City of Portland

2020 Stormwater Management Manual

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City of Portland
Stormwater Management Manual

December 2020

Prepared by the
Bureau of Environmental Services
Portland, Oregon

ENVIRONMENTAL SERVICES
CITY OF PORTLAND

working for clean rivers

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For More Information

[SWMM Website]

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List of Forms

Links below go to the PDF forms available online at Portland.gov.

Chapter 1. Requirements and Policies

This chapter establishes the City of Portland's stormwater management requirements. It includes the following sections:

1.1 Purpose of the Stormwater Management Manual

Urbanization results in removal of vegetation, compaction of soils, and creation of impervious surfaces. These changes increase the amount and rate of stormwater runoff and contribute to increased pollutants washing into creeks and rivers. Pollutants in waterways impact watershed health and habitat value. Construction of impervious areas prevents groundwater recharge. Increased flows can erode stream channels and contribute to localized flooding, combined sewer overflows, and basement sewer backups. Stormwater management maintains and enhances the City's livability and improves watershed health by mitigating the impacts of urbanization and conserving the existing and future conveyance capacity of storm sewers, drainageways, and combined sewers.

Portland adopted its first citywide *Stormwater Management Manual* (SWMM) in 1999 and completes regular updates to keep standards current with best practices and regulatory requirements. The SWMM includes retention, water quality, and flow control design standards for stormwater management facilities. Strategies for meeting the requirements in this manual depend on several site factors, including infiltration feasibility and the characteristics of the storm system or drainage basin to which stormwater from the proposed development is discharged. The SWMM allows the City to protect both watershed resources and infrastructure investments as the City experiences development by public and private entities. As each project subject to the SWMM meets the requirements of this manual, it will contribute to achieving these important citywide goals.

1.1.1 Regulatory Mandates

In response to the impacts of urbanization on water quality, Congress passed the Clean Water Act (CWA) of 1972 (amended in 1987), which prohibits the discharge of pollutants into waters of the United States unless the discharge complies with a National Pollutant Discharge Elimination System (NPDES) permit. The federal Safe Drinking Water Act (SDWA) of 1974 provides a comprehensive framework to ensure the safety of drinking water supplies. The City has two NPDES permits under the CWA: one for stormwater and the separated collection system, and one that regulates the wastewater treatment plant and the combined sewer collection system. The City also has a water pollution control facility (WPCF) permit under the SDWA for underground injection controls (UICs) to protect groundwater quality. All three of these permits are issued by the Oregon Department of Environmental Quality (DEQ) and managed by BES for the City.

The purpose of this manual is to respond to these regulatory mandates by providing stormwater management principles and techniques that help 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.

NPDES Municipal Separate Storm Sewer System (MS4) Permit

The NPDES stormwater permit requirements, published in 1990, require large (Phase I) cities such as Portland to obtain an NPDES stormwater permit for their municipal separate storm sewer system (MS4) discharges. The City's MS4 system is made up of natural and built features including catch basins, curbs, gutters, ditches, channels, storm sewers, and outfalls that collect and convey stormwater to rivers and streams. DEQ issued Portland's first MS4 permit in 1995. Portland City Council directed the Bureau of Environmental Services (BES) to lead the citywide response to stormwater requirements and to implement key program elements.

Compliance with the NPDES MS4 permit requires, in part, that the City establish a comprehensive stormwater management program, including establishing controls on post-development stormwater runoff. The SWMM is part of the implementation of the City's requirement to control post-development stormwater runoff. The SWMM focuses on low-impact development practices, stormwater management facilities, and conveyance features designed to minimize stormwater runoff and improve stormwater quality. The SWMM is part of the City's NPDES MS4 stormwater management program to protect the quality of Portland's waters.

NPDES Waste Discharge Permit

The City completed construction of the major elements of the Combined Sewer Overflow (CSO) Program in 2011. Ongoing management of the combined sewer system is primarily guided by the City's NPDES wastewater discharge permit for the Columbia Boulevard Wastewater Treatment Plant and the combined sewer collection system. These regulations include requirements for Capacity, Management, Operation and Maintenance (CMOM) and incorporate the EPA's CSO Policy regarding what it calls the Nine Minimum Controls for treatment of wet weather overflow events. Both CMOM and the Nine Minimum Controls rely on reducing stormwater discharges to the combined sewer. The SWMM requirements reduce the need for storage in the combined sewer collection system through volume reduction and flow control requirements. This helps prevent combined sewer overflows and reduces the amount of stormwater that is pumped in the collection system and treated at the wastewater treatment plant.

Underground Injection Control (UIC) WPCF Permit

The City's WPCF permit, originally issued in 2005, regulates stormwater discharges for all City-owned or City-operated underground injection controls (UICs) (e.g., drywells, sumps, soakage trenches). The City has over 9,000 public UICs that infiltrate stormwater runoff from the public right-of-way and on City-owned property. Compliance with this permit requires the City 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. The SWMM assists with the implementation of the City's UIC management plan by providing requirements for the design, operation, and maintenance of UICs covered by the City's WPCF permit.

1.1.2 City Authority

The SWMM is a BES Administrative Rule and is authorized by Portland City Code Chapter 17.38. The SWMM is 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 1999, City Council adopted code changes to Portland City Code Chapter 17.38 to authorize the Director of Environmental Services to adopt rules, procedures, and forms and to maintain a SWMM (Ordinance #173330). In 2000, in conjunction with a City Code update, City Council confirmed the authority of the Director of BES to update the SWMM (Ordinance #174745).

1.2 Applicability

The stormwater-related requirements of this manual must be met by projects proposing the following activities, with additional details and specific exemptions noted in each sub-section below:

- 1.2.1: Development and redevelopment activities that create or replace 500 ft^2 or more of impervious area.
- 1.2.2: New connections or new routes of conveyance to an approved receiving system.
- 1.2.3: Upgrades to site landscaping required by Portland Zoning Code Chapter 33.258, provided stormwater management is feasible.
- 1.2.4: Stormwater retrofits required by the City or other regulatory agencies.

Sites with drainageways are subject to the SWMM drainageway protections. See Chapter 5 for drainage reserve applicability, requirements, and exemptions.

Development-initiated stormwater improvements

The Bureau of Development Services (BDS) administers the development review process, including land use reviews and 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, Water, and Parks.

For more information about the City’s development review and permit processes, refer to the BDS website.

For more information about the City’s Public Works Permit process, refer to the Public Works Permitting website.

1.2.1 Development Activities

Applicability of Requirements

New development and redevelopment activities that create or replace 500 ft^2 or more of impervious area on property or in the right-of-way are subject to the requirements of this manual unless specifically exempt. The following development activities require stormwater management:

- Construction of new impervious area;
- Replacement of existing impervious area; and
- Additions to structures within an existing building footprint.

Exemptions

Exemptions for development related activities are described below; exemptions can be applied to specific portions of a project site. BES may require projects, even those that qualify for an exemption, to identify and obtain BES approval for a discharge point. Exemptions outlined below will not be granted if a violation of regulatory permits or other municipal regulations would occur as a result. BES determines applicability of exemptions to a specific project during review of that project.

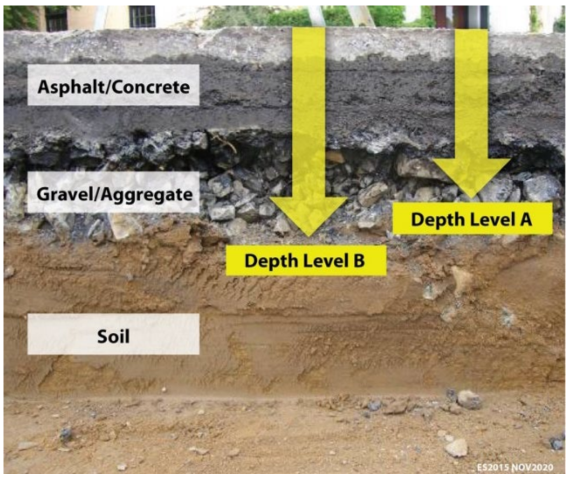
Pavement and Trenching - Exemptions

- Additional pavement replacement identified during construction due to conditions unforeseen at the design phase.
- Additional, pedestrian-only or residential driveway impervious areas totaling less than 500 ft^2 in aggregate that cannot drain to a stormwater facility.
- Pavement maintenance or repair including repaving and resurfacing within the existing footprint of the paved surface, provided no soil (subgrade) is exposed and pavement is replaced in-kind (Figure 1-1). For pedestrian-only areas, unless base repair is explicitly specified, replacement in-kind is assumed to be maintenance. (This acknowledges that for pedestrian-only areas existing pavement information may not be known at the design phase of a project.)
- Standalone projects consisting of pavement restoration of trenches for linear utilities on parcels.
- Pavement restoration for utility service connections, up to and including full street width crossings.
- Pavement restoration in public or private rights-of-way for the following where no more than 50% of the street width is removed or repaved. If a project exceeds 50% of the street width, the applicable area is all the new and

redeveloped impervious area on the subject side of the street (measured from the center line).

- Curb replacement in-place (and associated pavement restoration).
- Utility trenches.
- Base repair of public streets.

Figure 1-1. Paved Impervious Surface Cross Section



Development and redevelopment activities that reach **Depth Level A** do not trigger stormwater requirements (e.g., grind, overlay, or concrete replacement in-kind). Development and redevelopment activities that expose soil, **Depth Level B,** trigger stormwater requirements.

Photo: City of Portland

Buildings and Structures - Exemptions

- Re-roofing or repairing an existing roof. This includes roof structures such as a ground-level plaza that functions as the roof for a below-ground structure.
- Adding or modifying decking or pavers over an existing impervious surface.
- Adding temporary structures as defined by Portland City Code Chapter 17.38.
- Rebuilding structures following fire damage, flooding, earthquake, or other natural disaster, provided the following are met:
  - The structure is re-built within the same footprint.
  - The site discharges to the same level per the Infiltration and Discharge Hierarchy (Section 1.3.3) as it did prior to the damage.
  - Associated stormwater facilities that had been at the site prior to the damage are re-built. If rebuilding an existing facility poses a risk to public or environmental health and safety (e.g., infiltration in a landslide area or on a contaminated site) then replace it with a facility that complies with the requirements of this manual.
- Constructing vertical additions to an existing structure within the existing building footprint if the footprint of the new area is less than 10,000 ft^2.

1.2.2 New Connections or Routes of Conveyance

Projects that make new connections, route new drainage areas to a stormwater receiving system, or change an existing connection or discharge point must provide stormwater management for those areas if the project connects or reroutes impervious areas that are 500 ft^2 or more in aggregate. The following new connections or routes of conveyance require stormwater management:

- Changing a discharge point from one stormwater system level as defined by the Infiltration and Discharge Hierarchy (Section 1.3.3) to another. Changing connections within the same hierarchy level is not a new connection.
- Changing a discharge point from a private system to a public system.
- Creating a new route of conveyance where one did not previously exist.

Examples of activities that could require stormwater management under these criteria include, but are not limited to the following:

- Constructing a new connection to a combined sewer for the purpose of draining an existing parking lot that currently drains elsewhere (e.g., onsite drywell, sheet flow to vegetation).
- Removing an existing structure's connection to a combined sewer and replacing it with a new connection to a storm sewer.
- Changing a connection from a private outfall to a public outfall.
- Adding a new curb to an existing paved street that results in a new or enlarged drainage basin discharging to a City sewer or drainage system.

1.2.3 Landscape Nonconforming Upgrades

Projects that upgrade site landscaping to comply with Portland Zoning Code Chapter 33.258 (Nonconforming Situations) must construct the new or upgraded landscaped areas as vegetated facilities to manage impervious area runoff where feasible (this typically applies to parking lot upgrades.)

BES will determine the feasibility of constructing landscaped areas as vegetated facilities based on factors including whether existing grades allow stormwater to flow toward the landscaped area, whether it is possible to meet the facility and site design requirements of this manual, and whether the facilities can manage at least 500 ft^2 of impervious area. The applicant will need to provide information adequate for BES to conduct the feasibility review. When deemed infeasible, project landscaping upgrades are not subject to Special Circumstances or Offsite Management Fee requirements for the relevant impervious area.

