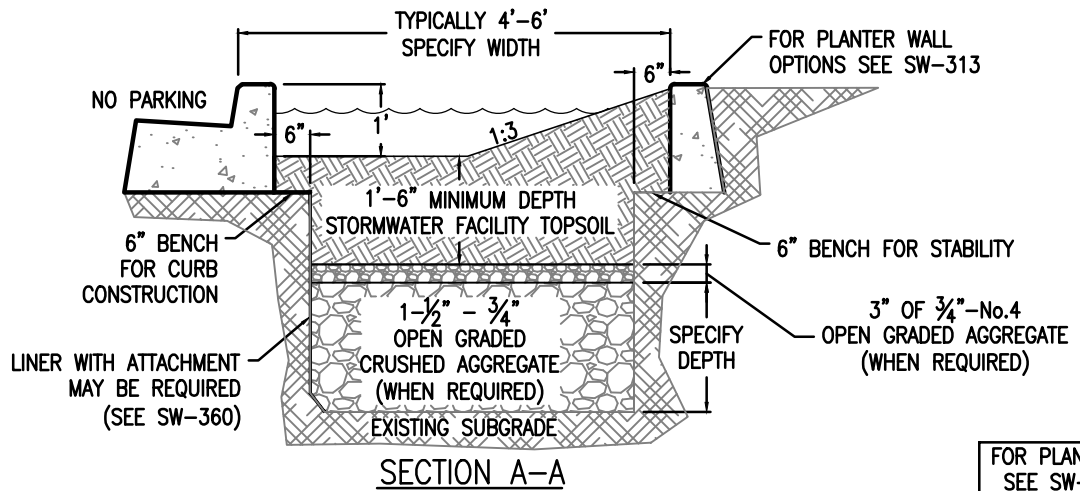
- Green Streets -
In-Planting-Strip Plan View
Curb Extensions



Bureau of Environmental Services



NUMBER
SW-321



CONSTRUCTION NOTE

Scarify the native soil following the initial excavation and before installing topsoil or rock.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Section Views
Curb Extensions



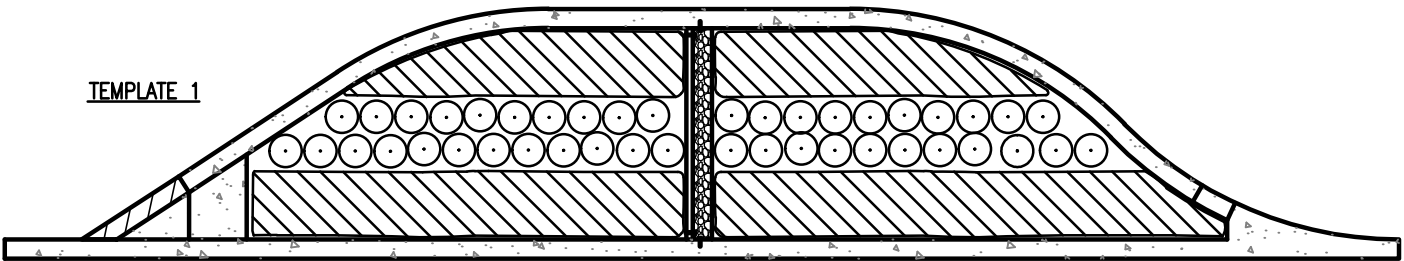
Bureau of Environmental Services



NUMBER

SW-322

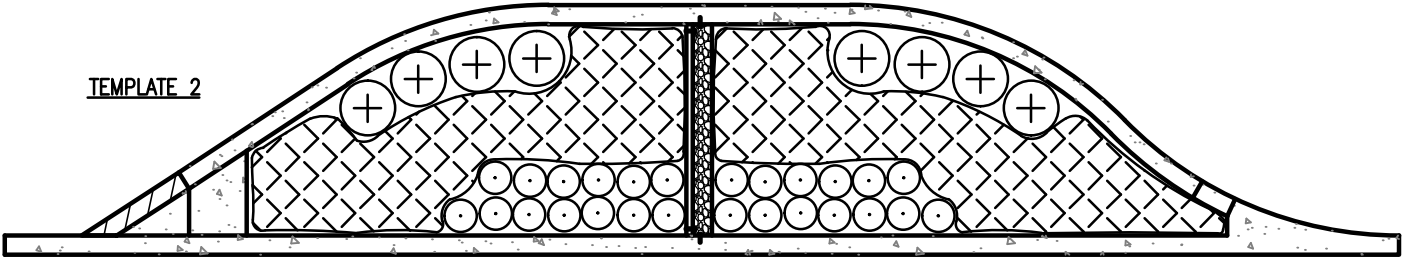
TEMPLATE 1



PLANT LEGEND 1

Symbol	Botanical Name	Common Name
	<i>Carex obnupta</i>	Slough sedge
	<i>Deschampsia cespitosa</i>	Tufted hair grass
	<i>w/Camassia leichtlinii</i>	Great camas- interspersed for accent

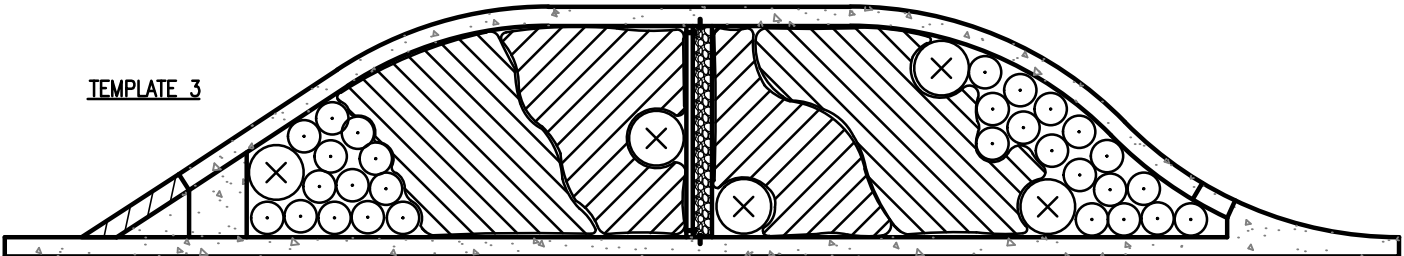
TEMPLATE 2



PLANT LEGEND 2

Symbol	Botanical Name	Common Name
	<i>Carex densa</i>	Dense sedge
	<i>Spiraea x bumalda 'Goldflame'</i>	Goldflame spirea
	<i>Deschampsia cespitosa</i>	Tufted hair grass
	<i>w/Camassia leichtlinii</i>	Great camas- interspersed for accent

TEMPLATE 3



PLANT LEGEND 3

Symbol	Botanical Name	Common Name
	<i>Juncus patens</i>	Spreading rush
	<i>Carex obnupta</i>	Slough sedge
	<i>Deschampsia cespitosa</i>	Tufted hair grass
	<i>Cornus sericea 'Kelsey'</i>	Kelsey dogwood
	<i>w/Narcissus spp.</i>	Daffodils- interspersed for accent

INSTRUCTIONS

1. Choose a template and alter it to design. These are examples of approved planting templates. Other planting plans may be approved.
2. Plant lists and quantity requirements are found in Section 2.3.3 and Appendix F.4, respectively, of the City of Portland Stormwater Management Manual.
3. Planting table required. State plant species, spacing, and quantities per planter. Include the square footage of planter.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Landscape Planting Templates
Curb Extensions

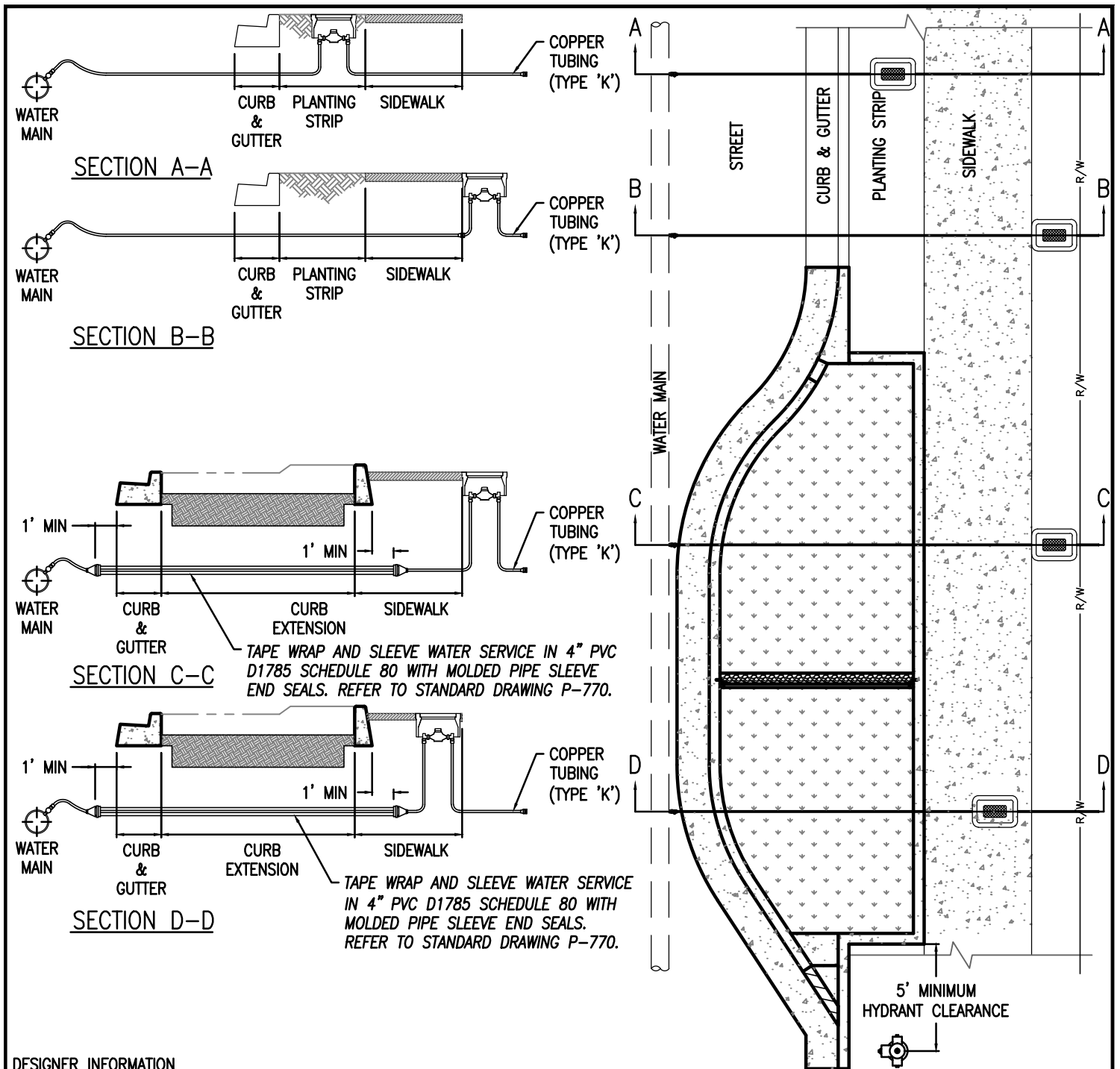


Bureau of Environmental Services



NUMBER

SW-323



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P-700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A. Option B or C can be used only if the meter box is fully within the Right-of-Way. Option D can only be used for an existing service and when other options are infeasible. Option E can only be used for an existing service and when other options are infeasible.
3. Refer to 1" Service Assembly Standard Drawing P-780. For larger services or other appurtenances, contact PWB development services at (503) 823-7368. Water service line must be 2 ft min. from bottom of stormwater facility topsoil.
4. Maintain 2 ft skin-to-skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross-section views are not required on construction plans.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
 Meter & Hydrant Locations
 Curb Extensions

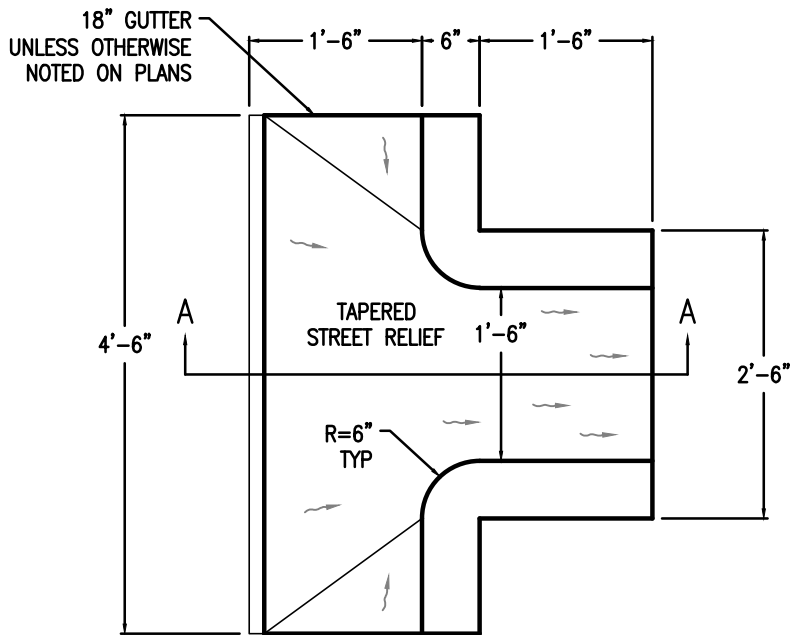


Bureau of Environmental Services

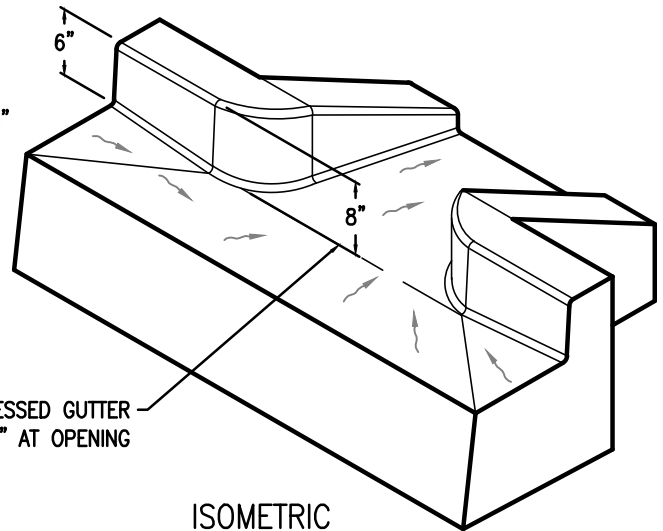


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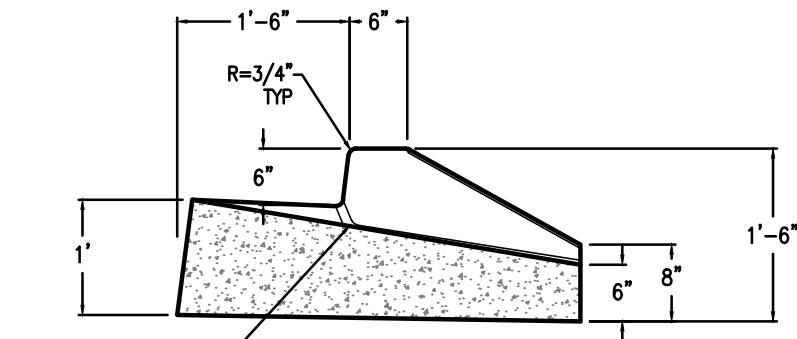
SW-324



PLAN



ISOMETRIC



SECTION A-A

DESIGNER INFORMATION

1. For use with stormwater facilities with side slopes.
2. Refer to Standard Drawing P-540. Match gutter pan of adjacent curb and gutter.
3. Metal Inlet assembly, SW-332, required on high traffic streets.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Concrete Inlet with Wingwalls
Curb Inlets

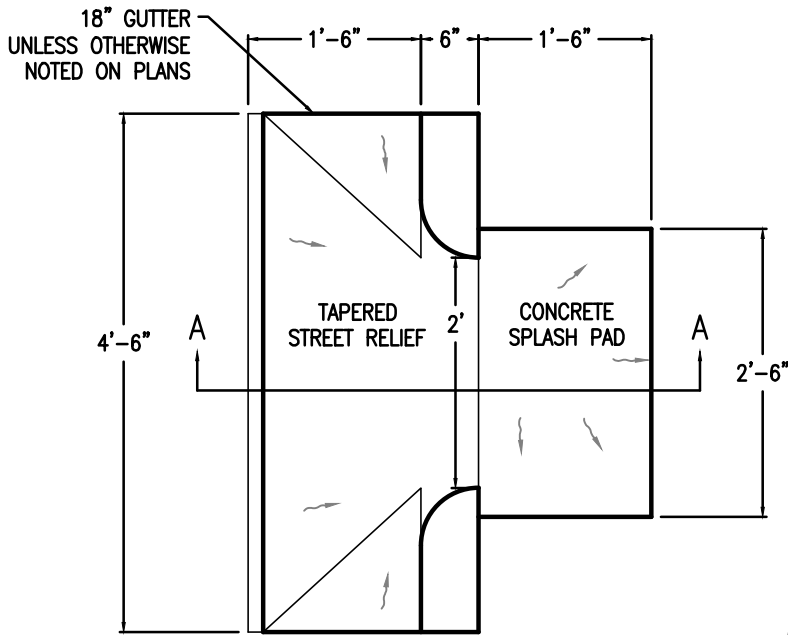
NUMBER

SW-330

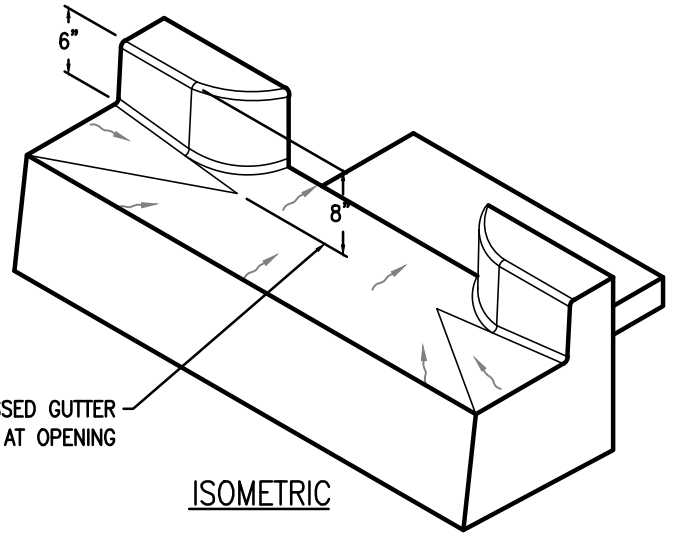


Bureau of Environmental Services

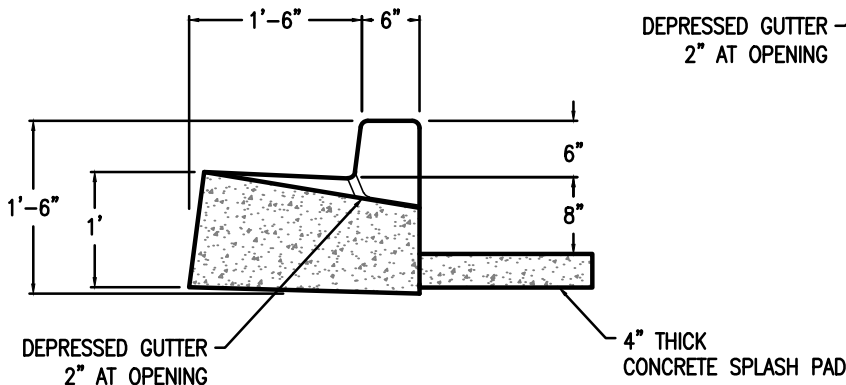




PLAN



ISOMETRIC



SECTION A-A

DESIGNER INFORMATION

1. For use with planters. If planter inlet is adjacent to planter wall, then include wall in detail.
2. Refer to Standard Drawing P-540. Match gutter pan of adjacent curb and gutter.
3. Metal Inlet assembly, SW-332, required on high traffic streets.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS



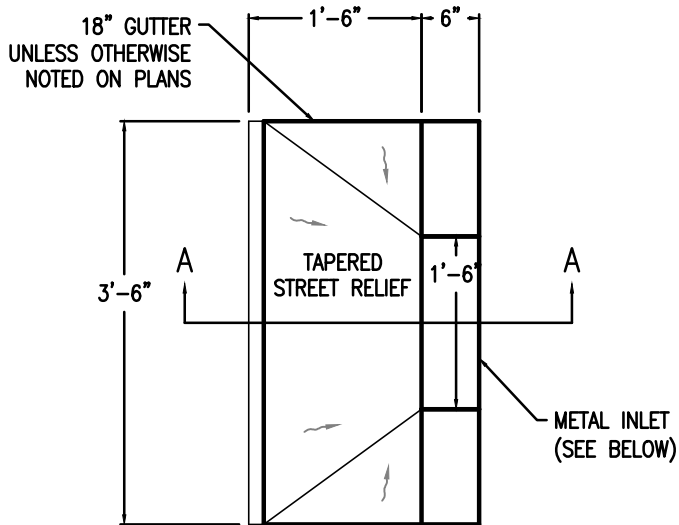
Bureau of Environmental Services

- Green Streets -
Concrete Inlet
Curb Inlets

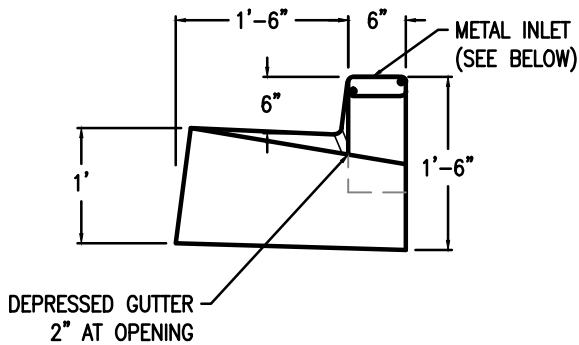


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SW-331

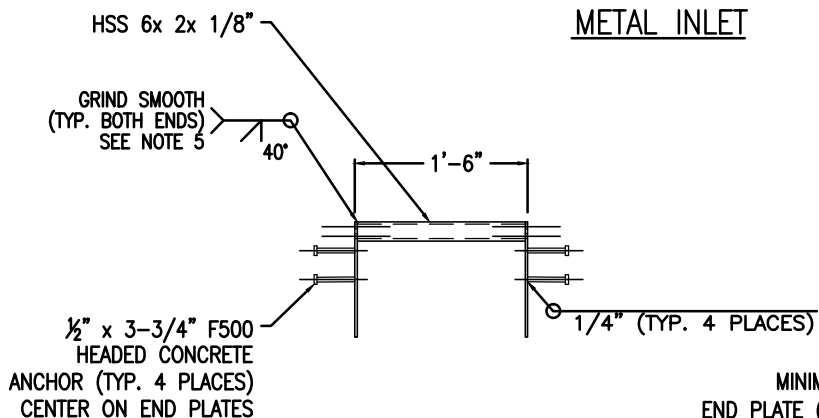


PLAN

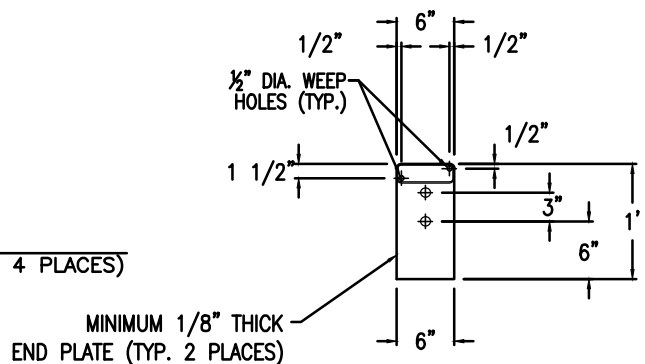


SECTION A-A

METAL INLET



FRONT



SIDE

DESIGNER INFORMATION:

1. Metal Inlets required on high traffic streets.
2. Thickened curb and gutter. Use PBOT Standard Drawing P-540.
3. Metal Inlet assembly used with SW-330, SW-331, and SW-335.
4. When using with SW-330, modify curb for Metal Inlet assembly.
5. Design vertical wheel load is 8.5kips (1/2 of tandem axles weight specified in FHWA-HOP-06-105).
6. Metal Inlet width can be modified to 2 ft if site conditions require a 2 ft interior inlet width.

CONSTRUCTION NOTES:

1. Headed concrete anchors shall meet the requirements of ASTM A-108.
2. HSS 6 x 2 x 1/8 Channel shall meet the requirements of ASTM A-500 Grade B.
3. End Plates shall meet the requirements of ASTM A-36.
4. Entire assembly shall be Hot-Dip Galvanized in accordance with ASTM A-123.
5. Single Bevel Groove Weld.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Metal Inlet
Curb Inlets

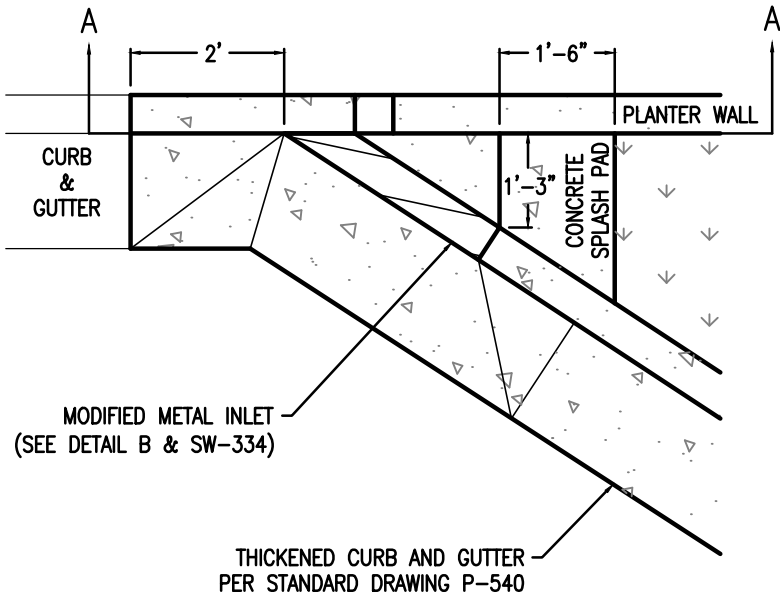
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SW-332

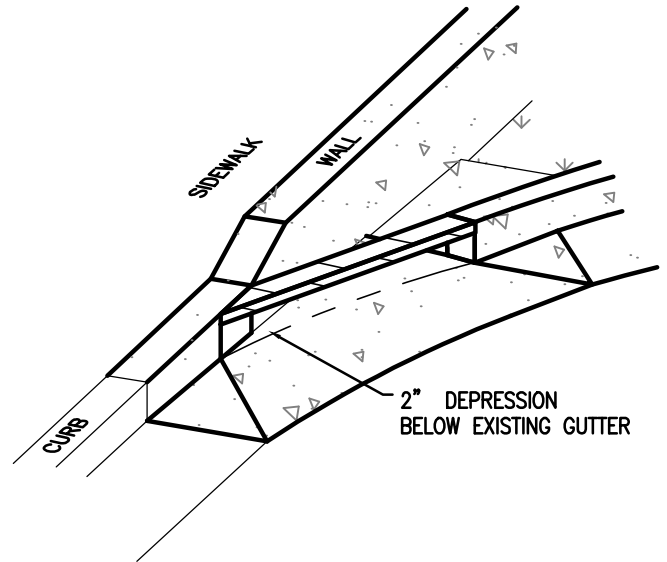


Bureau of Environmental Services

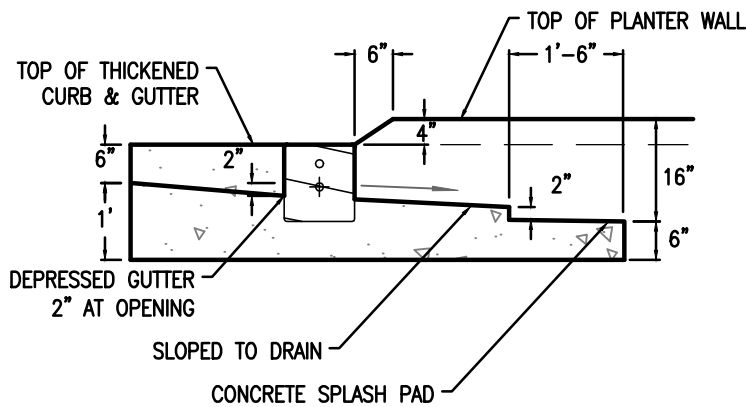




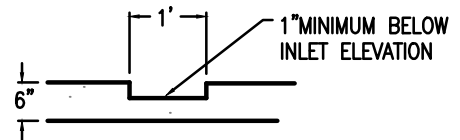
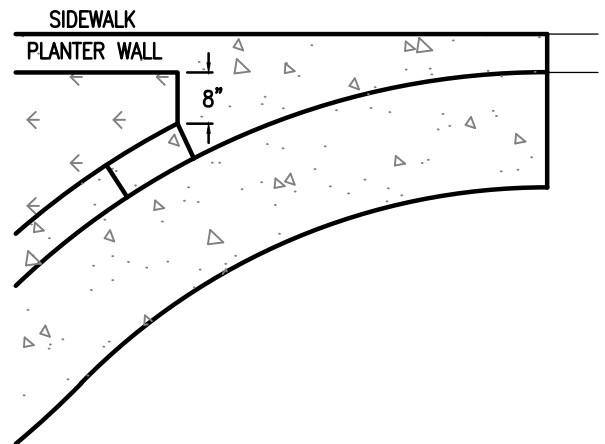
DETAIL A - INLET PLAN



DETAIL B - INLET PERSPECTIVE



SECTION A-A



DETAIL D - OUTLET NOTCH

DESIGNER INFORMATION:

1. Additional inlets can be added if necessary (preferably immediately downstream of each check dam to minimize potential backflow).
2. Sawcut beyond facility and transition existing curb to new curb and gutter at 1" per foot as necessary.
3. Inlet may be modified to maximize flow entry to stormwater facility.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS



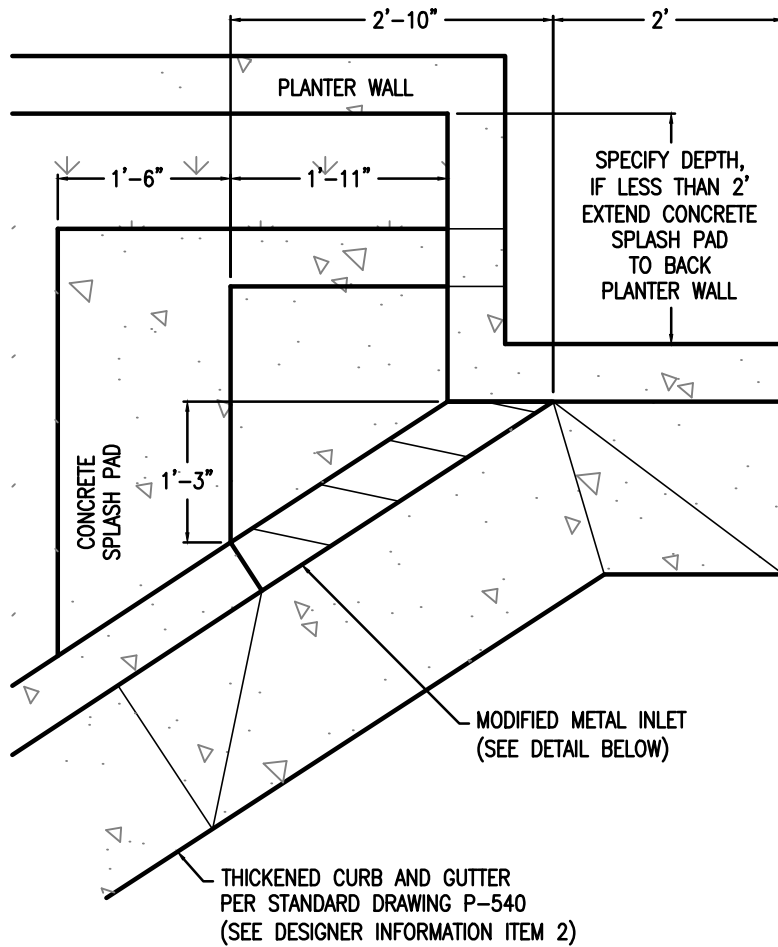
Bureau of Environmental Services

- Green Streets -
 Inlet & Outlet for Curb Extensions
 Curb Inlets

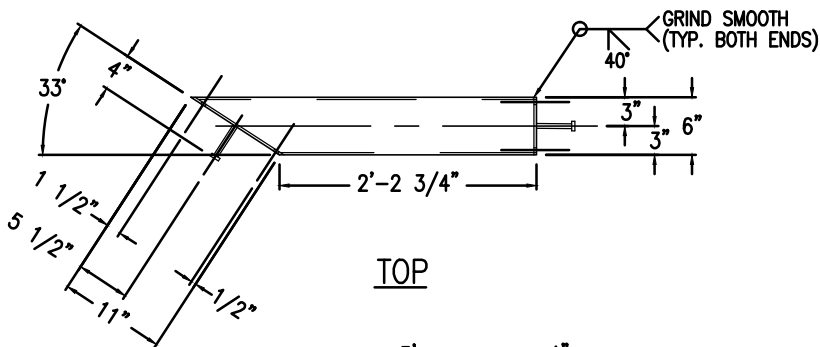


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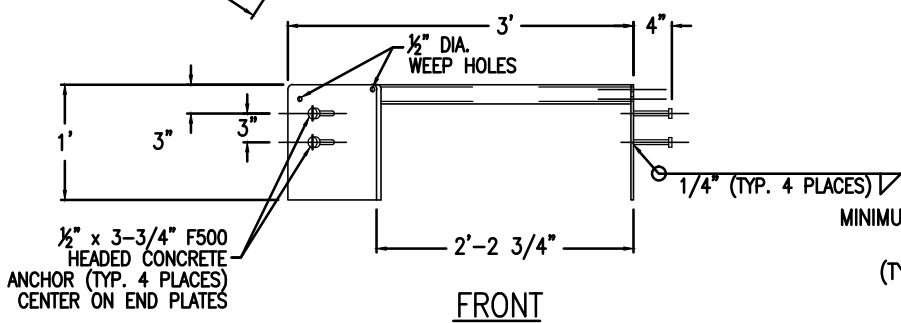
SW-333