1.2.4 Stormwater Retrofits

A stormwater retrofit is the installation of a new stormwater facility to treat stormwater from existing impervious area. There are three types of stormwater retrofits: City-required retrofits, retrofits required by state or federal agencies, and owner-initiated retrofits. SWMM requirements vary by type. Regardless of the nature of the retrofit, Source Control Manual (SCM) requirements may apply.

City-Required Stormwater Retrofits

City-required stormwater retrofits are required by the City as a result of City code, rule implementation, or an enforcement action. City-required stormwater retrofits must meet the SWMM requirements in full.

Stormwater Retrofits Required by State or Federal Agencies

Retrofits required by non-City imposed requirements include retrofits required by individual or general discharge permits (e.g., DEQ NPDES 1200-Z Tier II), source controls, clean-up actions, DEQ requirements for meeting discharge limits, or other permit or compliance requirements. Projects installing retrofits required by other regulatory mechanisms are required to meet the following sections of the SWMM:

- Site evaluation requirements in Section 2.2, including facility setbacks.
- Infiltration testing and subsurface investigation requirements in Section 2.3.
- Operations and Maintenance (O&M) requirements in Sections 1.6 and 3.3.

Applicants are not required to follow the specific stormwater management requirements in Section 1.3 (including the infiltration and discharge hierarchy) or the facility sizing and design requirements in Chapter 2 and Chapter 3 but may use them for guidance. It is the responsibility of the applicant to ensure the retrofit facility sizing meets the requirements specified by the regulatory agency.

Owner-Initiated Stormwater Retrofits

Applicants submitting stormwater retrofits as part of a development proposal should clearly note on project submittals and any permit applications that the project is an owner-initiated stormwater retrofit. Owners may initiate stormwater retrofits for many reasons, such as participating in City voluntary incentive programs, raising the level of stormwater management on their site to provide watershed and/or system benefits, or reducing stormwater utility charges. Compliance with this manual is not required, but an owner may choose to use it for guidance. Owner-initiated stormwater retrofits are encouraged to infiltrate to the maximum extent practicable but can use existing discharge systems (e.g., catch basins or storm pipes connected to offsite public systems).

1.2.5 Port of Portland

Any development or redevelopment project at the Portland International Airport (PDX) or at the Port-operated areas of Terminal 6 (T6) that meets both of the following applicability requirements is regulated by the Port's Stormwater Design Standards Manual (DSM) and is exempt from the SWMM:

- The project is located at PDX within the airfield security fence, is on Port-owned and -operated property outside the airport security fence, or is within the Port-operated area of T6; and
- Stormwater is discharged entirely to the Port's storm sewer system.

The Port of Portland will issue a Service Agreement Letter for projects required to use the DSM. The Service Agreement Letter will confirm that the scope of the project falls under DSM applicability and acknowledge the Port's responsibility to ensure that the design, operations, and maintenance of the stormwater management facilities, source controls, and systems will meet the Port's DSM and City's MS4 permit requirements.

Official boundaries of the DSM are maintained by the Port of Portland. See the Port's DSM or contact Port of Portland staff to determine applicability of this exemption. Projects on other Port-owned property must comply with the full requirements of this manual. See Table 1-1.

Table 1-1. SWMM Applicability to Port of Portland Properties

	Stormwater Design Requirements	O&M Plan	O&M inspections
Portland International Airport[1]	DSM	Port of Portland manages O&M.	Port of Portland
Terminal 6 – Port Operated Area	DSM	Port of Portland manages O&M.	Port of Portland
Portland International Center[2]	SWMM	BES reviews the O&M plan. File the O&M with BES and the Port.	BES
Other Port Properties	SWMM	BES reviews the O&M plan. Record the O&M at the County Recorder's Office.	BES

1. Including Air Cargo areas (Air Trans Center, PDX Cargo Center, North Cargo Complex)
2. Including Cascade Station

1.2.6 Applicability to City Projects

All City capital, operating, or non-operating projects must meet SWMM requirements for facility sizing methodology, design, and landscaping, and must follow SWMM construction details.

City Projects Requiring Stormwater Management

Projects that propose development activities described in Section 1.2 (Applicability) must meet the full requirements of this manual unless BES determines that the project is exempt from applicability.

City Retrofit Projects

Projects that propose to install stormwater facilities for existing impervious area that is not being redeveloped are retrofit projects. Retrofit projects have more flexibility regarding infiltration, water quality treatment, and flow control performance. These projects include, but are not limited to, those that are for improved sewer capacity, water quality treatment, habitat improvements for Endangered Species Act compliance, and meeting other environmental requirements or system needs.

A retrofit project's adopted goals to meet specific regulatory requirements or system needs may differ from SWMM requirements. When the project is being designed to provide local or regional system or watershed-specific improvements as identified in an approved and adopted plan, projects may be designed to meet those project-specific goals. For example, basin- and watershed-scale projects may consider the use of regional facilities rather than distributed facilities. In the absence of project-specific goals, retrofits should meet the SWMM requirements for disposal, pollution reduction and flow control.

1.3 Stormwater Management Requirements

Sites required to meet the standards in this manual must propose and obtain BES approval of a discharge point for the site's stormwater runoff. Based on the discharge point and requirements for the associated receiving system, stormwater facilities must be constructed to meet the design and performance standards described in this section and Section 1.4.

Stormwater management requirements for infiltration, water quality treatment and flow control vary depending upon the receiving system. Projects must complete site investigations to determine the appropriate receiving system for that site. Considerations include the site's geologic characteristics and the available storm system.

Portland has three primary receiving systems for disposal and conveyance of stormwater. BES ranks use of these systems for stormwater management in the Infiltration and Discharge Hierarchy in Section 1.3.3 of this Manual. They are listed below in order of preference (with 1 being the most preferred):

1. Onsite infiltration.
2. Surface water systems or separated storm systems that ultimately drain to surface water.
3. Combined sewers that convey water to the wastewater treatment plant.

The City's stormwater management requirements prioritize onsite infiltration and the use of vegetated facilities. The stormwater management requirements are designed to accomplish the following objectives:

- Require infiltration wherever feasible to restore historic hydrologic function and recharge groundwater.
- Protect watershed health by mimicking pre-development hydrologic conditions.
- Protect groundwater resources by removing pollutants from stormwater before discharging it into a UIC or other water pollution control facility.
- Protect streams and rivers by providing water quality treatment and flow control for stormwater before discharging it to surface water.
- Minimize long-term costs to the City of pumping and treating stormwater flowing through public wastewater treatment plants.
- Preserve the capacity of downstream infrastructure.
- Minimize CSOs and basement sewer backups within combined sewer system.

1.3.1 Onsite Stormwater Management Required

Onsite stormwater management is required to the maximum extent feasible unless stormwater management is provided in a regional facility as part of a larger plan or project. The term “onsite” refers to the limits of the project site and is not a distinction between property and the right-of-way. For example, a residential development proposal could manage the runoff from the building onsite (on private property) via drywells and the runoff from the frontage improvements onsite (in the public-right-of-way) through a vegetated planter. While development proposals on property may be bound by the parcel or taxlot geometry, the term “onsite” can be used to describe meeting the Infiltration and Discharge Hierarchy for any type of project.

1.3.2 Facility Selection: Vegetation and Infiltration

The City’s stormwater management approach prioritizes vegetation and infiltration to meet stormwater requirements and to maximize environmental, system and urban design benefits. Designers must evaluate and use vegetated and infiltration facilities to the maximum extent practicable.

Vegetation and infiltration provide numerous environmental benefits. Vegetation and infiltration facilities in the built environment minimize the effects of development on natural resources and the City’s built storm systems. They are also more resilient than other stormwater management methods (e.g., structural detention or manufactured treatment) to changes in hydrology anticipated due to climate change. Vegetation provides habitat for wildlife and scenic, aesthetic, and health benefits for humans. Infiltration of stormwater provides hydrologic benefits, better mimicking natural hydrologic processes, recharging groundwater, providing summer base-flows in streams, and reducing downstream flooding. The combination of soil, plants, and biological activity in vegetated facilities removes stormwater volume through retention and evapotranspiration and filters and degrades pollutants, keeping them out of the City’s systems and the natural environment.

1.3.3 Infiltration and Discharge Hierarchy

The Infiltration and Discharge Hierarchy ranks discharge systems by levels in order of preference. The highest technically feasible level must be used, unless otherwise directed by BES. It is the responsibility of the project designer to justify moving from one level to the next, based on technical issues or competing requirements. All cases are subject to BES review and approval and are evaluated on a site-by-site basis.

Full onsite infiltration, Level 1, is required to the maximum extent practicable for sites with design infiltration rates of 2 in/hr or more, unless site constraints prevent infiltration or the site qualifies for the ecoroof exception per Section 3.2.1.1. If full onsite infiltration is not practicable, offsite discharge to a storm-only or combined sewer is allowed (Level 2 or 3). For Level 2 (offsite discharge to a storm system), water quality treatment is always required, and flow control is also required in most situations. For Level 3 (offsite discharge to a combined system), flow control is required. Pre-development conditions are based on an undeveloped site (i.e., Lewis and Clark era) rather than current conditions at the site.

A summary of design requirements is given in Table 1-2 and descriptions of each hierarchy level are provided in subsequent sections.

Table 1-2. Summary of Infiltration and Discharge Hierarchy Stormwater Management Requirements[1, 2]

Level 1: Full Onsite Infiltration
Fully infiltrate the 10-year design storm. Ecoroofs: Sites with a qualifying ecoroof may receive an exception to infiltration requirements.
Level 2: Offsite Discharge to the Separated Stormwater System[3]
Pollution reduction required: • Achieve 70% TSS removal from the runoff resulting from 90% of the average annual rainfall. • In watersheds with a TMDL or on DEQ's 303(d) list of impaired waters, use a pollution reduction facility that will reduce pollutants of concern. Flow control required: • For discharge to surface water bodies directly or indirectly (such as via a piped system), limit post-development peak runoff rates to pre-development rates for the one-half the 2-year event and for the 5-, 10-, and 25-year events. • For discharge to storm-only systems that drain to large water bodies including the Willamette, Columbia Slough and Columbia River when there is a system need, limit the post-development peak runoff rates to pre-development rates for the 2-, 5-, and 10-year events.
Level 3: Offsite Discharge to the Combined Sewer System
Flow control required: • Limit the 25-year post-development peak runoff rate to the 10-year pre-development rate.

1. All storm events are 24-hour events.
2. Unless otherwise exempt.
3. Vegetated surface facilities in the right-of-way where ponding is limited to 9 inches or less are exempt from the 25-year flow control requirement.

1.3.4 Level 1: Infiltration Requirements

Full onsite infiltration of runoff is required for sites with design (or for Simplified Approach facilities, tested) infiltration rates of 2 in/hr or greater, unless the site qualifies for the ecoroof exception per Section 3.2.1.1 or infiltration is determined infeasible based on the site constraints outlined in Section 2.2. BES will determine if infiltration is feasible, including approving or denying requests to infiltrate onsite or to discharge offsite. Additional review of infiltration feasibility will be provided by BDS or DEQ as it relates to their requirements. Where complete onsite infiltration is feasible, the following standards apply.

Surface infiltration facilities

Surface infiltration facilities are designed to infiltrate water through the upper layers of the soil. The most common vegetated surface infiltration facilities are basins, planters, and rain gardens. Permeable pavement is also considered a surface infiltration facility unless design elements meet the criteria to be a UIC. Surface infiltration facilities are usually incorporated into the site landscape design and are often planted with vegetation. They are typically not regulated by DEQ.

Level 1 Sizing Requirements (Surface Infiltration)

- **Water quantity:** Surface infiltration facilities designed for full disposal must infiltrate Portland's 10-year, 24-hour design storm (3.4 inches).
- **Water quality:** Surface infiltration facilities provide water quality treatment by filtering the water quality storm through the upper layers of soil.