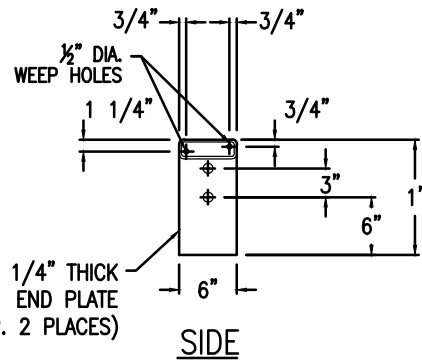
PLAN



TOP



FRONT



SIDE

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Splash pad are required at all inlets.
2. Refer to Standard Drawing P-540. Match gutter pan of adjacent curb and gutter.
3. Design vertical wheel load is 8.5kips (1/2 of tandem axle weight specified in FHWA-HOP-06-105).

CONSTRUCTION NOTES:

1. Headed concrete anchors shall meet the requirements of ASTM A-108.
2. HSS 6 x 2 x 1/4 Channel shall meet the requirements of ASTM A-500 Grade B.
3. End Plates shall meet the requirements of ASTM A-36.
4. Entire assembly shall be Hot-Dip Galvanized in accordance with ASTM A-123.
5. Single Bevel Groove Weld.

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Modified Metal Inlet Assembly
Curb Inlets

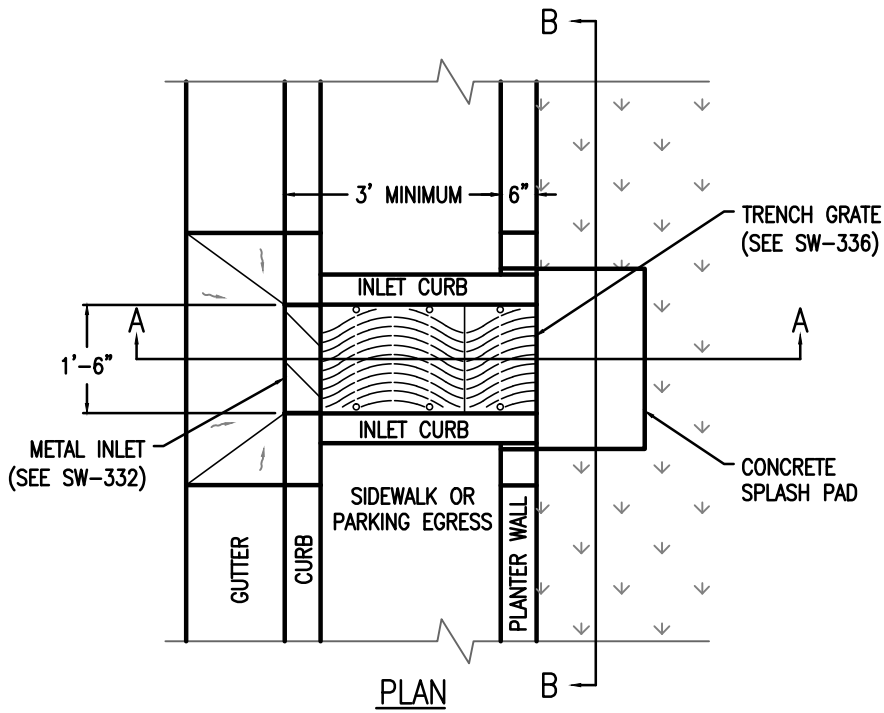
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SW-334

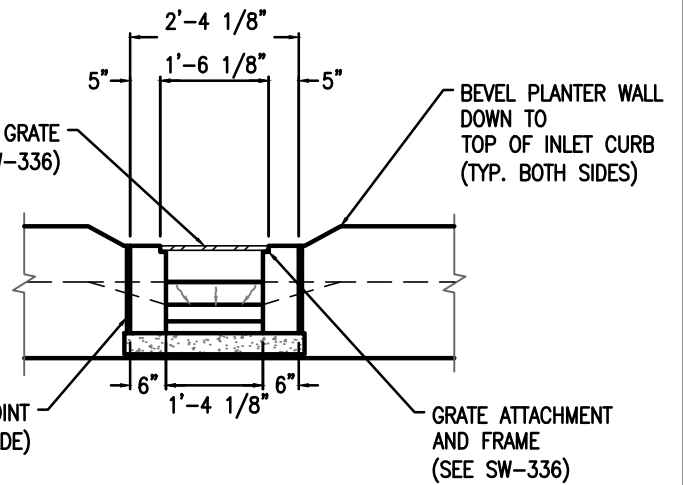
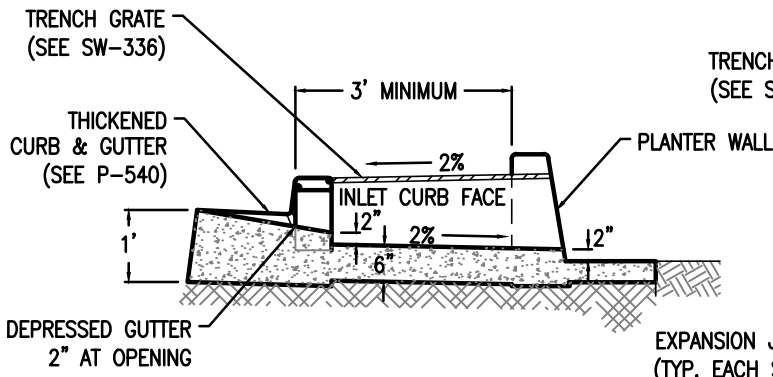


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PLANTER WALL



- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

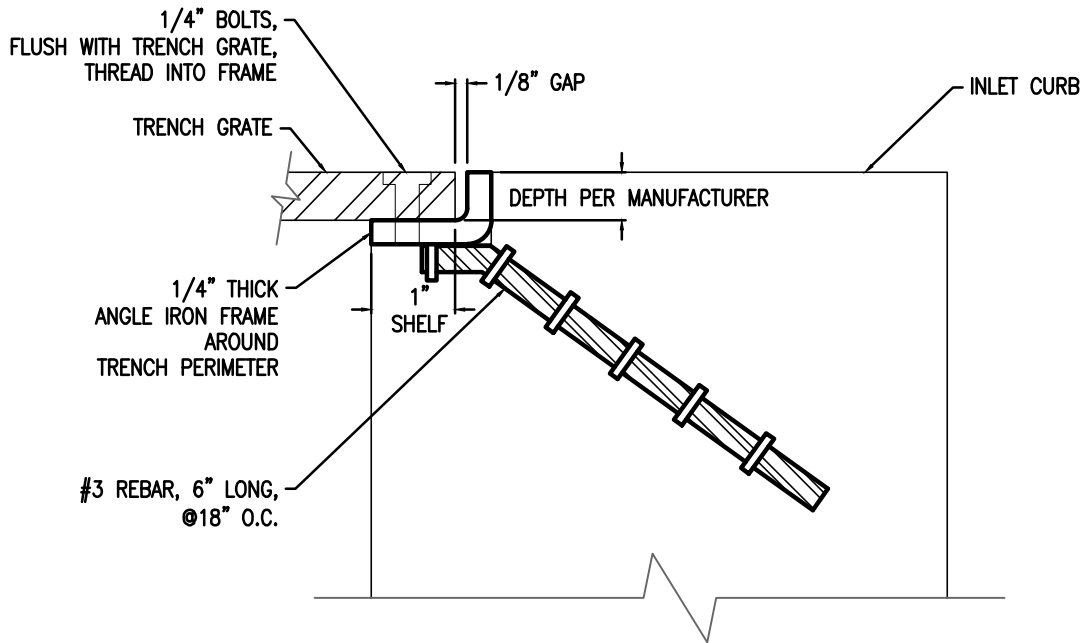
- Green Streets -
 Channel & Grate Details
 Curb Inlets



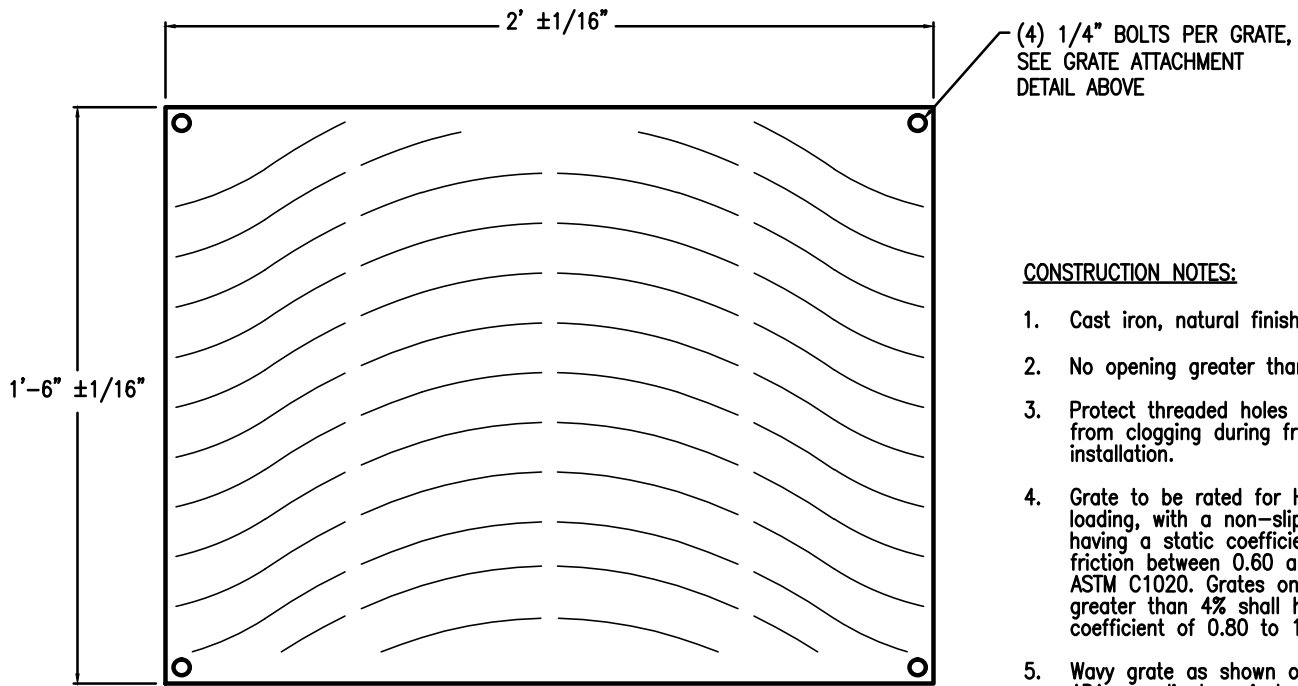
Bureau of Environmental Services



NUMBER
 SW-335



FRAME AND GRATE ATTACHMENT DETAIL



CONSTRUCTION NOTES:

1. Cast iron, natural finish.
2. No opening greater than 3/8".
3. Protect threaded holes in frame from clogging during frame installation.
4. Grate to be rated for H-20 loading, with a non-slip surface having a static coefficient of friction between 0.60 and 1.0 per ASTM C1020. Grates on inclines greater than 4% shall have a coefficient of 0.80 to 1.0.
5. Wavy grate as shown or approved ADA compliant equivalent.

TRENCH GRATE

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Grate & Frame Details
Check Dams

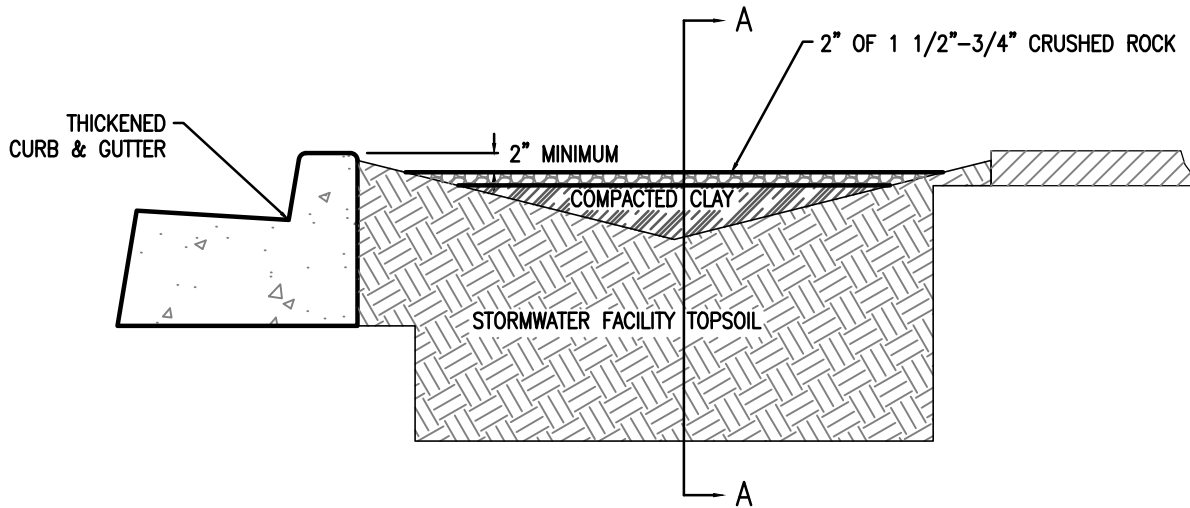
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SW-336

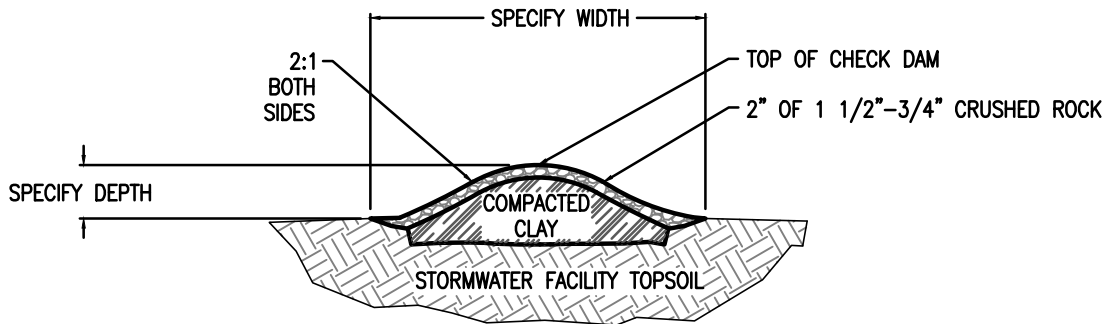


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TYPICAL SWALE SECTION



SECTION A-A

DESIGNER INFORMATION

1. Rock check dam for use in swales and curb extensions with side slopes.
2. Specify check dam elevation and width.
3. Provide stationing and/or dimensioning for check dams.
4. Hand tamp topsoil directly under check dam.
5. Key clay core into stormwater facility topsoil.

CONSTRUCTION NOTES

1. Hand tamp topsoil directly under check dam.
2. Key clay core into stormwater facility topsoil.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS



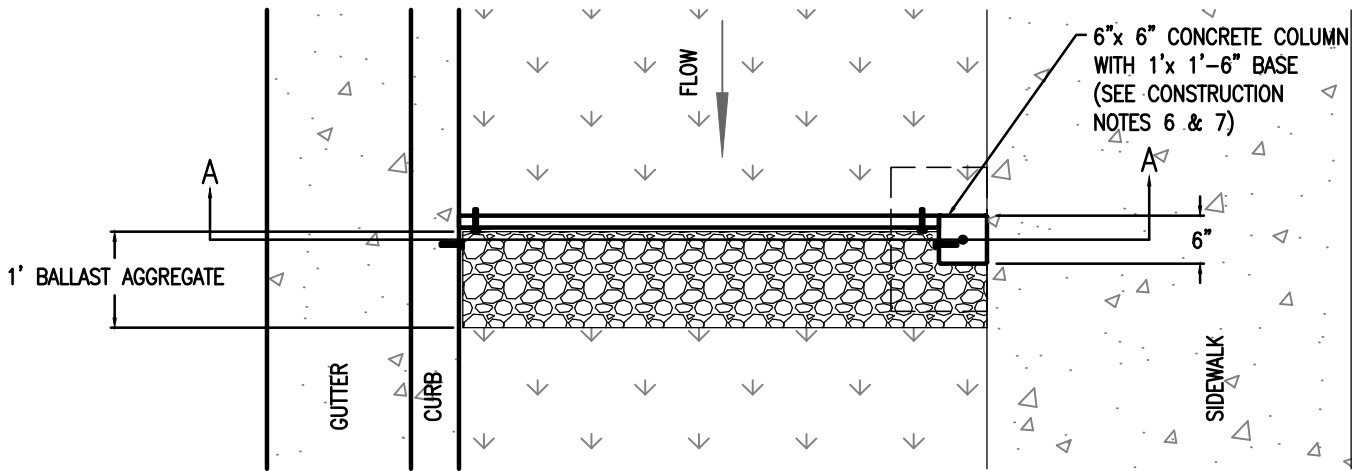
Bureau of Environmental Services

- Green Streets -
Rock Check Dam for Swales
 Check Dams

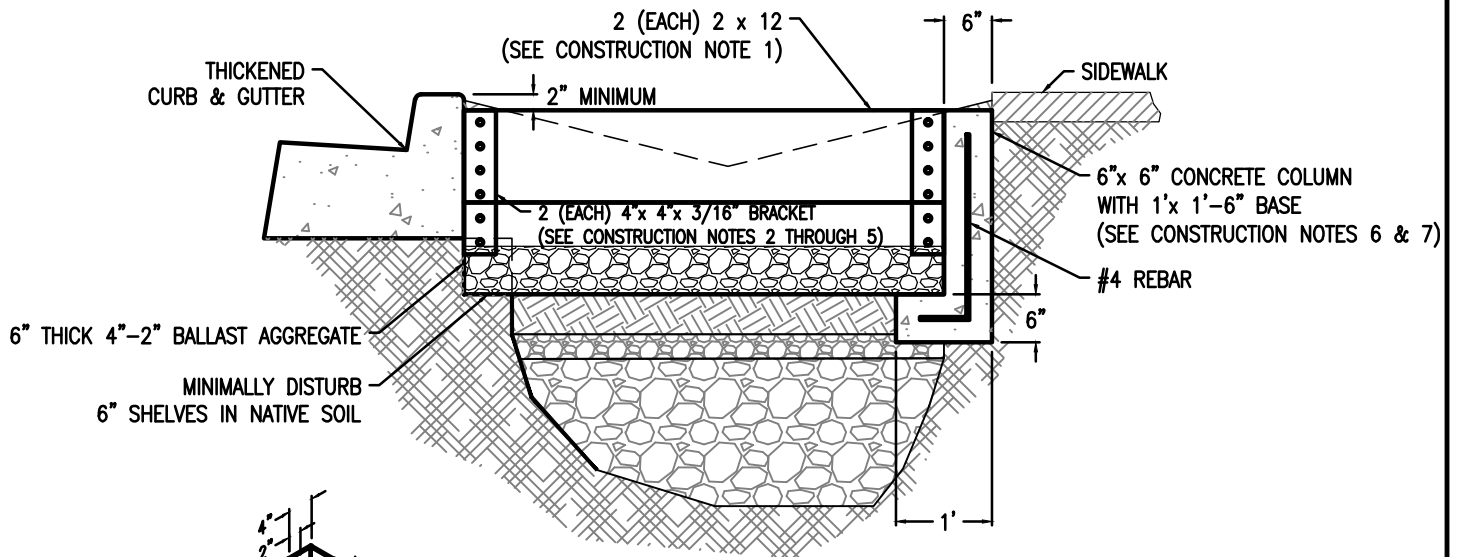


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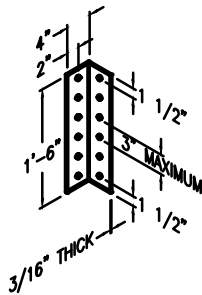
SW-340



PLAN



SECTION A-A



BRACKET DETAIL

DESIGNER INFORMATION

1. Provide elevations and stationing and/or dimensioning for check dams.
2. Ensure that check dam elevations do not cause stormwater to overflow to sidewalk.

CONSTRUCTION NOTES

1. Lumber to be a naturally rot-resistant wood (e.g. cedar). Manufactured products can be used with approval. No chemically treated wood will be allowed.
2. All fasteners to be stainless steel or aluminum.
3. 4"x 4"x 18" angle bracket, minimum 3/16" thick, stainless steel, or aluminum.
4. Top of bracket to be no higher than top of check dam.
5. Minimum 5/16" dia. bolts, 3 bolts into concrete, 2 bolts into each board
6. Construction grade concrete to be 3000 psi.
7. Base of column is 12"x 18" and 6" thick

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Wooden Check Dam for Swales
Check Dams

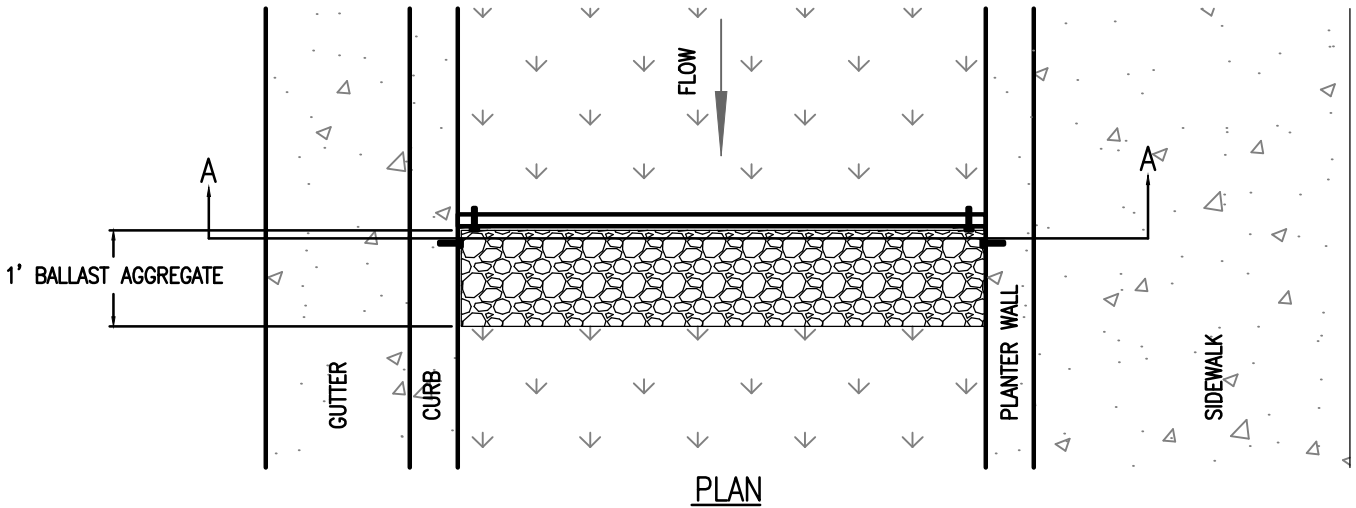
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SW-341

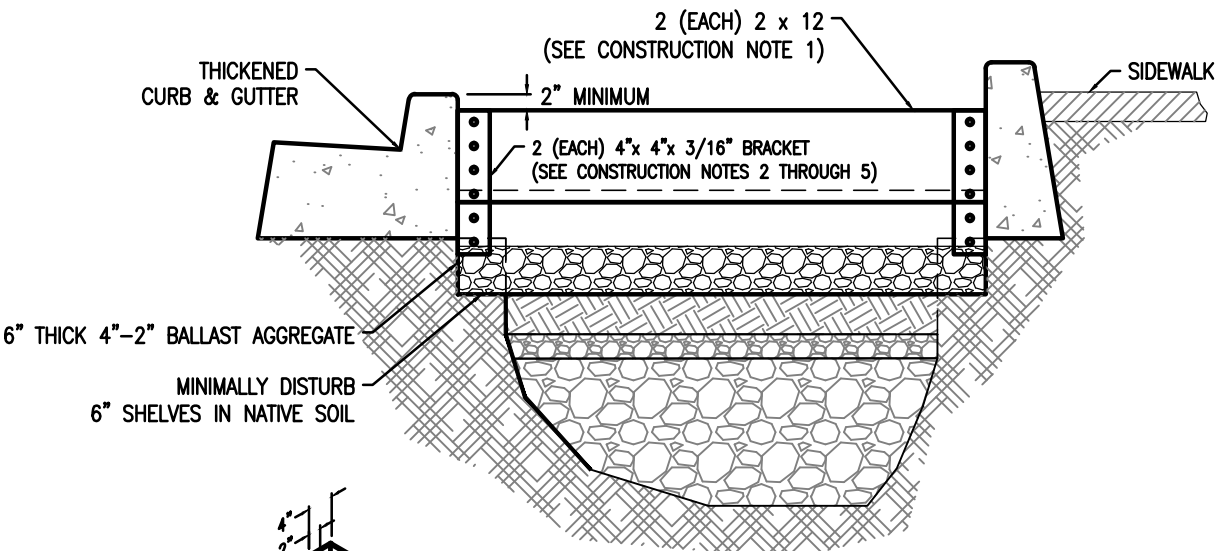


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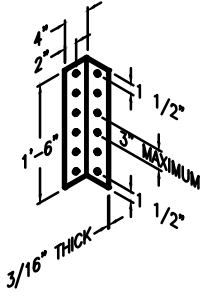




PLAN



SECTION A-A



BRACKET DETAIL

CONSTRUCTION NOTES

1. Lumber to be a naturally rot-resistant wood (e.g. cedar). Manufactured products can be used with approval. No chemically treated wood will be allowed.
2. All fasteners to be stainless steel or aluminum.
3. 4"x 4"x 1/8" angle bracket, minimum 3/16" thick, stainless steel, or aluminum.
4. Top of bracket to be no higher than top of check dam.
5. Minimum 5/16" dia. bolts, 3 bolts into concrete, 2 bolts into each board

DESIGNER INFORMATION

1. Provide elevations and stationing and/or dimensioning for check dams.
2. Ensure that check dam elevations do not cause stormwater to overflow to sidewalk.
3. For use in planters and curb extensions.
4. Cannot be used with an L-shaped planter wall.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Wooden Check Dam for Planters
Check Dams

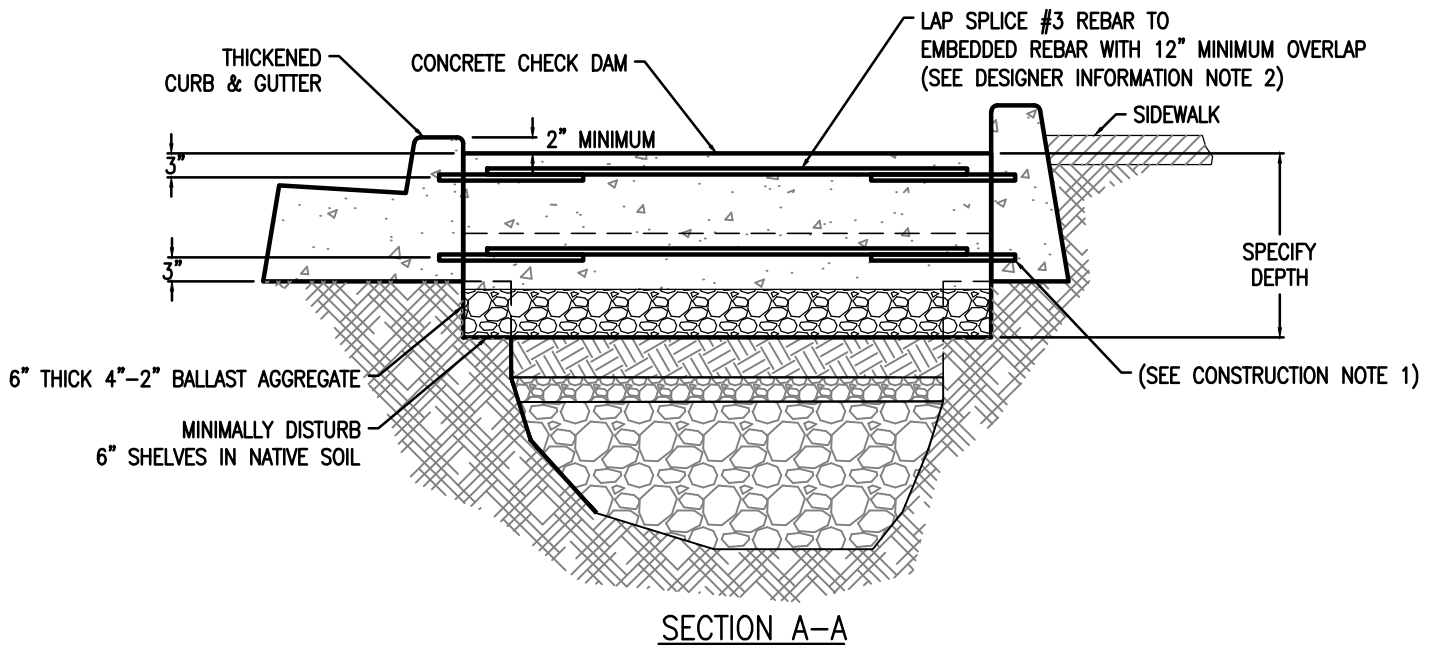
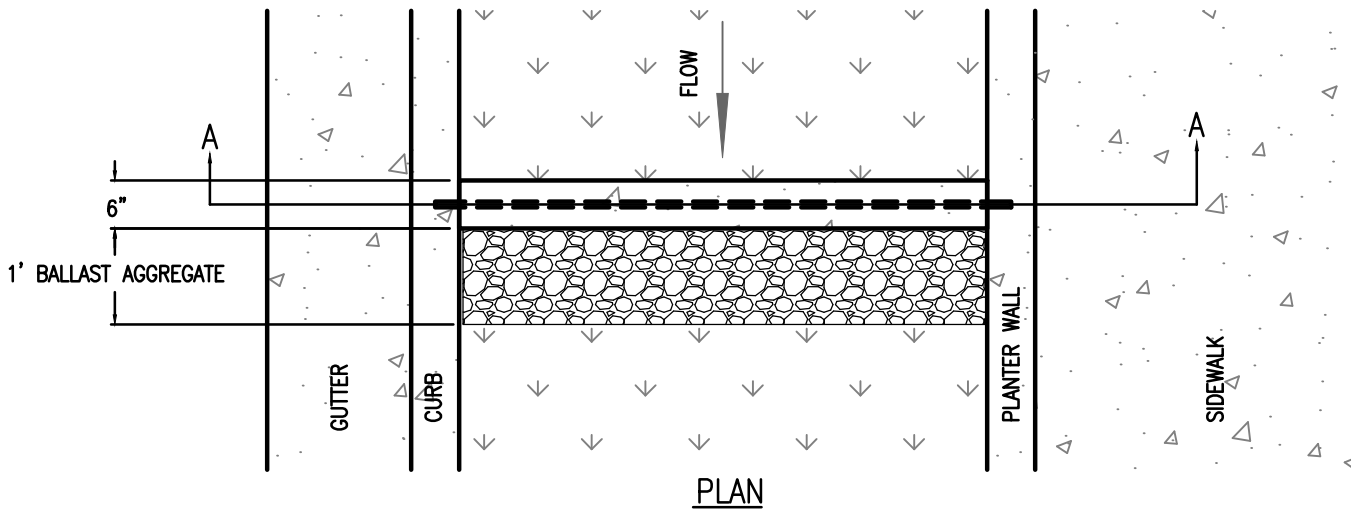
NUMBER

SW-342



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DESIGNER INFORMATION

1. Provide elevations and stationing and/or dimensioning for check dams.
2. Ensure that check dam elevations do not cause stormwater to overflow to sidewalk.
3. For use in planters and curb extensions.
4. For check dams that span longer than 12' specify rebar overlap length.
5. Show planter wall embedded in existing sub-grade or drain rock.