Level 1 Groundwater Separation Requirements (Surface Infiltration)

New surface infiltration facilities are required to have a minimum separation distance of 5 ft between the bottom of the facility and the seasonal high groundwater level unless otherwise approved by BES.

Underground Injection Control (UICs)

Underground Injection Control (UIC) systems are designed to infiltrate water below the ground surface. UICs must be properly designed, sited, and operated to ensure performance and to prevent polluting soil and groundwater. The most typical UICs referenced in this manual are soakage trenches (including manufactured chambers), drywells, and public sumps. Additional information about whether a facility is a UIC or not is available on the DEQ website. UICs must be registered with DEQ or BES depending on their location. See Section 1.4.1 for information about UIC regulation and registration.

Level 1 Sizing Requirements (UIC)

- **ROW public infiltration sump systems:** Sumps must infiltrate the peak flow rate from a 10-year storm (2.86 in/hr with a 5-minute time of concentration) with a safety factor of 2 applied.
- **Parcel-based:** UICs designed for full disposal must infiltrate Portland's 10-year, 24-hour design storm (3.4 inches over 24 hours). This includes UICs on public parcels, and private UICs in parcels or tracts, including private rights-of-way.
- **No overland escape route:** UICs with no overland escape route (e.g., those located below-grade under buildings) must infiltrate Portland's 100-year, 24-hour design storm (4.4 inches).
- **Connecting to existing:** New impervious area can be managed using existing UICs only if the UIC meets current design standards and has sufficient capacity to accept the additional runoff and still meet performance requirements. If existing facility records cannot determine capacity, BES may require testing of the UIC to determine available capacity.

Table 1-3. UIC Registration and Design Requirements by Installation Location

Location of UIC	Register with	Design Requirements
Public ROW	BES	10-year storm (2.86 in/hr for a 5-minute time of concentration) with a safety factor of 2 applied
City-owned parcel-based	BES	10-year, 24-hour design storm (3.4 inches)
Private parcels or tracts, including private ROW	DEQ	10-year, 24-hour design storm (3.4 inches)[1]

1. Size UICs with no overland escape route for the 100-year, 24-hour storm event (4.4 inches)

Level 1 Pretreatment Pollution Reduction Requirements (UIC)

Depending on the characteristics of the catchment area, pretreatment may be required prior to discharge to a UIC. See Section 3.2.4.1 and Section 4.2.2.1 for pretreatment requirements.

Level 1 Groundwater Separation Requirements (UIC)

New public and private UICs are required to have a minimum separation distance of 5 ft between the bottom of the UIC and the seasonal high groundwater level.

1.3.5 Level 2: Separated Storm System Requirements

Stormwater Infiltration and Discharge Hierarchy Level 2 applies to sites served by a separate storm system, and where full infiltration is not required, BES will require stormwater management onsite and authorize discharge offsite to an approved storm-only drainage or conveyance system. Discharge to a separated storm system requires meeting pollution reduction and any flow control requirements onsite.

Level 2 Pollution Reduction Requirements

Level 2 projects are required to meet the following pollution reduction (i.e., water quality) standards:

- 70% removal of total suspended solids (TSS) is required from the runoff from 90% of the average annual rainfall (1.61 inches over 24 hours, or 0.19 in/hr for a time of concentration of 5-minutes). See Appendix A.2 for more detailed information about the formulation of Portland's pollution reduction standards.
- In watersheds for which total maximum daily loads (TMDLs) have been established or that are on DEQ's 303(d) list of impaired waters, stormwater management facilities should be capable of reducing the pollutant(s) of concern (see Table 1-4), as approved by BES.

Table 1-4. TMDL and 303(d)-Listed Parameters by Watershed

Parameter		Waterbody											
		Columbia River		Willamette River and Tributaries[3]		Columbia Slough		Johnson Creek		Fanno Creek Basin		Tryon Creek	
		TMDL	303(d)	TMDL	303(d)	TMDL	303(d)	TMDL	303(d)	TMDL	303(d)	TMDL	303(d)
Biological	Biological Criteria				●		●		●		●		●
	Chlorophyll *a*				●	●				●			
General Chemistry	Dissolved Oxygen					●			●	●			●
	Phosphorous					●							
Metals	Arsenic										●		
	Copper				●						●		
	Iron				●		●				●		
	Lead				●	●			●		●		
	Mercury			●[1]	●	●[1]		●[1]		●[1]		●[1]	
	Thallium										●		
	Zinc										●		
Microbial	Bacteria (E.coli)			●		●		●		●		●	
Other Organics	Dioxin			●		●							
	Endosulfan								●				
	Endrin aldehyde								●				
	Ethylbenzene				●								
	Hexachlorobenzene				●								
	PAHs		●		●				●				
	PCBs		●		●	●			●				
	Tetrachloroethylene										●		
Pesticides	Aldrin				●								
	Total Chlordane				●								
	Cyanide				●								
	DDT/DDE		●		●	●		●[2]	●[2]				
	Dieldrin				●	●		●			●		
Physical	pH		●		●	●			●	●			
	Temperature		●	●		●		●		●		●	
	Aquatic weeds				●		●						

1 TMDL currently under development by Oregon DEQ,
2 DDT for the TMDL parameter and DDE for the 303(d) listing,
3 Includes Willamette River tributaries unless specified otherwise.

Level 2 Flow Control Requirements

In the separated storm system, flow control standards vary depending on the needs of the receiving system. The three categories of receiving systems within the separated storm system have varying flow control standards intended to respond to system-specific needs.

Smaller surface water bodies (hydromodification):

Smaller surface water bodies (i.e., all surface water bodies other than the Willamette River, Columbia River, and Columbia Slough) are susceptible to hydromodification. Hydromodification is the alteration of the natural flow of water, timing, frequency, and volume of runoff from the land surface as a result of urbanization. Hydromodification results in an increase in runoff energy and frequency in the receiving water bodies. This increase in energy leads to the degradation of natural stream and wetland systems through incision, bank erosion, and sedimentation. The flow control requirements in the SWMM are designed to help minimize these impacts.

Flow control requirements for smaller surface water bodies are designed to minimize hydromodification and preserve system capacity. Projects that discharge stormwater runoff to these water bodies, whether the discharge is direct or indirect (e.g., via a piped system), are required to provide flow control.

Flow control is required for all discharges to surface water bodies that are susceptible to hydromodification as a result of increased urbanization, including ditches, drainageways, and streams. This applies to discharges to private or public storm systems located on or off the project site. The purpose of this standard is to:

- Mimic pre-development storm flows to the maximum extent practicable to preserve hydrology and stream function;
- Minimize potential impacts of development to upstream or downstream flooding; and
- Minimize the potential for increased stream bank and stream channel erosion.

PERFORMANCE CRITERIA:

- Limit post-development peak runoff rates to pre-development rates for one-half the 2-year event, and for the 5-, 10-, and 25-year design storm events.

Larger surface water bodies: flow control for system capacity

Larger surface water bodies in Portland, the Willamette River, Columbia River, and Columbia Slough, do not require protection from hydromodification.

Flow control requirements for projects that discharge stormwater runoff into these water bodies through a private storm sewer, separated public storm sewer, or drainage district system are required to protect system capacity, when needed. The purpose of this standard is to:

- Preserve capacity in the storm system as determined by the system's owner.

PERFORMANCE CRITERIA:

- Limit the post-development peak runoff rates to their pre-development rates for the 2-, 5-, and 10-year design storm events.

Larger surface water bodies: flow control exemption

Sites that discharge directly into the Willamette River, Columbia River, or Columbia Slough through a private storm sewer, separated public storm sewer, or Multnomah Country Drainage District, PEN1 or PEN2 system with available capacity (as determined by the system's owner) may be exempt from the flow control requirements of this manual. In the Columbia Slough, available capacity is determined by the Multnomah County Drainage District, PEN1 and PEN2, which has regulatory authority. Flow control exemptions will be granted only after review of applicable site, system and discharge characteristics. Depending on the scenario, BES may require submittal of a capacity analysis and/or a system owner's determination of capacity availability prior to exemption approval.

1.3.6 Level 3: Combined Sewer System Requirements

Stormwater Infiltration and Discharge Hierarchy Level 3 applies to areas served by the combined sewer system, and where full infiltration is not required, BES will require stormwater management onsite and authorize discharge offsite to a combined sewer system. In the combined sewer system, flow control protects sewer capacity and prevents sewer backups and street flooding. Both partial infiltration and lined systems are useful tools to reduce risk.

Stormwater Requirements for the Combined System

- Infiltrate to the maximum extent practicable; provide some infiltration even if infiltration of the 10-year storm event is not feasible.
- For offsite discharges, limit the post-development peak flow from the 25-year, 24-hour storm event to the pre-development 10-year, 24-hour peak flow rate.

Additional Requirements for Right-of-Way Facilities

For projects in the public right-of-way where full onsite infiltration is not feasible within the development area and that propose to discharge to the combined sewer system:

- Lined stormwater facilities and/or piped overflows should only be used where there are local or regional capacity problems and where flow control and other benefits of lined systems have been identified.
- If there are no local or regional capacity problems, the applicant must maximize the use of tree credits and then request to pay an Offsite Stormwater Management Fee through the Special Circumstances process (Section 1.8).

1.4 Receiving System Requirements

All projects are required to identify and obtain approval of a receiving system for site stormwater runoff. Receiving systems include but are not limited to groundwater, the combined sewer, public or private ditches, constructed or natural drainageways, constructed channels, creeks, streams, storm-only sewers, and rivers. Facilities that provide full onsite infiltration of Portland's 10-year, 24-hour design storm (3.4 inches of rainfall over 24 hours) are approvable receiving systems. Unless full onsite infiltration can be accomplished, an offsite discharge point that connects to a receiving system must be identified. Sites that do not have access to an approvable discharge point may need a sewer extension or other public or private improvement to provide an approvable discharge point for the proposed project.

1.4.1 UIC Regulations and Registration

DEQ and BES regulate the installation and operation of UICs. DEQ manages the registration of UICs on private property. All new private UICs must comply with state plumbing code and, with few exceptions, register with DEQ. BES does not require new private UICs to be approved by DEQ prior to plan review. BES manages the registration process for UICs on City-owned properties and in the public right-of-way.

Groundwater Protection Regulations from other Agencies (DEQ and Portland Water Bureau)

DEQ: Complete DEQ UIC regulations, requirements, exclusions, exemptions, and contact information are available on the DEQ UIC Program website. The DEQ Water Quality Division UIC Program requires authorization before constructing, operating, modifying, or decommissioning any UIC on private property.

Portland Water Bureau: Infiltration is limited in the Portland Water Bureau's Wellhead Protection Area (WPA) to protect groundwater resources for potable use. Additional information about the WPA can be found at the Portland Water Bureau Groundwater Protection Program website.

1.4.2 Offsite Receiving System Requirements

BES may require project designers proposing to discharge stormwater offsite to evaluate impacts to the receiving system (e.g., combined sewer, storm sewer, ditch, drainageway). BES staff may determine that additional requirements are necessary (such as infrastructure upgrades, flow control or additional drainage reserve width) if the receiving system does not have sufficient capacity to accept the proposed flows or if flows will cause adverse impacts.

Offsite Discharge to Surface Water

Discharges to an offsite surface water conveyance feature (e.g., a ditch, drainageway, stream, or river) have the potential to cause adverse impacts upstream or downstream including channel erosion and exacerbated flooding. Discharges to a closed depression (e.g., a wetland or pond) have the potential to cause adverse impacts to water surface levels and habitat. In certain cases, BES may require downstream analysis, onsite controls, and system upgrades to mitigate those impacts. Developments should provide adequate energy dissipation to control in-stream erosion and should not increase the risk of flooding to downstream or upstream properties for the 2-, 5-, 10-, and 25-year events.

Offsite Discharge to Piped System

For projects proposing to discharge stormwater offsite to a piped sewer system, BES may determine that additional onsite flow or volume control is required if the sewer system does not have capacity to accept the proposed flows. Design levels of service for piped systems are in the Sewer and Drainage Facilities Design Manual (SDFDM).

Discharge to Existing Stormwater Management Facilities

Requirements vary depending upon whether the stormwater facility is publicly-owned or privately-owned.

Publicly-owned facility:

In most situations, private runoff cannot be discharged to a public facility. In unique situations a development may discharge to an existing, publicly-owned stormwater facility if all of the following criteria are met:

- The additional flows are reviewed and approved by BES.
- The stormwater management facility has capacity to manage the additional flows from the proposed development (i.e., either the stormwater facility was designed to manage the additional flows from the proposed development and that capacity is still available or an engineering report is provided to demonstrate that the facility meets current stormwater sizing standards when additional flows from the proposed development are included).

- The conveyance system routing flows to the facility meets BES requirements for pipes, open channels, or other approved methods as described in the SDFDM.
- Stormwater runoff from development on private property will not discharge into any public infiltration sump systems.

Privately-owned facilities:
A development may discharge to an existing, private stormwater management facility if all of the following criteria are met:

- The stormwater management facility has capacity to manage the additional flows from the proposed development (i.e., either the stormwater management facility was designed to manage additional flows from the proposed development and that capacity is still available or an engineering report is provided to demonstrate that the facility meets current stormwater sizing standards when additional flows from the proposed development are included).
- The conveyance system routing flows to the facility has adequate capacity per applicable requirements (e.g., BES standards, Oregon Plumbing Specialty Code).
- The private stormwater facility meets O&M standards as determined by BES. (BES may choose to conduct a site investigation to determine if the existing facility is being maintained per the existing O&M agreement on file with the appropriate county; per other agreement, if applicable; or if there is no agreement, per O&M best practices as determined by BES).
- If the existing facility is on a separate parcel from the proposed development, the development's owner must confirm the establishment of new or updated agreements as follows:
    - A written legal agreement, such as an easement, to prove the developer's owner has the necessary property rights to discharge site runoff to the existing facility. Proof of an executed agreement may be required by BES prior to approval of a land use application or issuance of a permit. BES must review and, if appropriate, approve this agreement, and the owners must record the agreement on both properties.
    - An O&M agreement that conforms with Section 1.6 and is recorded with the applicable county. Changes such as responsible owners, affected parcels, maintenance responsibilities, and facility details will necessitate an updated O&M plan be recorded on all affected parcels prior to permit issuance.

1.5 Stormwater Master Planning

Large campus or district-scale developments may choose to develop a stormwater master plan to guide phased development over a long period of time. A master plan will encompass development on private property and in existing and future rights-of-way. This may include educational, medical, or religious institutions, large site master plans, planned developments, or other master plans for large developments. Stormwater master plans may be a required condition of a development agreement or conditional use approval. Stormwater management for public rights-of-way within a master plan will be evaluated through the public works approval process.

A stormwater master plan should lay out current and proposed conditions and identify a phased approach to bridge the two conditions. This may include building stormwater facilities in advance of development, discharging to existing stormwater management facilities, incorporating shared facilities, or implementing planned upgrades to existing or proposed facilities to account for managing additional stormwater runoff. As development progresses in a master planned area, BES will review stormwater designs during each subsequent development phase through City review processes.

A stormwater master plan may have larger design flexibility within the geographic extent of the master plan boundaries (i.e., the entire master plan area would be considered "onsite") but still needs to meet the SWMM system-specific requirements at the point of discharge leaving the master planned area during each phase. The master plan may include land other than land that is currently controlled by the property owner, but those sections of the master plan cannot be implemented until so controlled. Otherwise, if multiple property owners are involved, the stormwater master plan needs to include development agreements, easements, covenants, conditions and restrictions (CC&Rs), or other binding agreements that would indicate future commitments to implement the stormwater master plan prior to conditional use or other land use approval.

1.6 Operations and Maintenance Requirements

All stormwater management facilities, conveyance features, and related components installed or protected per the SWMM must be operated and maintained in a way that preserves intended functionality. The requirements for operations and maintenance (O&M) depend on the design approach and whether the facility or conveyance feature is located on private or public property, or in the public right-of-way. For properties with drainageways, drainage reserves must be protected per the Notice of Drainage Reserve or protected and maintained per the O&M plan.

1.6.1 Public Right-of-Way Requirements

Maintenance of stormwater facilities located in the public right-of-way or in public easements is the responsibility of the permittee until the facilities are accepted by the City following completion of a 2-year maintenance warranty period at the conclusion of the public improvement process or Public Works Permit process.

For public stormwater facilities located in BES easements, BES maintains the public stormwater facility following the 2-year maintenance warranty. After the end of the 2-year maintenance warranty period, the property owner continues to maintain the property itself and any associated features, such as accessways, additional landscaping, or fencing. Designation of maintenance responsibility will be determined by BES and BDS and memorialized in a maintenance agreement recorded at plat approval. Additional requirements for the public right-of-way are in Section 4.2.1.4.

A Public Works Permit permittee may enter into an agreement with BES to provide vegetation maintenance in the future public stormwater facility during the warranty period; this does not exempt the permittee from other O&M requirements. See Section 4.2.1.4 for more information about establishment of public stormwater facilities.

1.6.2 Parcel-based Facility Requirements

Stormwater facilities and conveyance features on parcels (i.e., outside of the public right-of-way and BES easements) are the responsibility of the property owner(s). The property owner(s) must submit a draft O&M or Notice of Drainage Reserve to the City and receive approval prior to recording it with the appropriate county. A final recorded O&M or Notice of Drainage Reserve submittal must be filed with BES prior to permit issuance. See Section 3.3 for stormwater management facility O&M submittal requirements and Section 5.10 for drainage reserve O&M and Notice of

Drainage Reserve submittal requirements. The following requirements for O&Ms apply to these specific situations:

- City-required stormwater retrofits and retrofits required by other agencies must submit O&M information to the City and record it with the appropriate county.
- If multiple properties share one onsite private stormwater system, property owner(s) for each property must record and file the O&M submittal. All owners of properties that are served by the onsite stormwater system jointly own it and are equally responsible for its O&M.
- If a property served by a private stormwater system covered by an existing O&M is subsequently divided, a new O&M submittal must be approved at the time of BES review and recorded concurrent with the plat on each newly created parcel or lot that will be served by the stormwater facility.

1.6.3 Exemptions from O&M Submittal Requirements

Drywells and Soakage Trenches on Residential Lots:
Residential one- and two-family dwellings on individual lots are not required to provide an O&M submittal if a drywell or soakage trench is the only stormwater facility on the building or development permit. However, an O&M is required for a drywell or soakage trench that is shared between two or more one- or two-family dwellings on separate lots. Each lot of record is required to have its own O&M agreement for the shared facility.

Downspout Extensions:
O&Ms are not required for downspout extensions.

City of Portland or Port of Portland development projects:
For City or Port of Portland projects that involve building or other development permits, O&M submittals are required to be drafted by the applicant prior to plan approval and permit issuance. However, the City and the Port are not required to record O&M submittals with the county. O&Ms are filed with BES for City projects. See Table 1-1. SWMM Applicability to Port of Portland Properties.

1.6.4 Operations and Maintenance Enforcement

The City has the right to ensure site compliance with the recorded O&M and Notice of Drainage Reserve submittal filed with the City. City Code Chapter 17.38 authorizes BES right-of-entry for inspections, the ability to issue a code violation, and the ability to take enforcement actions and levy civil penalties.

BES provides post-construction inspections of stormwater facilities and drainage reserves on private property. The administrative rules governing inspections and enforcement are the Maintenance Inspection Program Administrative Rules (ENB-4.31) and the BES Enforcement Program Rules (ENB-4.15). BES staff inspects a site to verify that the property owner is properly operating and maintaining stormwater management facilities and drainage reserves in compliance with the recorded O&M submittal. Upon completion of an inspection, the inspector will provide a report addressed to the property owner or designated responsible party that outlines any required corrective action, deadline to correct, and City notification (if needed). In general, BES inspectors will strive to work with site owners and operators to ensure proper facility O&M. If technical assistance does not yield tangible O&M improvements, BES may take enforcement action.

1.6.5 Revisions to Recorded O&M Plans

Property owners must consult with BES maintenance inspection staff to determine if a permit and/or a new O&M submittal is required prior to making onsite stormwater system or stormwater management facility modifications. Stormwater system or individual stormwater facility modifications subject to City review and approval include but are not limited to changes to the discharge location, source of runoff, and structural or vegetated components.

The City may require a property owner to record a new or updated O&M submittal if the O&M submittal on file with BES is inaccurate or otherwise insufficient. The property owner must submit a draft O&M submittal to the City and receive approval prior to recording it with the county. A final recorded O&M submittal must be filed with BES.

Facility owners are encouraged to follow O&M maintenance activities in the current version of the SWMM.

1.7 Decommissioning Stormwater Facilities

1.7.1 Private Facilities (Non-UICs)

Development Permits: If a project proposes to redevelop a property that has an existing stormwater facility with a recorded O&M and the project scope involves removing the facility, then the project must replace the functionality of the removed facility in addition to meeting SWMM requirements related to the project scope. If an O&M is required, the new O&M must include all facilities and will supersede the prior O&M. If an O&M is not required for the new site configuration (e.g., for drywells on single-family residential sites), then the existing O&M must be nullified.

Enforcement: If a responsible party removes or modifies a stormwater facility without contacting or consulting with BES ahead of time, BES can issue a Class III or Class II violation notice. In the case of unauthorized removal, the responsible party will be required to apply for a permit and install a new stormwater facility that meets the SWMM requirements. In the case of modification, the responsible party will be required to provide documentation of the modifications, demonstrate that the facility still meets SWMM requirements, and submit and record a new O&M.

1.7.2 Public Facilities (Non-UICs)

Storm and Combined Sewer Systems: Decommissioning or modifying a public stormwater facility must first be approved by BES. BES's review will be based on system need and regulatory compliance. Replacement in-kind or payment of the Special Circumstances Fee may be required. BES will evaluate each case individually.

1.7.3 UICs

Privately-owned UICs: The decommissioning of a UIC system requires submittal of a completed pre-closure notification application to DEQ prior to closure. A City building or plumbing permit does not authorize the decommissioning of a UIC on private property. If stormwater is redirected from a private UIC to a City stormwater or drainage system, that project must meet the requirements of the SWMM as a new connection (Section 1.2.2). DEQ requirements for UIC decommissioning are described on the DEQ website.

City-Owned UICs: For any City-owned UICs (including those on parcels), BES manages the pre-closure application submittal process. The City will complete the decommissioning process in accordance with the City's UIC Management Plan, Appendix D: Decommissioning Procedure for UIC Systems. For information, contact: BESUIC@portlandoregon.gov.

1.8 Special Circumstances

Special circumstances on a proposed site may make it impractical to meet stormwater management requirements to the standards specified in this manual. A project designer can request to pay an Offsite Stormwater Management Fee instead of building a stormwater management facility for some or all of the stormwater management requirements for the project by submitting a Special Circumstances Request. The Offsite Stormwater Management Fee charged for a project is calculated per square foot of unmanaged impervious area.

BES uses collected Offsite Stormwater Management Fees to construct stormwater management facilities to meet system-specific needs. The Offsite Stormwater Management Fee is calculated based on the average construction costs for the City to install stormwater management facilities through retrofitting existing impervious area. The current rate is published and adopted through BES's annual budget process and is listed with the current fiscal year's Sewer and Drainage Rates and Charges. Special Circumstances requests that are submitted following permit issuance will be charged the Post-Permit Issuance Offsite Stormwater Management Fee.

There are two types of Special Circumstances: Staff-Review Special Circumstances and Committee-Review Special Circumstances.

1.8.1 Staff-Review Special Circumstances

Staff-Review Special Circumstances apply to projects or portions of projects that require stormwater management and propose to do one or more of the following:

1. Create, expand, or replace sidewalk and other pavement in the sidewalk corridor behind an existing curb in the right-of-way;
2. Create, expand, or replace pedestrian paths or walkways that cannot be otherwise managed; or
3. Add or replace impervious area to meet Americans with Disabilities Act (ADA) requirements.