CONSTRUCTION NOTE

1. Embed #3 rebar 3" into curb and 3" into planter wall.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Concrete Check Dam for Planters
Check Dams

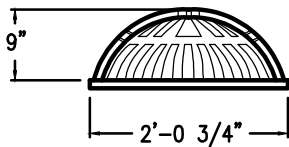
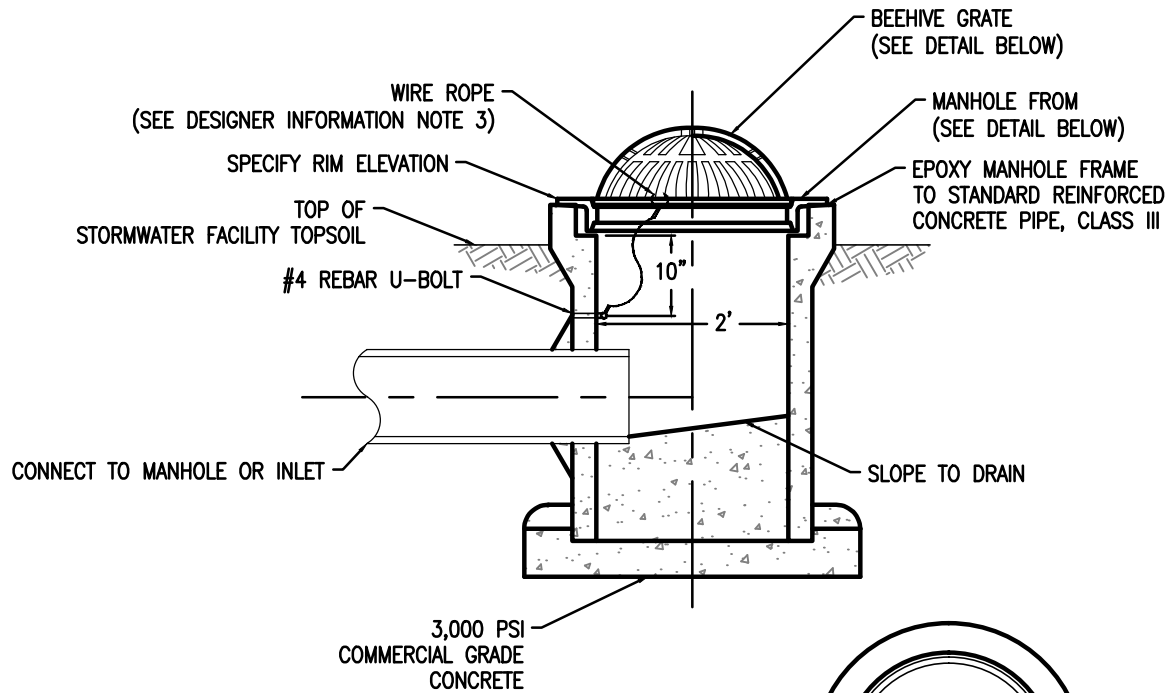
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SW-343

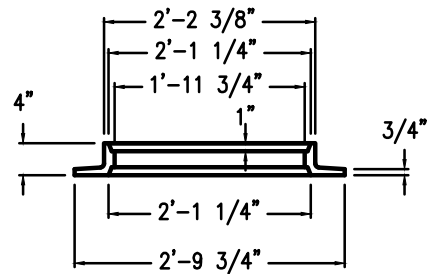
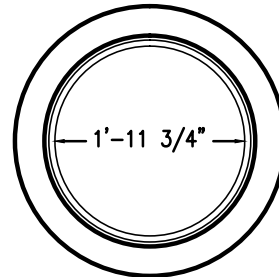


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BEEHIVE GRATE



24"x4" REVERSIBLE MANHOLE FRAME

DESIGNER INFORMATION

1. If connecting to a combination sewer main install a flapper valve or approved equal to prevent odor emissions.
2. Size inlet based on calculated flows & manufacturers recommendations.
3. Wire rope between 1/8"-3/16" diameter, stainless steel, 7 strands of 19 wires.

CONSTRUCTION NOTES

1. Secure grate in place with 54" of wire rope. Loop ends of wire rope around U-bolt and grate. Crimp each end of wire rope with 3" overlap.
2. Drill 2" deep holes into pipe and epoxy #4 rebar U-bolt (2"x 4") in holes.
3. Grate to be cast iron, ASTM A48 CL30.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Beehive Inlet Grate
Overflow Inlets

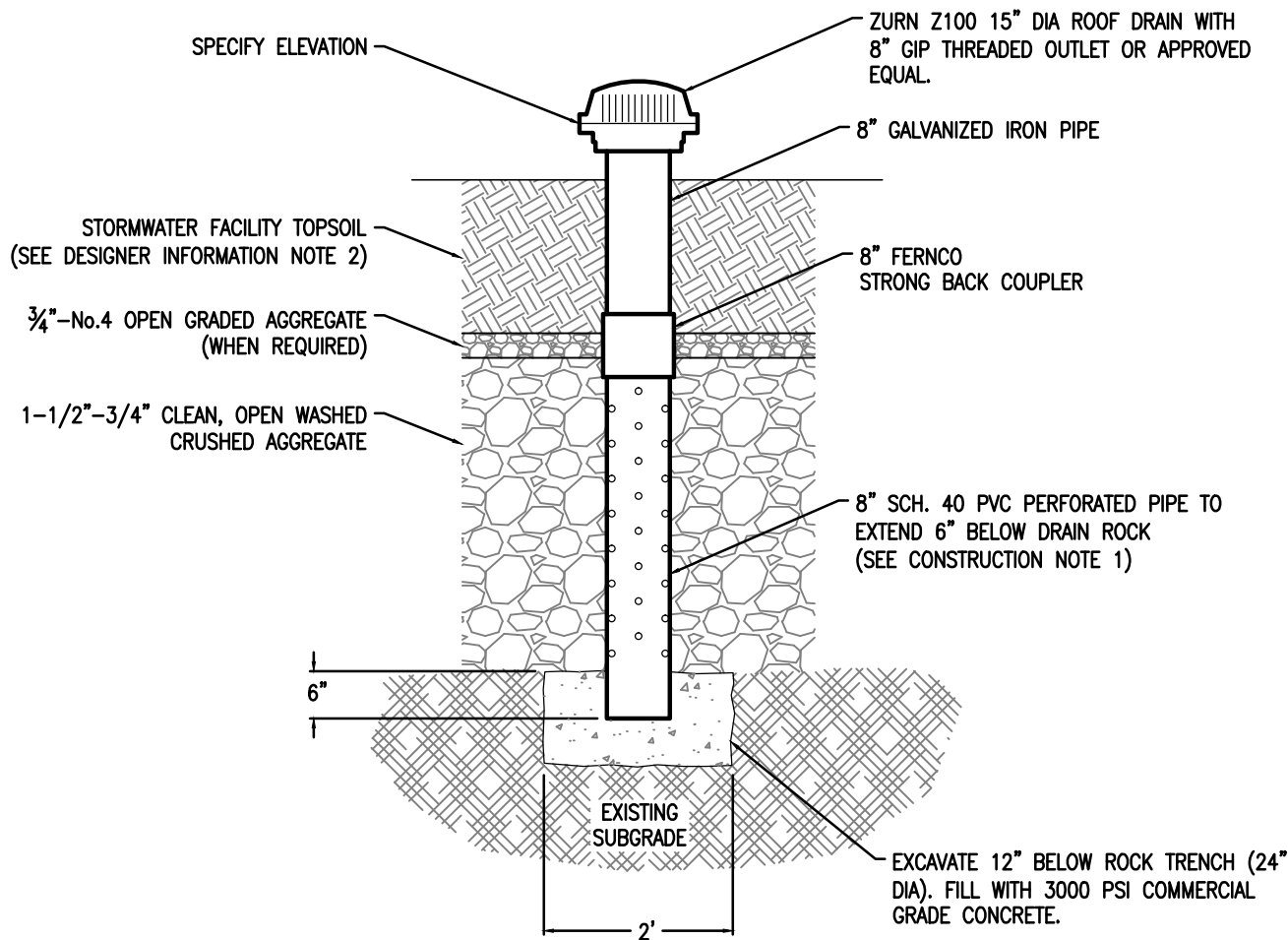


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NUMBER

SW-350



DESIGNER INFORMATION

1. Show overflow drain in swale, planter or curb extension section. Separate swale, planter or curb extension section views may not be needed.
2. Dimension stormwater facility soil and rock layers per your design. See sections SW-301, SW-312 and SW-322.

CONSTRUCTION NOTE

1. Perforate 8" Schedule 40 PVC with 1/2" holes, 90° degrees around pipe, rows 2" apart. Offset holes in rows by 45°.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
 Overflow Drain
 Overflow Inlets



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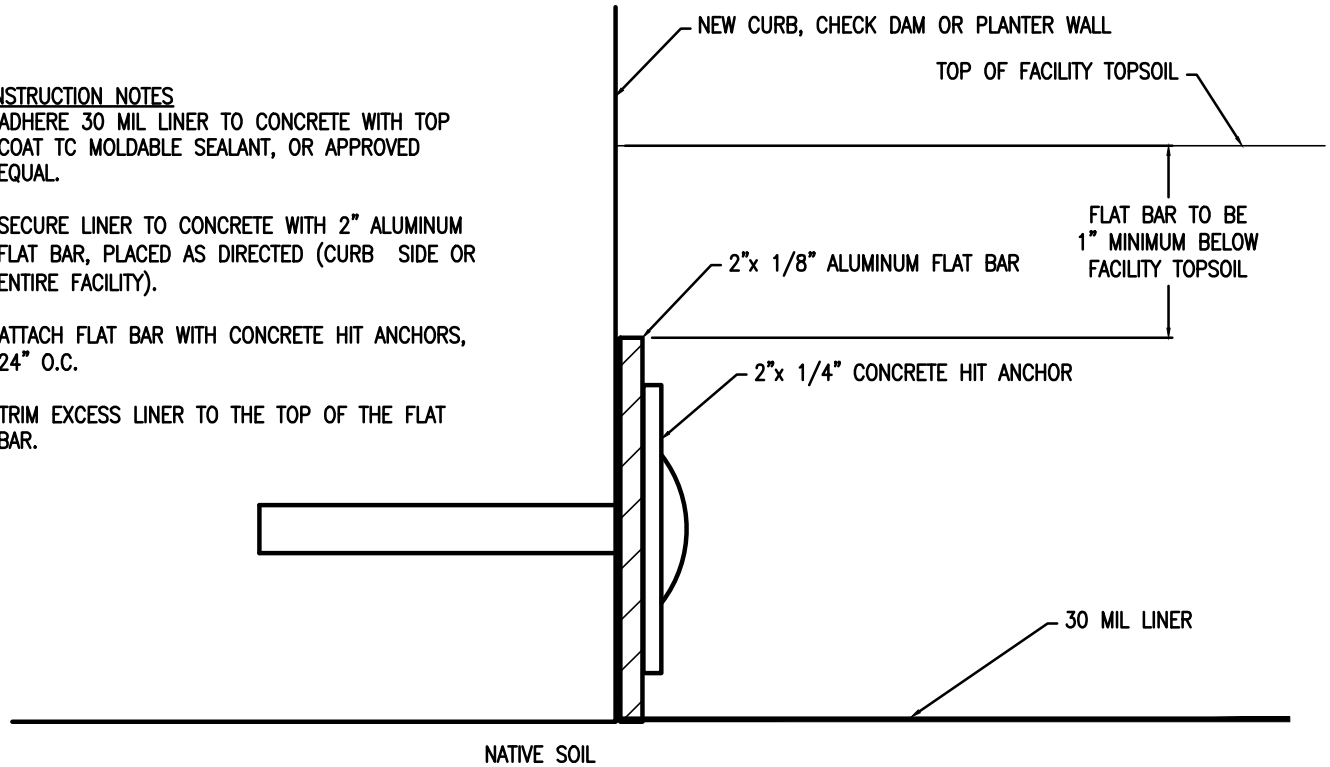


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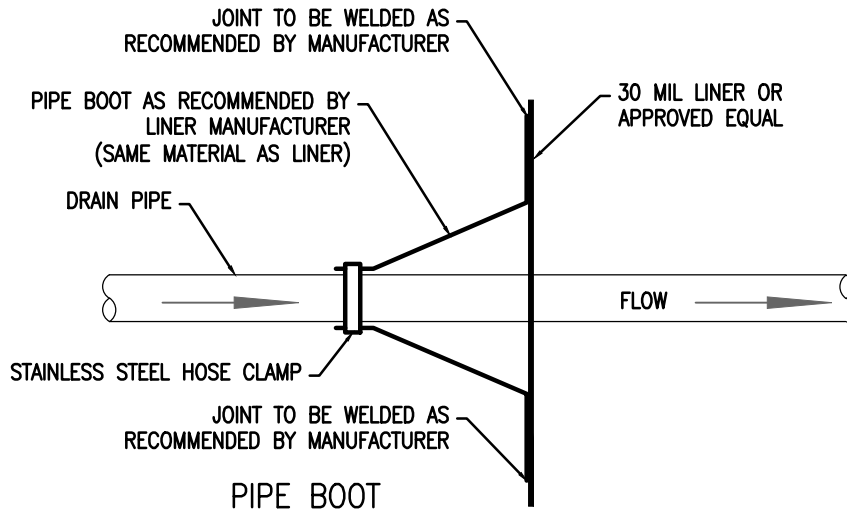
SW-351

CONSTRUCTION NOTES

1. ADHERE 30 MIL LINER TO CONCRETE WITH TOP COAT TC MOLDABLE SEALANT, OR APPROVED EQUAL.
2. SECURE LINER TO CONCRETE WITH 2" ALUMINUM FLAT BAR, PLACED AS DIRECTED (CURB SIDE OR ENTIRE FACILITY).
3. ATTACH FLAT BAR WITH CONCRETE HIT ANCHORS, 24" O.C.
4. TRIM EXCESS LINER TO THE TOP OF THE FLAT BAR.