For projects that meet the above criteria, the Offsite Stormwater Management Fee will be allowed through a Staff Review Special Circumstances for the qualifying areas. The form may be filled out by an applicant and submitted along with a permit application or may be filled out by BES staff on behalf of the applicant. Providing stormwater management for areas meeting these criteria is assumed to be impractical and no additional technical justification is required to qualify to pay the Special Circumstances Fee. However, if facilities are being constructed for other impervious areas on the site, size those facilities to accommodate runoff from qualifying areas. Any remaining impervious area requiring stormwater management and not meeting the above criteria must meet SWMM requirements or the project designer must submit a Committee-Review Special Circumstances request separately.

1.8.2 Committee-Review Special Circumstances

A Committee-Review Special Circumstances request must demonstrate why a stormwater facility is not technically feasible for the area not being managed. Typically, site constraints related to grading, slopes, or topography are most likely to make construction of a stormwater facility infeasible.

Stormwater management within the site must be achieved to the maximum extent practicable, as approved by BES, before BES will approve a Special Circumstances Application. If the request is to pay the Offsite Stormwater Management Fee for the entire site area, then the request must demonstrate why stormwater facilities are not technically feasible to manage runoff from any of the sub-basins within the site.

Committee-Review Special Circumstances requests are reviewed by the Special Circumstances Committee comprised of BES employees. BES will issue a decision letter that outlines general findings, the decision, and any instructions or conditions that must be met prior to the next approval milestone.

If BES approves a Special Circumstances request, the applicant must follow the instructions in the decision letter.

1.8.3 Special Circumstances Submittal Requirements

A complete Special Circumstances application, including the applicable Special Circumstances form, is required before BES will consider a Special Circumstances request.

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 Staff- or Committee-Review Special Circumstances Form.
- One set of plans (site plan and any necessary details) clearly showing the square footage and drainage basin area(s) to which the request pertains.
- Supplemental information specific to the project request.

Each Special Circumstances request must be clear, concise, accurate, complete, and stand on its own merit and will be reviewed based on the specific conditions related to the project under consideration.

Special Circumstances Form

The Special Circumstances Form requests the following information:

- Project information, including development or improvement proposal number (permit, land use review, or project number), development proposal location, applicant information, and owner information (if different than applicant).
- A Special Circumstances request, including the total square footage of new or redeveloped impervious area and the total square footage of impervious area for which Special Circumstances review is requested.

Committee Review Special Circumstances Form Additional Information

- A description of the features of the project that make constructing a stormwater facility infeasible.
- A description of how stormwater will be managed from all impervious areas on the site subject to the requirements of this manual, including proposed stormwater management facilities (if applicable), proposed discharge point(s), the receiving system for any offsite discharges (e.g., infiltration, storm sewer, specific water body, or combined sewer), and how runoff from the site will be conveyed.

Plans

One set of plans must accompany the Special Circumstance application. Plans must show the total amount of impervious area being created or redeveloped, all existing and proposed stormwater management and conveyance facilities, the areas considered to be a special circumstance, and 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.

Supplemental Information

If relying on infiltration test results, geotechnical reports, or other technical information to support the Special Circumstances request, submit that information along with the application. Submitting other supplemental information (e.g., engineering analyses, infiltration test data) that will help clarify the request or make it easier to understand is encouraged.

How to Submit a Special Circumstances Application

Special Circumstances applications are only reviewed in association with a development proposal, building permit, land use review, or public improvement project. They can be reviewed after an Early Assistance meeting and associated with the Early Assistance process. Applications for Committee Review will be screened for completeness within three business days of staff assignment. Inaccurate or incomplete applications will be returned and will cause a delay in considering the request.

For questions regarding the submittal process, call the BES Development Review Hotline at 503-823-7761.

Committee Review Application Fee

The Committee-Review Special Circumstances application requires payment of the application fee. The amount of the fee is listed with the current fiscal year's Sewer and Drainage Rates and Charges. The application fee should be submitted electronically or by mail with the Special Circumstances application form. Checks can be mailed to 1900 SW 4th Avenue, Suite 5000, Portland, Oregon, 97201, to the attention of BES.

There is no application fee for Special Circumstances requests made by public agencies through public improvement projects.

Decisions

Staff-Review Special Circumstances decisions are made concurrently with the applicable development review process and by the BES staff permit reviewer. BES will issue Committee-Review Special Circumstances decisions within 21 calendar days of receiving a complete application (following a positive completeness check). Decisions will be emailed to the applicant. If the Offsite Management Fee is approved, the fee must be paid prior to the most appropriate BES review or approval milestone.

The Special Circumstances decision is valid for two years from the decision date but can be nullified sooner as determined by BES if the area of development or redevelopment or other project circumstance changes significantly.

CITY OF PORTLAND
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STAFF REVIEW SPECIAL CIRCUMSTANCES
APPLICATION FORM

Only use this form for the portions of your project where either of the following apply:

☐ The project creates, expands or replaces pavement in the sidewalk corridor behind an existing curb in the right-of-way;

☐ The project creates, expands, or replaces pedestrian paths or walkways that cannot be otherwise managed;

☐ The project adds or replaces impervious area to meet Americans with Disabilities Act (ADA) requirements.

If none of the above scenarios apply, this form is not applicable to your project.

PROJECT INFORMATION

Permit Number/LUR Case/Public Works Project Number: ____________________

Site ID (R number(s)): ____________________

Project Location/Site Street Address: ____________________

City/State/Zip: ____________________

Project Name *(if applicable)*: ____________________

APPLICANT INFORMATION

Applicant Name/Business: ____________________

Mailing Address: ____________________

City/State/Zip: ____________________

Phone Number: ____________________

Email: ____________________

OWNER INFORMATION *(if applicable)*

Owner Name: ____________________

Mailing Address: ____________________

City/State/Zip: ____________________

Owner Email: ____________________

Briefly describe and attach a site plan that clearly shows the area requesting special circumstances review:

____

____

Request Location *(choose only one)*: ☐ Private property ☐ Right of way

A. Project Impervious Area: *(only include area meeting the criteria described above)* ____________ ft^2

B. Applicable Tree Credit: *(only applicable for improvements in the ROW, attach Tree Credit Form)* ____________ ft^2

C. Project Impervious Area subject to Special Circumstances Fee (unmanaged impervious area): ____________ ft^2 *(subtract B from A)*

Applicant or Owner's Signature: ____________________ Date: ____________

(for staff use only)

Received by: ____________________ Date: ____________ US Folder Number: ____________

☐ Approved as submitted ☐ Approved with corrections (see below for final unmanaged area)

☐ Rejected (does not qualify) ☐ Approved at land use review; pay with building/public works permit *(circle one)*

Current offsite management rate: ____________ Unmanaged impervious area ____________ ft^2 Fee total ____________

ES 2015

COMMITTEE REVIEW SPECIAL CIRCUMSTANCES

APPLICATION FORM

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Please fill this form out completely.

For assistance in completing the form, consult with the Bureau of Environmental Services (BES) staff assigned to review your proposal or with BES staff in the Development Services Center. Refer to Section 1.8 of the *2020 Stormwater Management Manual* for the complete Special Circumstances Submittal Requirements.

(for staff use only)

Received by: ____________________

Date: ____________________

Deemed complete on: __________

A complete Special Circumstances submittal consists of this form, the Special Circumstances Application Fee (if applicable), one (1) set of plans, and any supplemental information that supports this Special Circumstances request. Plans should clearly indicate the proposed new or redeveloped impervious area and proposed stormwater management. Also clearly show the unmanaged area for which the project is requesting special circumstances review.

1. PROJECT INFORMATION

SITE INFORMATION

Permit Number/LUR Case/Public Works Project Number: ____________________

Site ID (R number(s)): ____________________

Project Location/Site Street Address: ____________________

City/State/Zip: ____________________

Project Name *(if applicable)*: ____________________

Special Circumstances request location *(choose one)*: ☐ Private property ☐ Right of way

APPLICANT INFORMATION

Applicant Name: ____________________

Applicant Business Name: ____________________

Applicant Mailing Address: ____________________

City/State/Zip: ____________________

Applicant Phone Number: ____________________

Applicant Email Address: ____________________

OWNER INFORMATION *(if applicable)*

Owner Name: ____________________

Owner Mailing Address: ____________________

City/State/Zip: ____________________

Owner Email Address: ____________________

Describe the development or improvement proposal *(one set of plans must be submitted that match this description):*

____

____

____

____

____

COMMITTEE REVIEW SPECIAL CIRCUMSTANCES

APPLICATION FORM

2. SPECIAL CIRCUMSTANCES INFORMATION

Provide reason for the Special Circumstances request:

- Why are stormwater management facilities not technically feasible?
- Why should this proposal be considered given the stormwater management requirements in the Stormwater Management Manual?

____

____

____

____

____

3. STORMWATER MANAGEMENT INFORMATION

Describe any existing or proposed stormwater management facilities on the site.

____

____

____

____

____

____

ALL PROJECTS

A. Project impervious area *(only include area triggering SWMM requirements)* ______________ ft^2

B. Project Impervious Area subject to Special Circumstances Fee *(unmanaged impervious area):* ______________ ft^2

PROJECTS IN THE RIGHT-OF-WAY USING TREE CREDITS

C. Applicable Tree Credit *(attach Tree Credit Worksheet)* ______________

D. Project impervious area subject to Special Circumstances Fee adjusted with tree credit. *(Subtract C from B)* ______________ ft^2

Where will stormwater be discharged if Special Circumstances is approved.

- ☐ Onsite infiltration
- ☐ Storm-only system:
  Watershed or waterbody: ______________
  Location of storm-only sewer: ______________
- ☐ Combined sewer:
  Location of combined sewer: ______________

Signature: ______________________ **Date:** ______________

Print Name: ______________________ **I am the** ☐ Applicant ☐ Owner

1.9 Administrative Reviews and Appeals

The administrative review process allows applicants to request a review of staff interpretations of the City Code and rule, and of adopted policies and procedures that guide the review of development proposals. The purpose of an administrative review is for the bureau to determine if City Code and rule were applied consistently and correctly to the case at hand. The bureau will not grant exceptions to its requirements through the administrative review process or any other process. A BES decision made under these rules is subject to administrative review by BES and appeal to the Code Hearings Officer unless otherwise stated in this section.

BES will not grant administrative review of a requirement or to any technical standard in these rules or associated City Code provision that is considered a Facial Challenge, as that term is defined in this manual. A requirement to submit a plan, report, test result, form, record, or other source of information necessary for BES staff to determine a party's compliance with technical standards is not subject to administrative review or appeal.

For example, bureau interpretation of the requirements in the SWMM (e.g., applicability of stormwater management requirements, staff assessment of a site's stormwater management hierarchy level, or a permit denial), including interpretations underlying decisions made under the Special Circumstances process, are eligible for administrative review and appeal. Although a person may obtain administrative review of the bureau's application of technical requirements, standards, and engineering assumptions to the person's work that is subject to the SWMM, the technical requirements, standards, and engineering assumptions themselves are not subject to review.

The following types of decisions are subject to administrative review but are not subject to appeal to the Code Hearings Officer:

- Decisions rendered regarding the approval of manufactured stormwater treatment devices;
- A BES determination of a drainage reserve or drainageway channel; and
- A BES determination of a request for encroachment into a drainage reserve or a drainageway channel.

Administrative reviews are conducted by bureau personnel. A person must submit a written request for administrative review within 20 business days of the date that BES issued the letter, notice, or decision. In the case of a BES decision that is issued through a City process administered by BDS (e.g., through a land use review or building permit review), a person must submit a written request for administrative review of the BES decision within 20 business days of the date that the City issues the development decision (e.g., development permit or land use decision) that incorporates or is based on the underlying BES decision, or within 20 business days of the date that BES transmits the BES decision to the person, whichever is sooner.

In all cases, the requestor must provide all information known to the requestor that supports an assertion made in the written request for administrative review. The requestor must provide such information via graphic, written, or recorded communication, or in person at the administrative review meeting.

BES will hold an administrative review meeting within 15 business days of receipt of the written request for administrative review unless BES determines in its reasonable discretion that a delay is justified. The requestor may provide detailed information in writing in lieu of attending the administrative review meeting.

There is no application or review fee charged for an administrative review.

BES will use Portland City Code Chapter 17.38, the provisions of these rules, and ENB-4.15, City records, and the testimony and documentation provided by the requestor to make a final determination on the issue that is the subject of the administrative review.

BES will issue to the requestor a written final determination within 15 business days of the administrative review meeting unless BES determines that extenuating circumstances justify a reasonably longer time frame. The written final determination will provide information about the process for filing an appeal to the Code Hearings Officer if appeal to the Code Hearings Officer is an option.

When the City takes enforcement action under administrative rules other than the SWMM, the provisions of those rules relating to administrative review and appeal also apply.

An administrative review is a required precursor to an appeal. Appeals are made to the Code Hearings Officer per Portland City Code Title 22. A person may only appeal a decision that has undergone administrative review by BES.

Administrative Reviews and Appeals

Information about BES Administrative Reviews and Appeals, including timelines, submittal requirements, fees and forms, is found online.

1.10 Enforcement

Enforcement of the SWMM by BES is authorized under Portland City Code Chapter 17.38 and may involve the enforcement tools, civil penalties, City abatement, and cost recovery measures described in Portland City Code section 17.38.045. BES requires compliance with the SWMM through a variety of avenues, including the development review and permitting processes, implementation of the BES Maintenance Inspection Program (under administrative rules ENB-4.31), and implementation of the BES Enforcement Program (under administrative rules ENB-4.15).

1.11 Relationship to Other Requirements and Standards

Other City technical standards, design guidelines, and policies may impact the selection, placement, and design of stormwater facilities, conveyance features, and related infrastructure. Other state or federal requirements may also apply depending on the project's size, scope, and impacts to waterways. The location and scope of the proposed development or improvement, or the status of existing infrastructure may also require compliance with other regulations, codes, or rules. Before finalizing any design, it is the responsibility of the project designer to ensure relevant requirements are met and to resolve potential conflicts.

1.11.1 Sewer and Drainage Facilities Design Manual

Both the SWMM and the Sewer and Drainage Facilities Design Manual (SDFDM) are under the authority of the BES Chief Engineer and are administrative rules that may be revised by the Director of BES. They are complementary documents that share standards related to hydrologic and hydraulic design of public drainage facilities.

The SDFDM describes standard design requirements for all public sanitary, stormwater/drainage, and combined sewers that will be owned by BES or located in public ROWs and easements. It applies to infrastructure that is designed and constructed by the bureau, contractors and private permittees.

The SWMM requires stormwater management and drainageway protections to maintain and enhance the City's livability by improving watershed health and protecting public storm infrastructure. The SWMM applies to projects on private property and in the right-of-way as described in Section 1.2 Applicability and Section 5.2 Applicability.

Table 1-5 provides some common examples of when one or both manuals may be applicable. Both manuals provide design requirements and guidance for culverts, outfalls, ditches/road shoulder improvements, and drainageways or open channels.

Table 1-5. Relationship between the SWMM and the SDFDM

Design Requirements by Project Scope	SWMM	SDFDM
Public sanitary, combined, or storm-only sewers		X
Public stormwater management facilities with no overflow conveyance to public combined or storm-only sewers (e.g., sumps)	X	

Design Requirements by Project Scope	SWMM	SDFDM
Public stormwater management facilities with overflow conveyance to public combined or storm-only sewers or drainage facilities	X	X
Private stormwater management facilities with no conveyance to an offsite storm system	X	
Private stormwater management facilities with offsite conveyance to a public combined or storm-only sewer	X	X

The content of the two manuals may overlap while addressing different aspects of stormwater system design. Designers must reference both manuals when working in the City to determine the appropriate standards that apply to a project.

1.11.2 Source Control Manual

Both the SWMM and the Source Control Manual (SCM) are under the authority of BES. The SCM is a separate manual and is authorized by Portland City Code.

Some site characteristics, activities, and uses on property (either publicly or privately owned) may generate or mobilize specific pollutants of concern or levels of pollution that are not addressed solely through implementation of the SWMM. The SCM defines these site characteristics, activities, and uses, and identifies best management practices and structural source controls that must be implemented to manage pollutants at their source. Any project of any size that exhibits or introduces these site characteristics, activities, and uses must comply with the SCM. This includes new development, redevelopment, tenant improvements, changes to site uses or activities, and changes to specific site or activity areas, even if no impervious area is added or replaced.

The content of the two manuals may overlap while addressing different aspects of stormwater management. A project may be required to meet the requirements of both manuals. For example, a site with known or suspected contamination of soil or groundwater may be required to follow the site characterization requirements in the SCM to determine the feasibility of onsite infiltration of stormwater. Designers must reference both manuals when working in the City to determine the appropriate standards that apply to a project.

1.11.3 Public Works Improvements

The Portland Bureau of Transportation (PBOT) has broad code authority over public improvements in the public right-of-way under Title 17 and Title 33 of Portland City Code. Street improvements required as a condition of development will often result in a project also having to meet SWMM requirements. Street and stormwater improvements in the public right-of-way required as a condition of approval are most often constructed under a Public Works Permit (Portland City Code Chapter 17.06, Administration of Public Works Permitting). Work in the public right-of-way has applicable design standards and construction requirements. Projects going through the Public Works Permit process will have opportunities during concept design review to identify and resolve any conflicting requirements with City staff.

1.11.4 Title 10 (Erosion and Sediment Control Regulations)

Title 10 of Portland City Code requires development and construction activities to reduce erosion and control sediment during and following construction, including all ground-disturbing activities. Erosion control is a requirement of the City's MS4 permit as a mechanism to reduce pollutants in stormwater runoff. The Bureau of Development Services (BDS) enforces temporary and permanent erosion control measures for development and construction projects on private property during the development review and construction inspection processes. Individual infrastructure bureaus manage their own erosion control activities for construction in the public right-of-way, in a public easement, or under a Public Works Permit or contract. Technical guidance for meeting the erosion control requirements of Title 10 is found in the Erosion Control Manual.

Erosion control practices can help protect constructed or existing stormwater management facilities and conveyance features from sedimentation, thereby reducing the amount of maintenance needed to preserve required functionality.

1.11.5 Title 11 (Trees)

Tree preservation and planting requirements are found in Title 11 of Portland City Code and associated administrative rules. Title 11 is implemented by BDS for private trees in development situations and by Portland Parks and Recreation and the City Forester for trees not in development situations. The City Forester implements Title 11 for City and street trees in development situations. Title 11 may apply to existing and new trees on private property, street trees, and other trees in the public right-of-way.

Vegetated facilities integrated into project landscape areas may be able to meet Title 11 tree requirements. Trees required by Title 11 may be counted towards meeting the facility-specific landscape requirements of the SWMM. Similarly, trees that meet the requirements of the SWMM may also meet Title 11 requirements.

1.11.6 Title 21 (Water)

To protect groundwater as a source of drinking water for the region, the Portland Water Bureau regulates the storage, handling, use, and transportation of hazardous materials in the Columbia South Shore Well Field Wellhead Protection Area (see Figure 1-2. Columbia South Shore Well Field Wellhead Protection Area). Requirements focus on spill control measures and preventing pollutants from entering groundwater. The full regulations are contained in the Columbia South Shore Well Field Wellhead Protection Manual and 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. Portland Water Bureau review is required to verify compliance with the wellhead protection regulations.

Public and private stormwater facilities in the Columbia South Shore Well Field Wellhead Protection Area that receive runoff from commercial areas or highly travelled residential roadways must be equipped with impervious spill control features. Specifications and requirements are found in the Wellhead Protection Area Reference Manual and the City of Portland Standard Construction Specifications.

Figure 1-2. Columbia South Shore Well Field Wellhead Protection Area

Current as of 2016; official boundaries maintained by the Portland Water Bureau.

1.11.7 Titles 24 and 25 (Building and Plumbing Regulations)

State building and plumbing code requirements are implemented through BDS during the development review process for private property. BDS reviews private parking and driveway surfaces (see Portland City Code Chapter 24.45), development in flood hazard areas (see Portland City Code Chapter 24.50), and installation of private downspouts, pipes and sewers, including those that lead to or from stormwater management facilities.

1.11.8 Title 33 (Planning and Zoning)

Planning and Zoning requirements are implemented by BDS during the development review process. The Zoning Code may require a specific type of stormwater management facility, specify landscape requirements or protection of environmental features, or provide incentives or options for incorporating stormwater management facilities to meet Title 33 requirements of Portland City Code. The sections below describe some of the relevant planning and zoning requirements that may impact stormwater management facility and conveyance feature selection, siting, and design. Code requirements such as minimum density, minimum lot coverage, and required zero-lot-line setbacks for urban districts may preclude the use of onsite infiltration facilities. Even if space constraints prohibit the construction of onsite infiltration facilities, stormwater management requirements for the site must still be met. Project designers should coordinate with BDS and research the specific zoning codes, overlays, and other planning and zoning requirements that apply to their site.

Ecoroof Requirements and Floor Area Ratio Bonuses. Where provisions in Title 33 require a new development or redevelopment project to include an ecoroof or award bonus floor area or height due to the inclusion of an ecoroof, the ecoroof must meet all of the technical design and maintenance standards detailed in Section 3.2.1.1 of the SWMM, as approved by BES. Title 33 will specify when these provisions are required and the specific percent ecoroof coverage standards that must be met.

Landscaping. When vegetated stormwater management facilities are integrated into landscape areas, they can meet many, if not all, of the Title 33 landscape requirements. The benefits of integrated design include construction cost savings, combined maintenance, aesthetic benefits, and the greater likelihood of maintaining long-term functionality. Well-designed and established landscaping will also prevent post-construction soil erosion. Where the requirements of the SWMM and Title 33 differ, the most stringent requirements must be met. For example, when plant material requirements vary, the larger quantities and sizes must be used (fractions should be rounded up to the next whole number). Landscaping required by Title 33 may be counted toward meeting the facility-specific landscape requirements of Chapter 3 of the SWMM if the plantings are located within the facility area. Similarly, plantings that meet the requirements of Chapter 3 of the SWMM may also meet Title 33 landscape requirements.

City of Portland Green Building Policy

Construction of new City buildings must meet the City's Green Building Policy requirements for stormwater management. Complete criteria and applicability for the City's green building policy are described in Policy Document ENB-9.01.

1.12 Revision and Amendment Process

The SWMM is reviewed and updated as necessary. The review process includes the following:

- Consideration of new or pending regulatory requirements.
- Consideration of updated and new technologies.
- Review of administrative review requests and appeals during the preceding interval.
- Review of approved performance-based approaches.
- Review of community comments and concerns, including those of advisory bodies and professional organizations.
- Review of other City design or review processes and permit submittal requirements for consistency with City Code and administrative rules.
- Review of BES staff comments and concerns.

The amendment process will also include a public comment period on proposed amendments as required by Portland City Code Chapter 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 emailed to BESStormManual@portlandoregon.gov or sent to the following address:

City of Portland, BES
1120 SW 5th Ave., Room 613
Portland, OR 97204
Attention: SWMM

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Chapter 2. Stormwater Facility Selection and Sizing

This chapter describes the process to select and size stormwater facilities that meet the requirements of Chapter 1.

2.1 Project Planning

This chapter outlines the process to evaluate a site, select a stormwater facility type, and size the stormwater facility. Key steps are described below.

1. Plan the project. Establish the project requirements (see Chapter 1 for stormwater requirements), develop a conceptual site design that minimizes runoff, and determine which design approaches are applicable.
2. Evaluate the site for available stormwater infrastructure, constraints on stormwater facilities, and the need for any subsurface investigation.
3. Perform infiltration testing, unless waived, and any related subsurface investigation, if needed.
4. Develop a conceptual facility design that maximizes infiltration and identifies the offsite discharge point if needed.
5. Size each facility using one of the approved design approaches and design in accordance with Chapter 3 if the project is not in the public right-of-way and in accordance with Chapter 4 if the project is in the public right-of-way.