LINER ATTACHMENT



DESIGNER INFORMATION

1. Liner materials to be HDPE or PVC. Liner to extend from top of topsoil to the bottom of excavation.
2. 3" of concrete is required on all sides of attachment. Adjust sidewalk depth as necessary.
3. Liner required when face of new curb is less than 2' from OD of adjacent water main.
4. Liner required on neighborhood collectors and higher street classifications.
5. Liner may be required on local streets with transit routes, higher traffic volumes, or when a facility is adjacent to travel lane at the discretion of the City Engineer.
6. In the Columbia South Shore Well Field Wellhead Protection Area or areas with contaminated soils the facility must be completely lined with a 40 mil liner unless facility's bottom and sides are monolithic concrete.
7. Liners may be required near basements or other underground structures.
8. Trees allowed in lined facilities only at the discretion of City of Portland staff.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Liner Attachment & Pipe Boot Detail

Miscellaneous

NUMBER

SW-360



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1. GENERAL

Facility Number: _____ Inventory Date: _____ Photo No: _____

Person(s) Doing Inventory: _____

Adjacent Property Address: _____

2. STORMWATER

Flow Direction? From: N NW W SW S SE E NE → To: N NW W SW S SE E NE

Type of Sewer? Combined / Stormwater

Existing Inlet Nearby? Yes / No

Collection Area (sf) : _____

Known Local Basement Seepage? Yes / No

Adjacent Basement within 15' of Facility? Yes / No

Contaminated Soils? Yes / No

(Need a minimum of 4:1 slope from bottom of facility to floor of basement)

Groundwater <10' from Bottom of Facility? Yes / No

Well Head Protection Area? Yes / No

3. STREET

Street Classification? Local Service / Neighborhood Collector / District Collector

Street Width? _____ Street Grade? _____ Curb Exposure? _____

On-street Parking? Yes / No

Pavement Moratorium? Yes / No

Pavement Type? Asphalt / Hassam Concrete / Asphalt Overlay (Portland Cement Concrete)

Adjacent Corner Ramps? Yes / No

Are Ramps ADA Compliant? Yes / No

Planting Strip Width? _____

Carriage Path/Concrete Walkway? Yes / No

(Measured from face of sidewalk to face of curb)

Existing Street Pavement allow for proper drainage into the facility? Yes / No

4. WATER SERVICE

Adjacent Fire Hydrant? Yes / No

Adjacent Water Meter? Yes / No

(5' buffer required to avoid hydrant relocation)

Standard Meter Box? Yes / No

Large Meter Box? (36" x 24") Yes / No

Relief Valve Vent? Yes / No

Water Sampling Testing Stations Yes / No

Water Main adjacent to Facility? Yes / No

Distance from Face of Curb? _____

Size of Water Main? _____

5. PRIVATE UTILITIES (POWER / COMMUNICATION / GAS)

Utility Poles on Same Side of Street? Yes / No

Power Pole in Facility? Yes / No

Type of Overhead Utility? Electrical / Communication

Guy-wires? Yes / No

Gas Lines in Facility? Yes / No

Vaults / Duct Banks? Yes / No

6. EXISTING VEGETATION

Existing Street Trees? Yes / No

Species: _____ Caliper Inch: _____

Species: _____ Caliper Inch: _____

Species: _____ Caliper Inch: _____

Other Existing Landscaping to be Preserved? Yes / No

Describe: _____

7. FACILITY DESIGN

Facility Type? Curb Extension / Swale / Planter **Approximate Length?** _____

Distance from facility outlet to nearest landmark (e.g. driveway, corner, mature tree)? _____

Does roadbed need to be protected? Yes / No

(When face of curb is <2 ft. from water line or on neighborhood collectors and higher street classifications.

Roadway protection may be required on local streets at the discretion of the City Engineer.)

Does facility need to be fully lined, or need clay/bentonite plug to seal utility trenches? Yes / No

(Where basement is within 15 ft of facility, or groundwater levels are within 10' of facility bottom, or general infiltration is a concern)

Inlet Type? Concrete Inlet (SW-330) Metal Inlet (SW-331)
 Channel & Grate (SW-333) Inlet / Outlet for Curb Extension (SW-335)

Parking to be Removed? Yes / No **Water Meter need to be moved?** Yes / No

Will stormwater inlet be located inside facility? Yes / No Beehive Atrium Inlet (SW-350)

Has there been a history of Odor complaints in the area? Yes / No

(ArcGIS / MapWorks layer "Odor Complaint History" can be viewed to get more detailed information)

8. NOTES

9. PHOTO / SKETCH

Appendix G.5 Table of Contents

SW-500: Source Control Spill Control Manhole

SW-501: Source Control Oil-Water Separator

SW-510: Source Control Trash Enclosure

SW-511: Spill Control Sign Examples

SW-520: Outfall - Check Dams

SW-521: Outfall - Open Channel Outfall

SW-522: Outfall - Piped Outfall

SW-523: Outfall - Rock Energy Dissipator

SW-524: Outfall - Upland Dispersion

SW-525: Outfall - End Wall Detail

SW-526: Outfall - Grated Protection Detail

SW-530: Culvert

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Supplemental Details -
Table of Contents

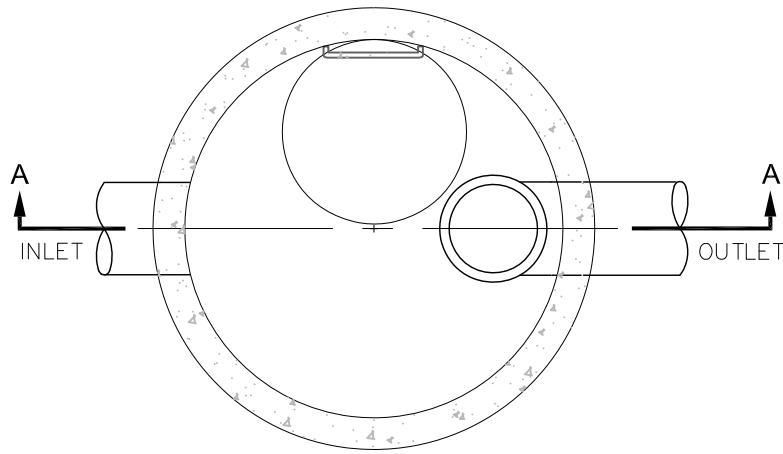
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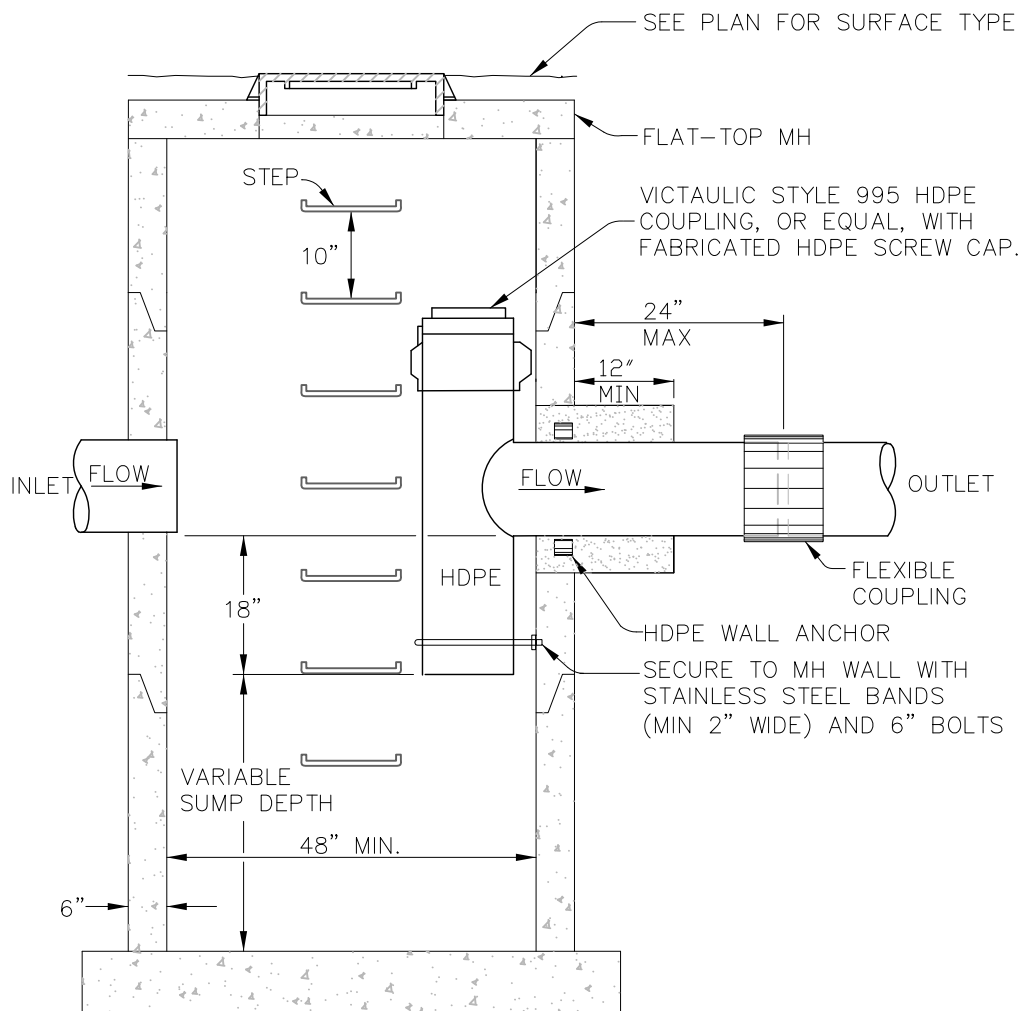


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PLAN



- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -
Spill Control Manhole
 Source Control

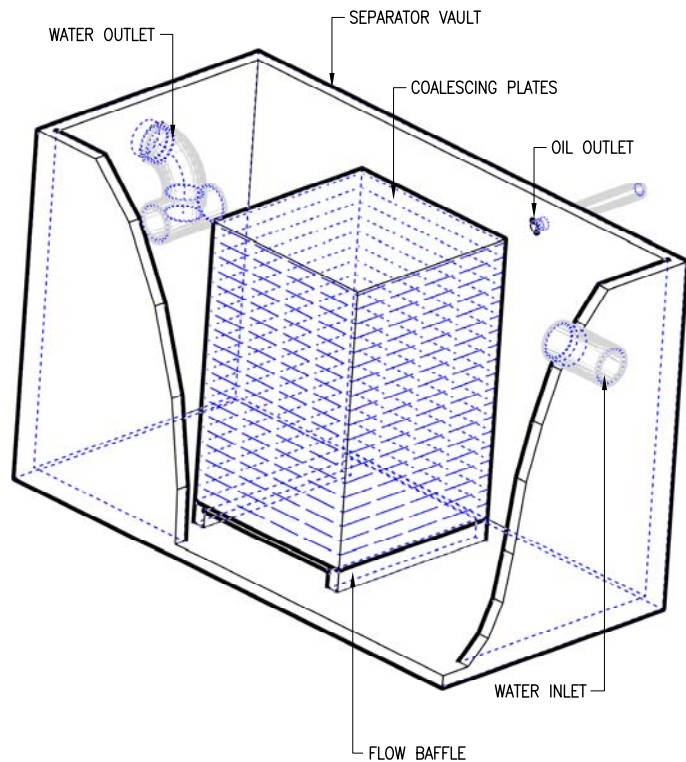
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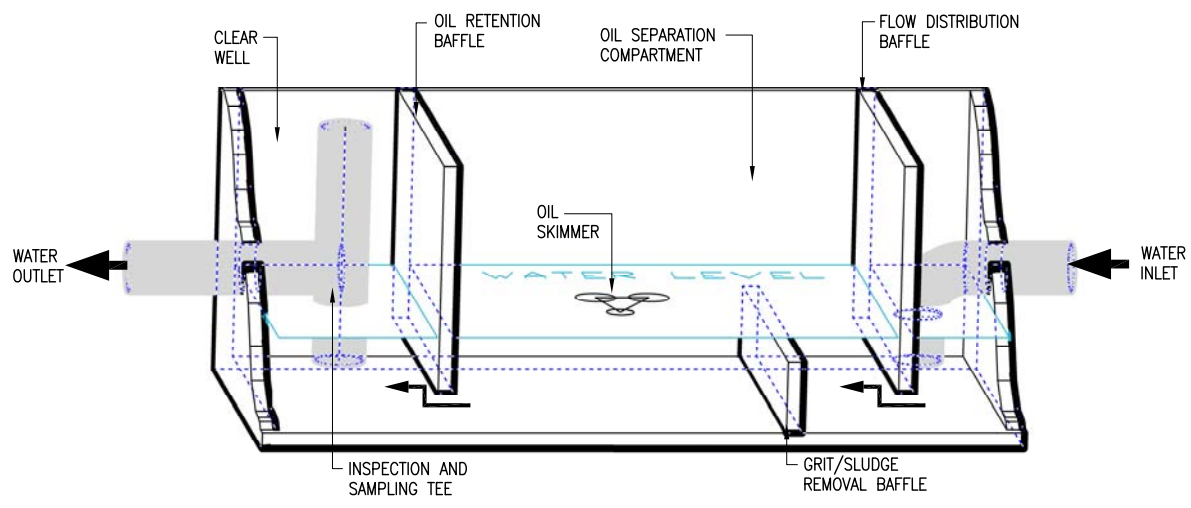


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COALESCING PLATE (CP) SEPARATOR



AMERICAN PETROLEUM TYPE (API) SEPARATOR

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -
Oil-Water Separators
 Source Control

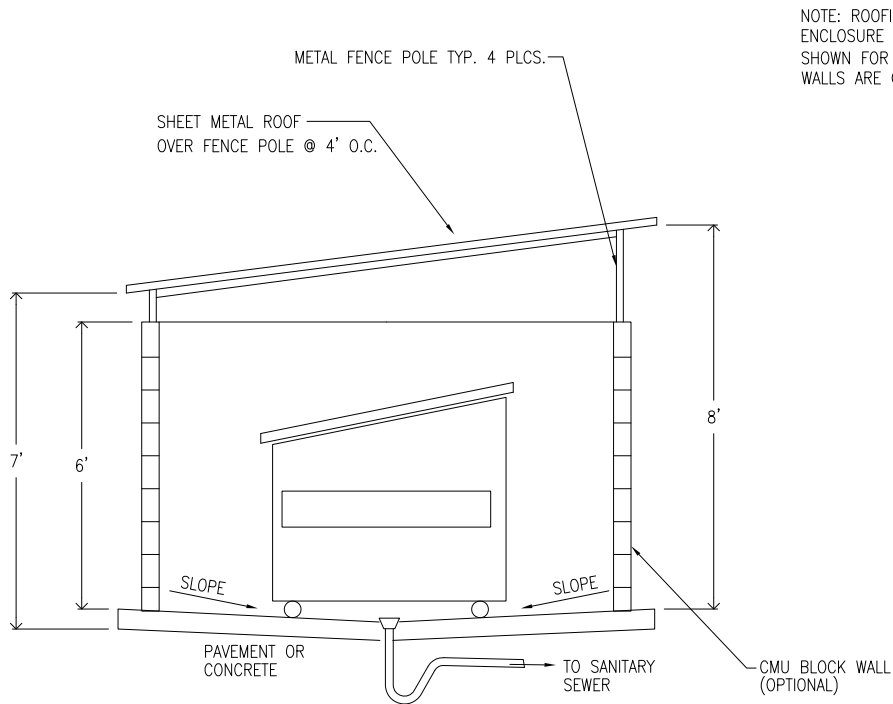
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SW-501



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- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -
Trash Enclosure
 Source Control

NUMBER

SW-510



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Pollution Control

IN THE EVENT OF A SPILL

USE Safety Precautions

- Wear protective gear
- Keep vehicles and people out of spill
- Contain materials with the spill kit
 - 1) Seal off drains
 - 2) Berm to contain the spill
 - 3) Clean up with absorbent materials

① Turn off valve located at _____
 (your location, ie: NE corner of parking lot)

② CALL: Supervisor @ 503 XXX-XXXX
 and Environmental Services
 Emergency Spill Response
 @ 503 823-7180

SAMPLE



Pollution Control

IN THE EVENT OF A SPILL

① Turn off valve located at _____
 (your location, ie: NE corner of parking lot)

② CALL: Supervisor @ 503 XXX-XXXX
 and Environmental Services
 Emergency Spill Response
 @ 503 823-7180

USE Safety Precautions

- Wear protective gear
- Keep vehicles and people out of spill
- Contain materials with the spill kit
 - 1) Seal off drains
 - 2) Berm to contain the spill
 - 3) Clean up with absorbent materials

SAMPLE

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -

Spill Control Sign Examples

Source Control

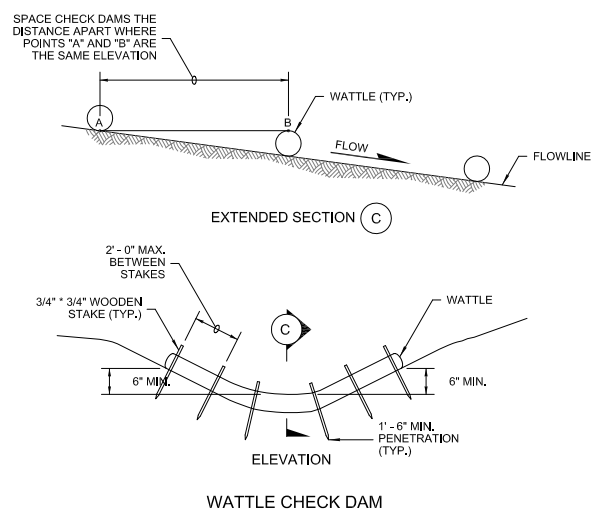
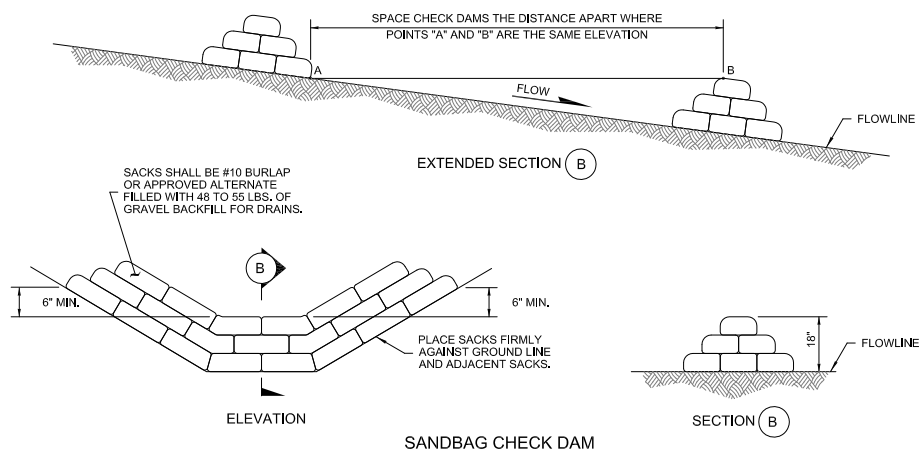
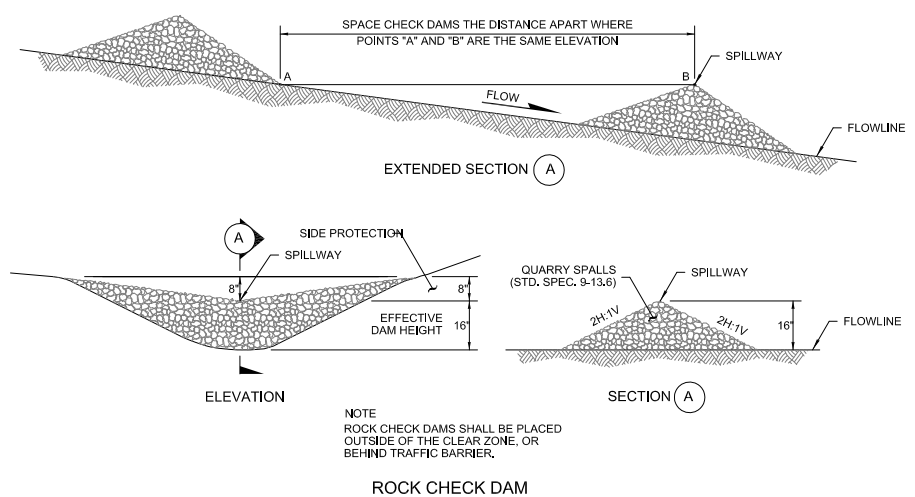
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SW-511



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- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -
**Outfall
Check Dams**

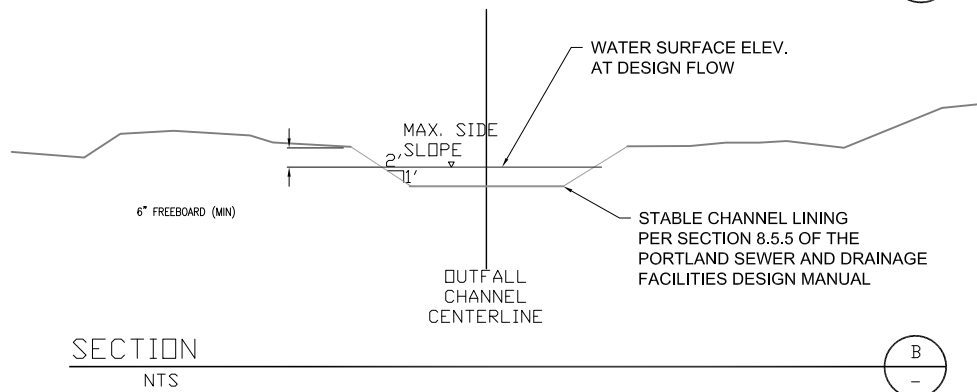
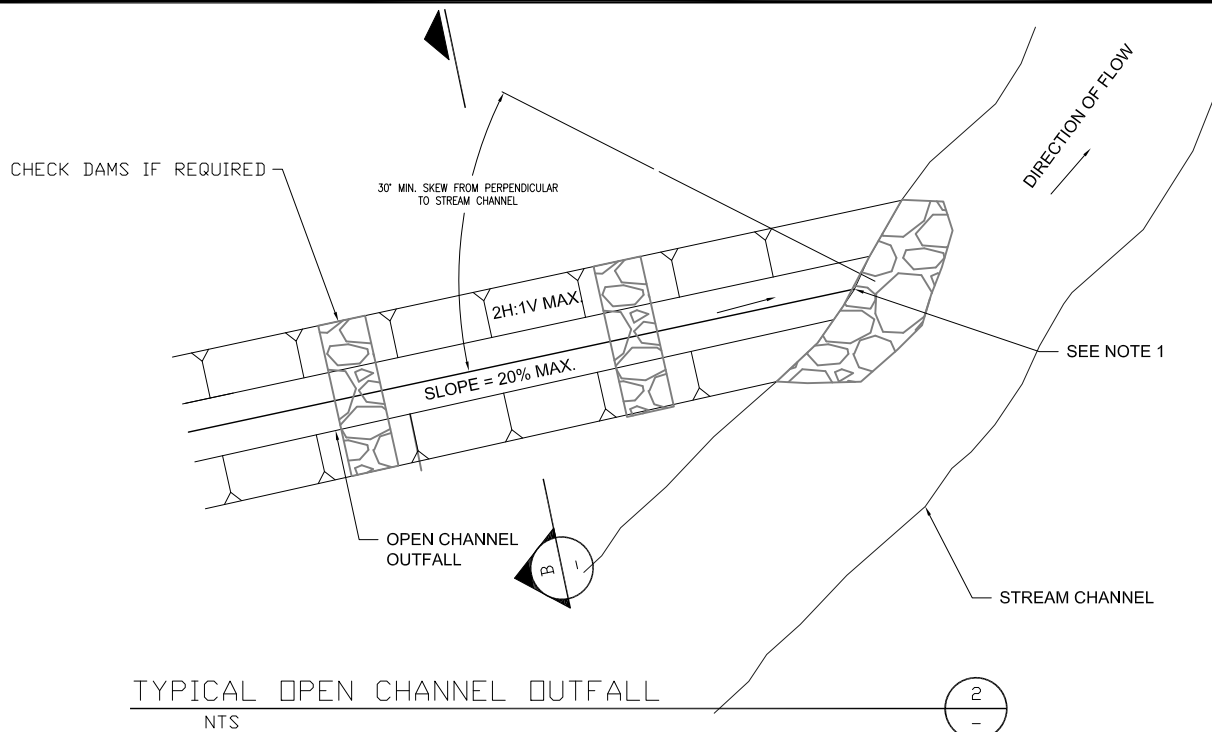


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NUMBER

SW-520



NOTES

1. INVERT ELEVATION OF OPEN CHANNEL OUTFALL AT CONFLUENCE WITH STREAM CHANNEL SHALL BE AT OR NEAR INVERT OF MAIN CHANNEL.
2. OPEN CHANNEL OUTFALLS SHOULD NOT BE CONSTRUCTED IN AREAS WITH UNSTABLE SOILS.
3. MAXIMUM LONGITUDINAL SLOPE FOR OPEN CHANNEL OUTFALL = 20 PERCENT
4. FOR LINING REQUIREMENTS, SEE SECTION 8.5.1 OF THE PORTLAND SEWER AND DRAINAGE FACILITIES DESIGN MANUAL 2006. FLEXIBLE LININGS RECOMMENDED FOR CHANNEL SLOPES > 2 PERCENT.
5. MAXIMUM SIDE SLOPES 2 H: 1 V. SHALLOWER SIDE SLOPES MAY BE REQUIRED DEPENDING ON THE CHANNEL MATERIAL (SEE SECTION 8.5.1 OF THE DESIGN MANUAL)
6. ALL DISTURBED AREAS TO BE REPLANTED WITH NATIVE VEGETATION. SEE SECTION 8.5.6 OF THE PORTLAND SEWER AND DRAINAGE FACILITIES DESIGN MANUAL 2006 AND SECTION 2.7 OF THE STORMWATER MANAGEMENT MANUAL (BES 2004).
7. CHECK DAMS MAY BE PROVIDED AS AN ALTERNATIVE TO LININGS TO MEET VELOCITY RESTRICTIONS OF SECTION 8.5.3 OF THE DESIGN MANUAL (SEE FIGURE 1)
8. 6 TO 12 INCHES OF FREEBOARD ABOVE THE 25-YEAR DESIGN STORM SURFACE WATER ELEVATION REQUIRED.
9. FOR MORE INFORMATION AND DETAILS SEE *CONCEPT DESIGNS AND TECHNICAL GUIDANCE: STORMWATER OUTFALLS* (HERRERA 2007).

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -
Outfall
 Open Channel Outfall

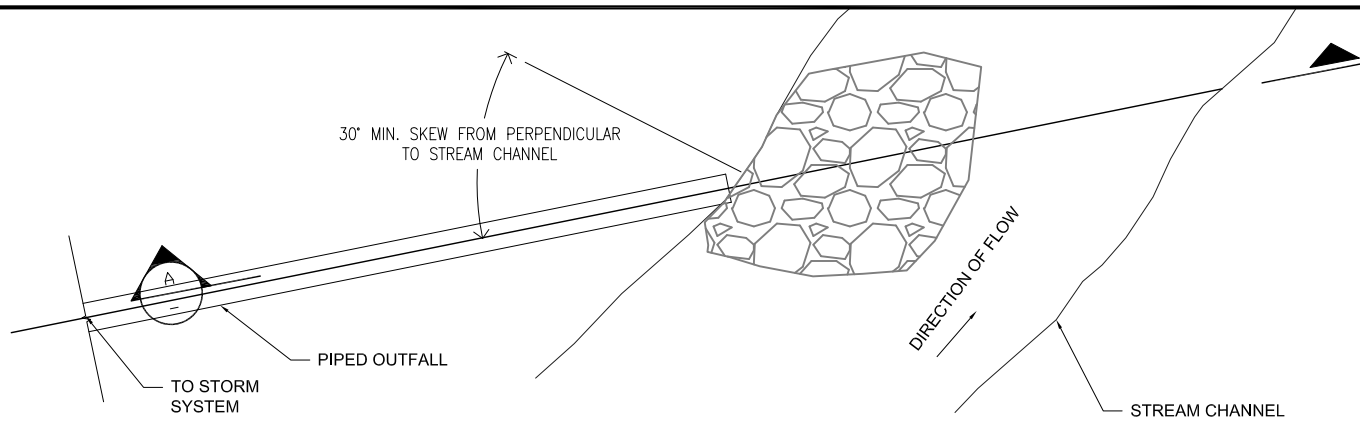
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SW-521



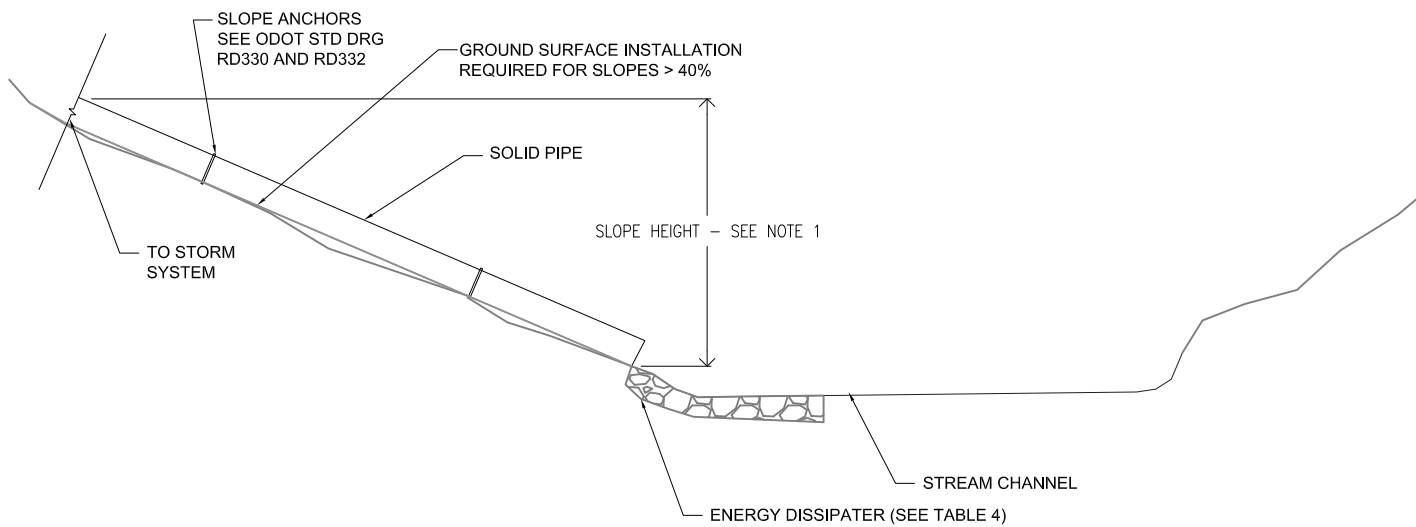
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TYPICAL PIPED OUTFALL - TIGHTLINE

1
-



SECTION

A
-

Notes:

1. For design guidelines for buried pipe, including materials, minimum cover, and bedding requirements, see Chapter 4 of the Portland Sewer and Drainage Facilities Design Manual 2006.
2. See Part 0400 of the City of Portland Standard Specifications for additional requirements on bedding, backfill and pipe materials.
3. Solid pipe required for slopes higher than 20' with gradient of 15% or greater.
4. Solid pipe may be installed in shallow trench if outfall pipe gradient is between 15 and 40%. ground installation (as shown) recommended for slopes greater than 40%.
5. All disturbed areas to be replanted with native vegetation. See section 8.5.6 of the Portland Sewer and Drainage Facilities Design Manual 2006 and Appendix A.5 of the Stormwater Management Manual.
6. For more information and details see Appendix A.5 of the Stormwater Management Manual.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -

Outfall
Piped Outfall

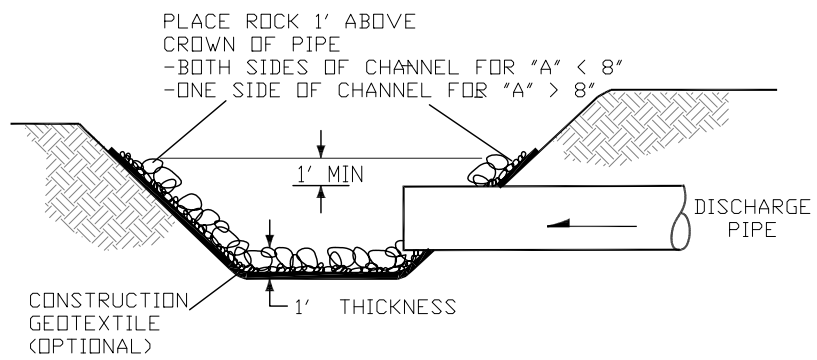
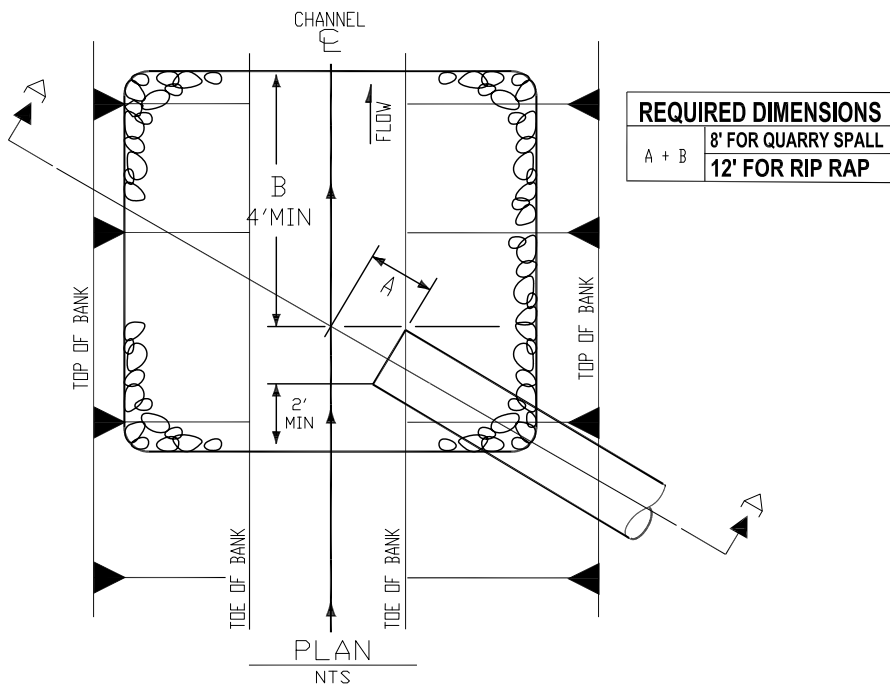
NUMBER

SW-522



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THIS DRAWING IS ONLY A TEMPLATE THAT NEEDS TO BE ADJUSTED AND REVISED FOR EACH PROJECT

PIPE/CULVERT OUTFALL DISCHARGE PROTECTION

NOTES

1. SOURCE: WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) HIGHWAY RUNOFF MANUAL, FIGURE 5.4.3.8.
2. FOR MORE INFORMATION AND DETAILS SEE *CONCEPT DESIGNS AND TECHNICAL GUIDANCE: STORMWATER OUTFALLS* (HERRERA 2007).