2.1.1 Site Design

Site design must account for the information gathered during the site evaluation, infiltration testing, and any related subsurface investigation. Key design goals are to reduce stormwater runoff and retain flow pathways to lessen downstream impacts. Use the following site design strategies to help meet these goals:

1. Protect natural resources by preserving site features such as drainageways, streams, wetlands, and mature trees.
2. Reduce impervious area coverage.
    - Minimize impervious areas (e.g., reduce building footprints, design efficient parking areas, and use driveway center strips).
    - When pavement is necessary, use permeable pavement if feasible.
    - Remove abandoned pavement, unless otherwise recommended.
    - Avoid compacting soil in undeveloped areas.
3. Increase site evapotranspiration.
    - Plant trees, especially evergreens, and provide vegetated areas.
    - Install ecoroofs.
4. Lay out the site such that an area or areas with soils that can infiltrate stormwater runoff, if present, are set aside for stormwater facilities.

2.1.2 Design Approach

The City allows three approaches to design stormwater facilities: Simplified, Presumptive, and Performance. It is the applicant's responsibility to determine which design approach to use. The Bureau of Environmental Services (BES) has the authority to require the use of the Presumptive or Performance Approach.

The Simplified Approach is based on standard stormwater facility designs and simple sizing ratios. It does not require a design professional. It can be used for projects on parcels with a total of up to 10,000 ft^2 (~0.23 acre) of new or redeveloped impervious area. This design approach is most appropriate for small-scale residential development (e.g., roofs, patios, parking areas, driveways). If infiltration rates substantially exceed 2 in/hr, the Simplified Approach may result in large facilities and the Presumptive or Performance Approach is recommended to reduce the size of facilities. The Simplified Approach is <u>not</u> allowed for the following:

- Large, complex projects;
- Projects with multiple catchments that, when combined, exceed 10,000 ft^2 of new or redeveloped impervious area;
- Projects that propose infiltration on sites with challenging geotechnical conditions (e.g., steep slopes, landslide concerns, or fill);
- Projects in the public right-of-way subject to a public works permit; and
- Private streets, unless all of the stormwater runoff from the private street has been approved to discharge to a drywell.

The Presumptive Approach uses a City-provided online calculator to design planters, green streets, and basins with typical details and configurations. It requires design by an Oregon-licensed professional engineer or other qualified design professional.

The Performance Approach is required for projects with unique circumstances that need analysis beyond the limitations of the Simplified or Presumptive Approach. It requires design by an Oregon-licensed professional engineer and is used to address a range of circumstances, including, but not limited to, the following:

- Sizing stormwater facilities not included in the Presumptive Approach;
- Using the Presumptive Approach Calculator (PAC) with values outside of the recommended ranges or programs and calculators besides the PAC;
- Proposing infiltration on sites with challenging geotechnical conditions (e.g., steep slopes, landslide concerns, or fill); and
- Proposing an alternate design method or facility specification.

2.2 Site Evaluation

The primary goals of the site evaluation are to determine the location(s) where stormwater facilities can be placed and whether the site can infiltrate stormwater runoff. The site evaluation includes consideration of existing and proposed utilities; existing and proposed topography; easements; plan districts; environmental overlay zones; the Columbia South Shore Well Field; the location within the City; the presence of wetlands, waterways, and drainageways; setbacks; and subsurface conditions (e.g., soils, depth to groundwater, landslide risks, contamination, and presence of fill material).

The applicant is responsible for checking local zoning and building code requirements.

> **City Zoning and Building Code Requirements**
>
> See the City of Portland BDS website for information regarding City zoning and building code requirements.

2.2.1 Location

The site's location within the City will impact the stormwater design. A variety of site-specific information is available online through Portland Maps.

Plan Districts

Portland City Code Title 33 may require an ecoroof for projects in specific areas such as the Central City Plan District and may award bonus floor area to projects that include an ecoroof in specific areas.

Environmental Overlay Zones

If any portion of the stormwater facility or disposal system is proposed within an environmental overlay zone, it is subject to the regulations of Portland City Code Title 33, Chapter 33.430.

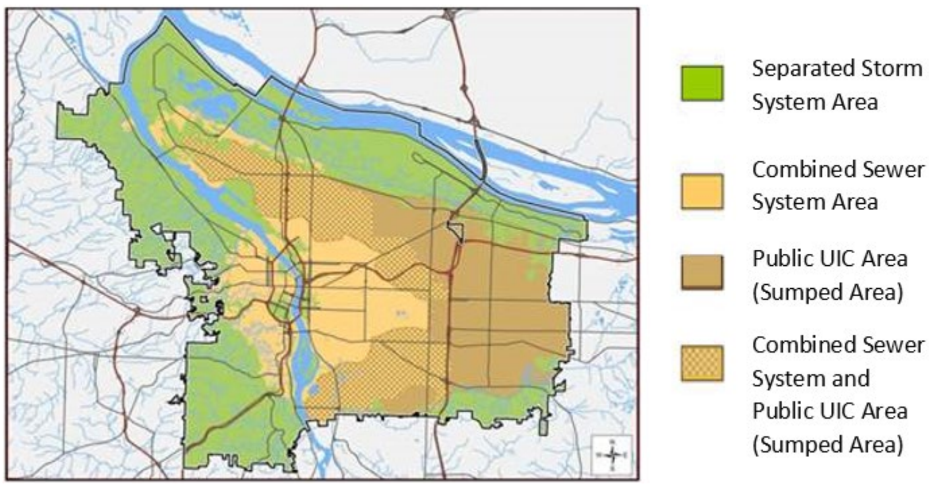
The Columbia South Shore Well Field

The Columbia South Shore Well Field Wellhead Protection Area is an area with a regionally significant source of public drinking water supplies. Special groundwater protections have been established for this area (Figure 1-2). These protections can limit stormwater infiltration and need to be considered in stormwater facility design in this area. The Wellhead Protection Area map and requirements can be found at the City's Groundwater Protection Program website.

2.2.2 The City's Stormwater Systems

The City's stormwater systems vary by location (see Figure 2-1. Map of the City's Stormwater Systems[1] and Portland Maps). The full infiltration of the 10-year design storm is most feasible on the east side, especially in the sumped area where the soils typically have high infiltration rates. For projects where full infiltration of the 10-year design storm is infeasible, BES will allow stormwater discharges to surface water either through the combined sewer system, the separated storm sewer system, or a private pipe or via overland flow. Under the Presumptive and Performance Approaches, water quality treatment and flow control requirements vary depending upon the system through which the stormwater flows (see Table 2-8).

Figure 2-1. Map of the City's Stormwater Systems[1]



1. This map is for reference only. Enter an address in Portland Maps and check utilities for site design.

2.2.3 Wetlands, Waterbodies, and Drainageways

The presence of wetlands, waterbodies, and drainageways on a site may restrict where stormwater facilities can be placed. The applicant is responsible for checking with the City, Oregon Department of State Lands, and the United States Army Corps of Engineers for any mitigation requirements.

Drainageways

This manual requires protection of drainageways on properties. The applicant must identify any surface features that could be potential drainageways (Chapter 5). BES will place a drainage reserve over any portion of a property with flow conveyance features that meet the definition of a drainageway. Placement of a drainage reserve may be based on any combination of the factors listed in Section 5.4; not all the factors must be present to require a drainage reserve.

2.2.4 Setbacks

The following summarizes the minimum standards for setbacks. Setbacks can be increased at the discretion of BES. Other geotechnical requirements and codes, including the State Plumbing Code and the City of Portland Zoning Code, may require additional setbacks.

No Setbacks Are Required by this manual for the following:

- Lined stormwater facilities, except for ponds;
- Permeable pavement (this cannot be installed on > 10% slopes); and
- Facilities along property lines with the public right-of-way.

Per City zoning, stormwater facilities constructed above grade cannot have walls 30 inches high or greater if within 5 ft of property lines (including property lines adjacent to other parcels and those adjacent to the public right-of-way).

Setback Requirements

Setbacks are required for infiltration facilities (except for permeable pavement), filter strips, downspout extensions, and ponds. See Table 2-1 for standard setbacks for infiltration facilities. Rain gardens, filter strips, downspout extensions, and ponds have facility-specific setback requirements.

Table 2-1. Standard Setbacks for Infiltration Facilities[1]

Setback to	Facility Type	Distance (ft)
Property Lines along Parcels[2]	All	5
Foundations	All except mini drywells	10
Foundations	Mini drywells	8
Drainfields Downslope of the Facility	All	100
Top of Grade Breaks > 3 ft High and Top of Slopes ≥ 20%	All	100
Top of Slopes > 50% and > 10 ft High	All	200
Drinking Water Wells[3]	Underground injection controls (UICs)	The 2-year time-of-travel or 500 ft, whichever is longer

1 This table applies to both full and partial infiltration facilities, except for permeable pavement, rain gardens, filter strips, downspout extensions, and ponds. Rain gardens, filter strips, downspout extensions, and ponds have facility-specific setback requirements.

2 No setbacks are required for property lines with the right-of-way.

3 The Oregon Drinking Water Protection Program Interactive Map Viewer shows the 2-year time-of-travel if one has been established.

Rain Gardens, Filter Strips, and Downspout Extensions

The following setbacks apply to rain gardens, filter strips, and downspout extensions:

- 2 ft from any onsite building without a basement.
- 6 ft from any onsite building with a basement.
- 5 ft from property lines along parcels.
- 10 ft from neighboring structures (for rain gardens, this last setback requirement is measured from the deepest point of the rain garden; for other facilities, this is measured from the edge of the facility).
- For rain gardens only: 5 ft from the base of retaining walls > 3 ft high.
- For rain gardens only: 10 ft from the top of retaining walls > 3 ft high.

Ponds (both Lined and Unlined)

See Section 3.2.5.6 for setbacks that apply to both lined and unlined ponds.

Encroachments into Standard Setbacks

BES may require any project not meeting standard setbacks to be designed under the Presumptive or Performance Approach and may require the applicant to provide additional design analysis including stamped reports and plans from design professionals, which the City will review to determine if the design can be approved. Examples of additional analyses include the following:

- For encroachments into slope setbacks, an analysis from a geotechnical engineer certifying the design is protective of slope stability;
- For encroachments into structural setbacks, an analysis from a structural engineer certifying the design is protective of structures; and
- For encroachments into drinking water well setbacks, an analysis from a registered geologist or environmental professional certifying the design is protective of drinking water quality.

Drywells placed under buildings are reviewed as a setback encroachment. They may be allowed provided the drywell is sized to infiltrate the 100-year design storm or an overland escape route is provided.

BDS Building Code Appeals

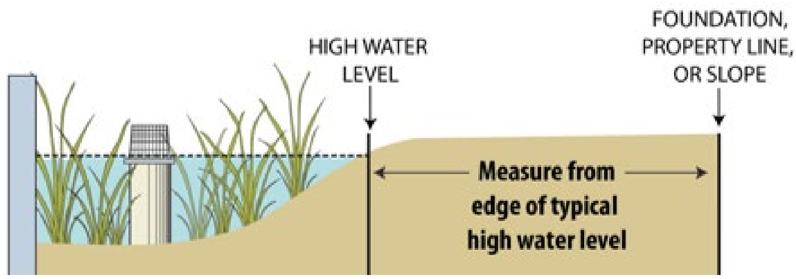
See the City of Portland BDS website for information regarding building code appeals and other related guidance.

Measuring Setbacks

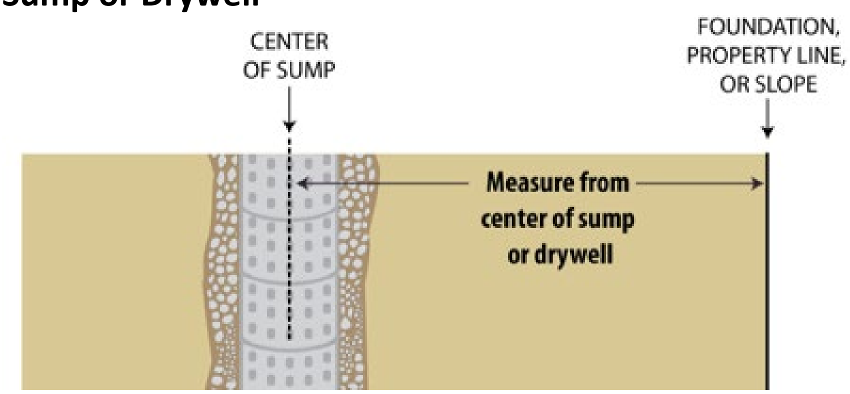
All setbacks are measured from the *high water level at the edge of the facility,* with the exception of drywells and sumps with no more than a 1-ft wide perimeter of rock, which are measured from the *center of the facility* (see Figure 2-2).