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -
Outfall
 Rock Energy Dissipator

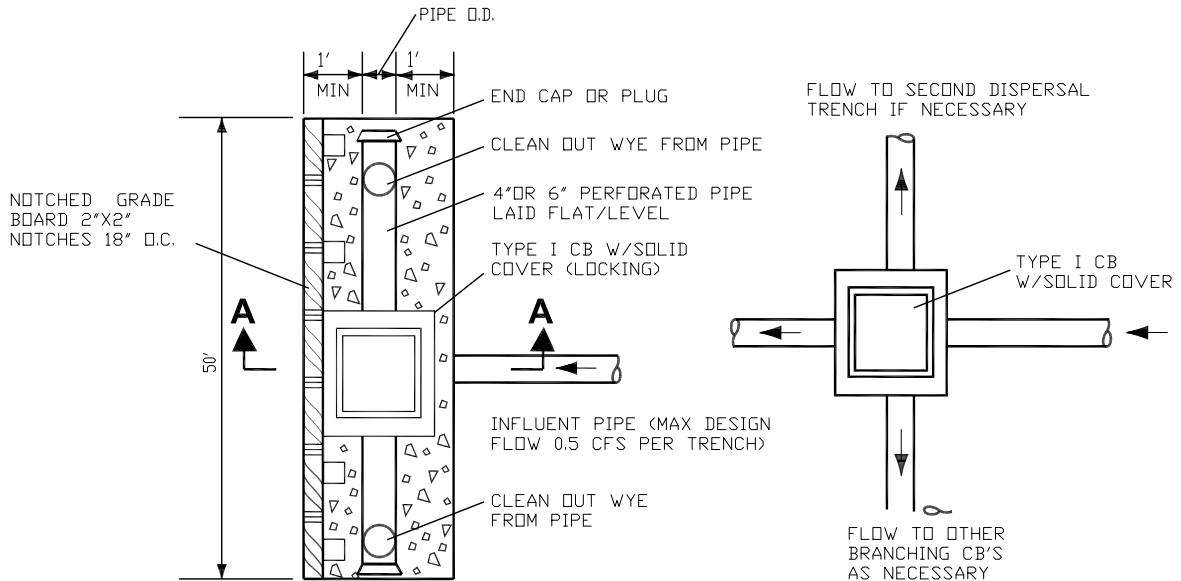
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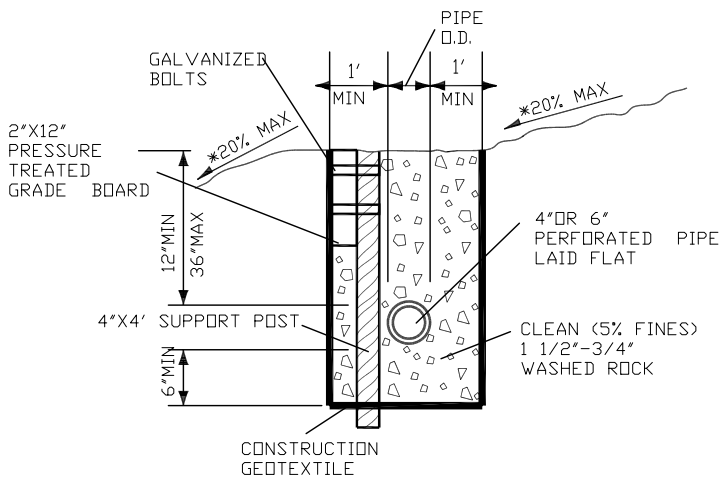


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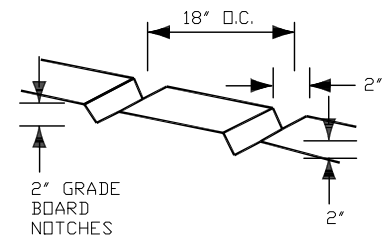


**PLAN
NTS**



**SECTION A-A
NTS**

*15% MAX FOR FLOW CONTROL/WATER QUALITY TREATMENT IN RURAL AREAS.



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 FLOWLINE)
3. TRENCH AND GRADE BOARD MUST BE LEVEL. ALIGN TO FOLLOW CONTOURS OF SITE.
4. SUPPORT POST SPACING AS REQUIRED BY SOIL CONDITIONS TO ENSURE GRADE BOARD REMAINS LEVEL.

FLOW DISPERSAL TRENCH

NOTES

1. SOURCE: WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) HIGHWAY RUNOFF MANUAL, FIGURE 5.4.3.9.
2. FOR MORE INFORMATION AND DETAILS SEE *CONCEPT DESIGNS AND TECHNICAL GUIDANCE: STORMWATER OUTFALLS* (HERRERA 2007).

THIS DRAWING IS ONLY A TEMPLATE THAT NEEDS TO BE ADJUSTED AND REVISED FOR EACH PROJECT

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -

Outfall
Upland Dispersion

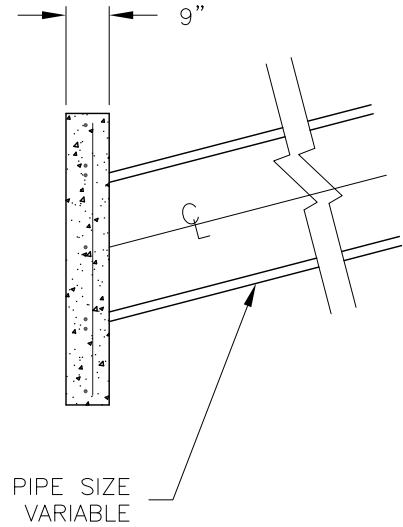
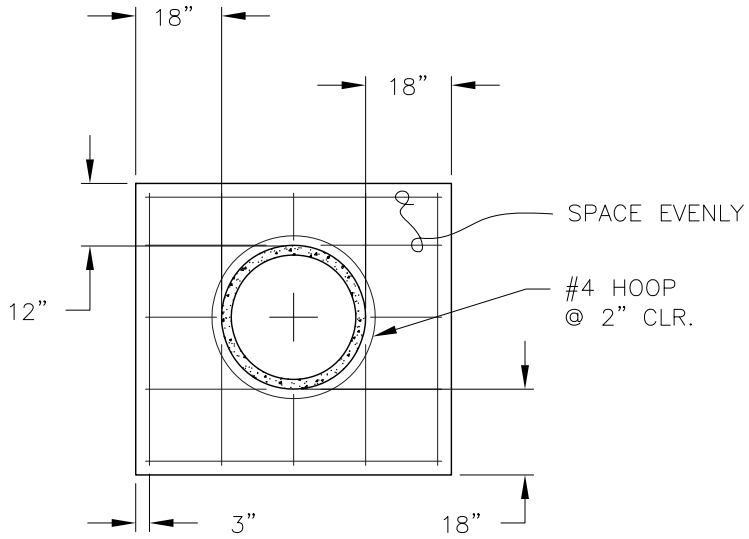
NUMBER

SW-524



Bureau of Environmental Services





NOTES:

1. CONCRETE TO BE 3000psi (28 DAYS ULTIMATE STRENGTH, SLUMP OF 2" TO 5" AND 1 1/2" MINUS AGGREGATE).
2. ALL REINFORCING STEEL $f_y = 60,000\text{psi}$.
3. FILL AROUND ENDWALLS TO 6" BELOW TOP OF WALL.
4. BASE OF OUTFALL SHALL BE POURED AGAINST UNDISTURBED SOIL.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -

**Outfall
End Wall**

NUMBER

SW-525



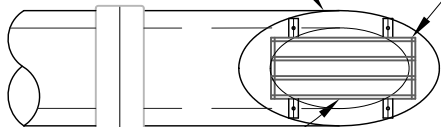
Bureau of Environmental Services



APPLICATION FOR
18" OR LARGER PIPE.

DEPENDING ON PIPE SIZE,
APPLY ENOUGH BARS TO
COVER OPENING IN BEVELED
END OF PIPE MAINTAINING
4" O.C. MAX. SPACING.

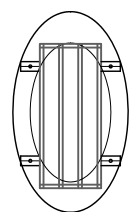
NOTE:
REFERENCE EXHIBIT 2-22
FOR GRATES APPLICABLE TO
OUTFALLS GREATER THAN 24".



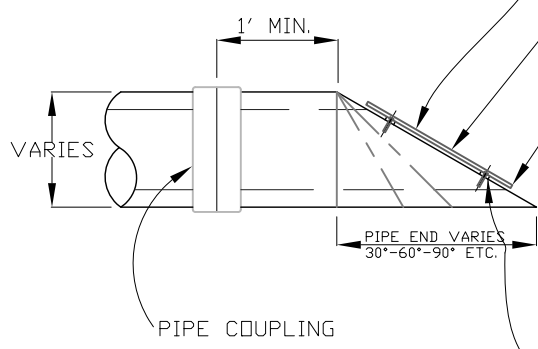
3/4" DIA. SMOOTH BARS
WITH ENDS WELDED TO
BAR-FRAME.

3/4" DIA. BAR-FRAME

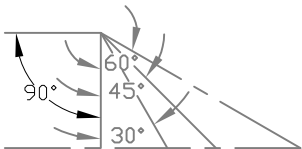
BUILD FRAME TO COVER
TOP AND BOTTOM EDGES
OF INSIDE DIA. OF PIPE
AS SHOWN ABOVE.



4" O.C.
MAX. BAR
SPACING



2" WIDE ANCHOR STRIPS WELDED
TO 3/4" DIA. BAR-FRAME AT 4
PLACES SPACED UNIFORMLY.
FASTEN WITH 1/2"
NON-CORROSIVE BOLTS AND
NUTS.



END ANGLE VARIABLE

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -
Outfall
Grated Protection

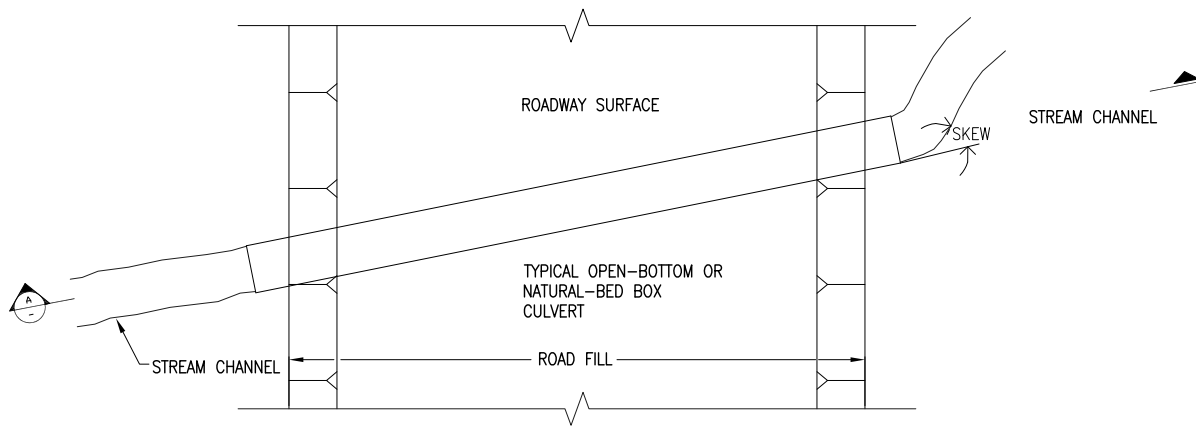
NUMBER

SW-526

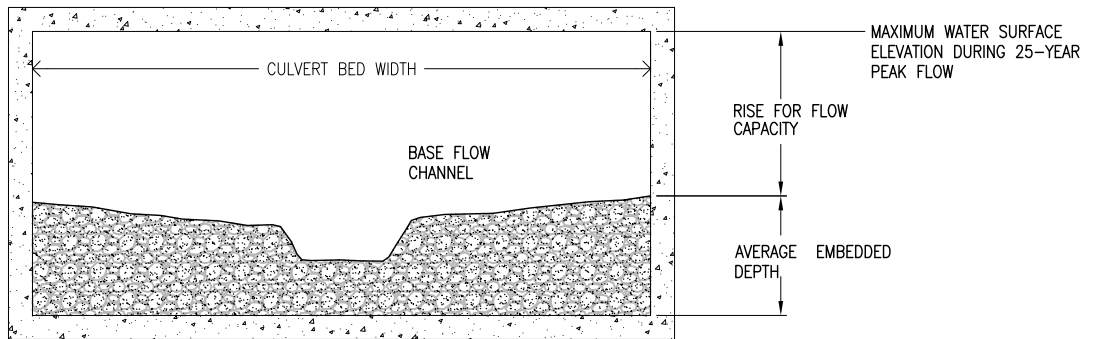


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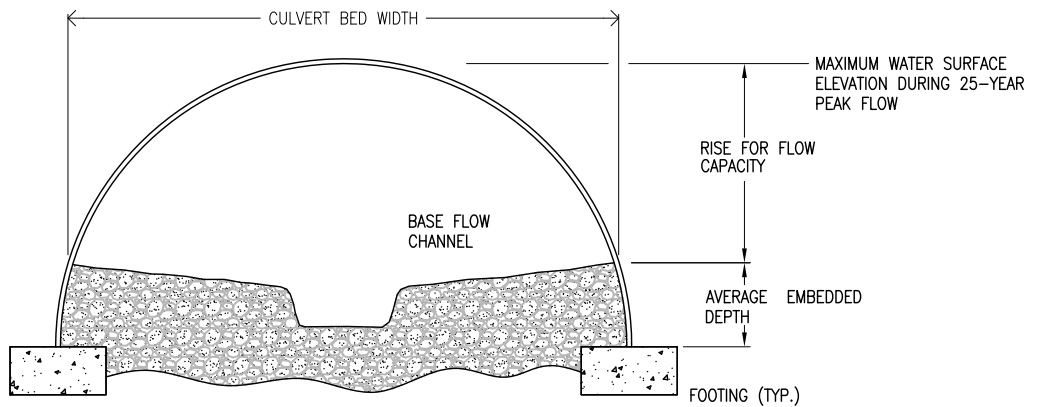




TYPICAL OPEN-BOTTOM OR NATURAL-BED BOX CULVERT



TYPICAL NATURAL-BED BOX CULVERT



TYPICAL OPEN-BOTTOM METAL ARCH CULVERT

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL SUPPLEMENTAL DETAILS

- Supplemental Details -
Culvert
 Alignment & Profile

NUMBER

SW-530



Bureau of Environmental Services