Figure 2-2. How to Measure Stormwater Facility Setbacks

Surface Facility

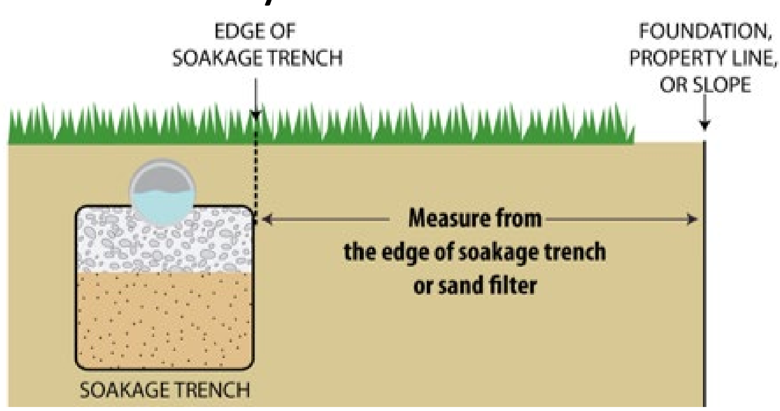


Sump or Drywell*



Unless the perimeter rock width exceeds 1 ft, in which case measure from the outside edge of the perimeter rock.

Subsurface Facility



City of Portland Bureau of Environmental Services

2.2.5 Subsurface Conditions that Could Restrict Infiltration

BES has the authority to determine if infiltration is feasible on a given site. BES will review available City data, including permit records, site history, geologic and soils maps, engineering and environmental reports, and other documentation as requested to evaluate the risk of onsite infiltration, the risk to any proposed offsite receiving system, and the need for limitations.

2.2.5.1 Soils and Depth to Groundwater

The infiltration rate is directly influenced by the soil's structure, porosity, and gradation and the presence of any restrictive soil layers or groundwater. Soil maps available from the United States Department of Agriculture Natural Resource Conservation Service (NRCS) can be helpful in making preliminary assessments of an area's potential for shallow infiltration. Generally, infiltration potential decreases from Hydrologic Group A to Group D. Use of these maps does not preclude the need for onsite infiltration testing, soil testing, and other geotechnical investigations.

BES may require a depth-to-groundwater investigation report in areas where the seasonal high groundwater is less than 50 ft below the ground surface (see Section 2.3.1). Design stormwater facilities so that seasonal high groundwater neither inundates the facility nor prevents the facility from draining between storm events. Infiltration facilities must be at least 5 ft above seasonal high groundwater, unless otherwise approved by BES.

2.2.5.2 Landslide Risks

If the applicant's agent determines it is needed or if directed to by BES, the applicant must consult with an Oregon-registered geotechnical engineer or certified engineering geologist to determine if excavation or infiltration should be avoided or limited in any area of the site to prevent increasing landslide risks beyond existing conditions.

2.2.5.3 Contamination

Infiltration of collected stormwater runoff on a site with contamination is generally prohibited to protect human health, surface water bodies, groundwater, and the City's sewer systems. In certain cases, BES may allow or require onsite infiltration where it can be demonstrated that infiltration will not result in negative or adverse impacts, including, but not limited to the following:

- Movement of infiltrated stormwater through contaminated soil or fill that could result in groundwater or surface water degradation and potential risks to human health or the environment from exposure to contaminants (e.g., contaminant movement to a groundwater well used for drinking water, irrigation, or industrial uses; contaminant movement to a surface water body where ecological receptors or humans could be exposed);

- Movement of infiltrated stormwater through contaminated soil or fill that could result in negative impacts to the sewer system; or
- Increased movement of an existing groundwater contamination plume (e.g., exacerbation).

Given the complex nature of soil and groundwater hydrology and contaminant migration, BES reserves the right to require additional investigations and analyses to ensure human health, the environment, and the City's sewer systems are adequately protected. Sites with contamination must comply with the requirements described in the City's Source Control Manual and other applicable City regulations. Infiltration on contaminated sites must meet applicable state and federal cleanup requirements.

Determining Whether the Site has Onsite Contamination: It is the applicant's responsibility to identify historical or existing onsite soil or groundwater contamination. Sources include the DEQ Environmental Cleanup Site Information (ECSI) Database, DEQ Facility Profiler, DEQ Leaking Underground Storage Tank (LUST) Database, and any other available information. Any existing environmental reports should be provided to BES for review to help determine additional testing needs.

BES may know of additional locations of contamination through sources such as DEQ, BES programs, and other records. BES will consider possible contamination on nearby and adjacent sites that might have migrated to, or have the potential to migrate to, a project site. BES may require environmental investigations to determine if soil or groundwater contamination could limit infiltration.

Site Environmental Investigation Requirements: If BES requires environmental investigations, the applicant must complete soil and groundwater sampling and analysis, as appropriate, to characterize the type(s) of contaminants present and to assess the extent and magnitude of contamination in the area(s) where infiltration is proposed in accordance with best professional practices performed under the direct supervision of an Oregon-licensed professional engineer, certified engineering geologist, or registered geologist.

- If testing does not identify soil or groundwater contamination in proposed infiltration areas above DEQ clean fill screening level values or other DEQ-approved screening levels for infiltration, then onsite contaminants do not prohibit infiltration. If the applicant is installing underground injection controls (UICs), BES may require the applicant to submit a signed copy of the DEQ Class V UIC Rule Authorization application form submitted to DEQ or DEQ written approval.

- If testing confirms soil or groundwater contamination in proposed infiltration areas, the applicant must meet the requirements described below.

Requirements for Projects Proposing Infiltration on Known Contaminated Sites: If there is known soil or groundwater contamination on the project site, BES may restrict or prohibit stormwater infiltration to avoid exacerbating the mobilization of contaminants in a way that would cause adverse impacts. For projects where applicants propose to infiltrate stormwater onsite or where BES requires infiltration, applicants must submit a report that demonstrates whether the proposed infiltration will result in adverse impacts. At a minimum, the report must describe the methodology and assumptions used to assess contaminant leaching from subsurface soils; the direction and rate of groundwater flow; groundwater contaminant fate and transport; and potential adverse impacts to human health, the environment, and the City's conveyance system (i.e., a preferential pathway analysis). The report must be prepared and stamped by an Oregon-licensed professional engineer, certified engineering geologist, or registered geologist qualified to perform the analysis.

- If the report demonstrates the proposed infiltration will not result in an adverse impact, BES may require infiltration. BES may require DEQ concurrence that infiltration at a contaminated site is acceptable before issuing a permit allowing construction of infiltration facilities. If BES discovers that DEQ does not have all relevant information (e.g., development plans, hydrologic and geotechnical reports), BES will share the relevant information with DEQ, which may result in project delays.
- If the report demonstrates the proposed infiltration will result in an adverse impact, BES will prohibit infiltration.

2.2.5.4 Fill

Engineered Fill: Infiltration into engineered fill requires a full geotechnical investigation stamped by an Oregon-licensed professional engineer or certified engineering geologist that supports the proposed infiltration.

Undocumented Fill: BES does not typically support infiltration into undocumented fill due to its potential for creating differential soil settlement, slope instability, contaminant mobilization, and preferential subsurface flow. However, infiltration may be compulsory in cases where no approvable offsite receiving system is available, or where infiltration is mandated by a DEQ cleanup action. If infiltration below the undocumented fill is not feasible, BES will require the applicant to submit a geotechnical investigation stamped by an Oregon-licensed professional engineer or certified engineering geologist that supports the proposed infiltration and addresses the following concerns:

- A decrease in slope stability and
- Damage to onsite structures or those on adjacent property as a result of infiltration into fill.

2.3 Infiltration Testing and Related Subsurface Investigations

The primary goal of infiltration testing and related subsurface investigations is to determine the degree to which the site can infiltrate stormwater. BES may require infiltration testing or other subsurface investigations prior to and during land use and permit reviews. Tests performed for a proposed land division or land use review can be used at the building permit stage provided the results of the tests are submitted with the separate permit applications. Simplified Approach facilities require infiltration testing, but typically do not require additional subsurface investigations.

> **BES Development Review**
> For questions regarding infiltration testing requirements, call BES Development Review at 503-823-7761.

Deeper Investigation and Testing May be Required: In areas where infiltration is anticipated to be feasible, BES advises and may require investigation and testing to a depth of 30 ft below the ground surface.

Waiving Testing: Infiltration testing and subsurface investigation requirements may be waived if BES deems existing subsurface and infiltration information is sufficient or the applicant demonstrates that site constraints preclude infiltration. Records from past investigations at or near the site may be considered. The applicant may also opt out of the infiltration testing and related subsurface investigation requirement for a roof (and some incidental areas) by constructing a qualifying ecoroof (see Section 3.2.1.1).

2.3.1 Boring Log and Depth-to-Groundwater Investigation

Soil testing is used to adequately measure and describe site conditions in the strata below and surrounding the proposed infiltration facility. When boring logs and depth-to-groundwater investigations are required, they must be completed by an Oregon-licensed geotechnical engineer, certified engineering geologist, or registered geologist. The following steps are for the exploratory boring work and depth-to-groundwater investigation:

6. Call the Oregon One-Call Center at 1-800-332-2344 to locate all underground utilities.
7. For stormwater facilities with a proposed total depth of 5 ft or less, advance the boring to a minimum of 15 ft below the bottom of the proposed

stormwater facility; for stormwater facilities deeper than 5 ft, advance the boring to at least 20 ft below the bottom of the proposed stormwater facility. Provide continuous soil sampling and follow appropriate protocols.

8. Take a sample of material below the stormwater facility within 5 ft of the bottom where infiltration is proposed and conduct a particle gradation analysis to determine the combined silt and clay content of the material.
9. Describe subsurface conditions on a boring log in accordance with the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure, American Society for Testing and Materials (*ASTM) D2488) and any pertinent subsurface information, including, but not limited to the following:
    - Depth and description of native soil or fill;
    - Range of particle size (i.e., grainsize) and gradation;
    - Presence of debris (e.g., asphalt, concrete, brick, organic material, metal, garbage);
    - Soil particle angularity or shape;
    - Soil consistency, stiffness, or density;
    - Soil moisture condition;
    - Soil color and mottling;
    - Staining;
    - Odor;
    - Structure and cementation;
    - Depth of contact between soil types; and
    - Whether groundwater (i.e., saturated conditions or water seeps) was encountered.
10. If groundwater is encountered, monitor groundwater as described below; otherwise, skip to step 6.
    - If long-term groundwater monitoring is deemed necessary by either BES or the qualified professional, install a piezometer or monitoring well, survey it to a datum, and monitor the water depth, as needed. Construct wells in compliance with the Oregon Water Resources Department's Oregon Administrative Rules Chapter 690, Division 240.
    - If long-term groundwater monitoring is deemed not necessary by both BES and the qualified professional, perform the following steps:

a) For fine-grained soils only, allow water levels to equilibrate for a minimum of 1 hour before measuring the depth.

b) After the water level has stabilized, use an electronic water level indicator or a weighted tape to measure the depth to groundwater relative to ground surface to the nearest 1/8 inch (~0.01 ft). Take measurements until two measurements taken at least 15 minutes apart differ by less than 1/8 inch.

c) Subtract the seasonal correction factor from the measured depth to groundwater to calculate the estimated depth to seasonal high groundwater. See Table 2-2 and Figure 2-3.

$$\text{Depth to Seasonal High Groundwater} = \text{Measured Depth to Groundwater} - \text{Seasonal Correction Factor}$$

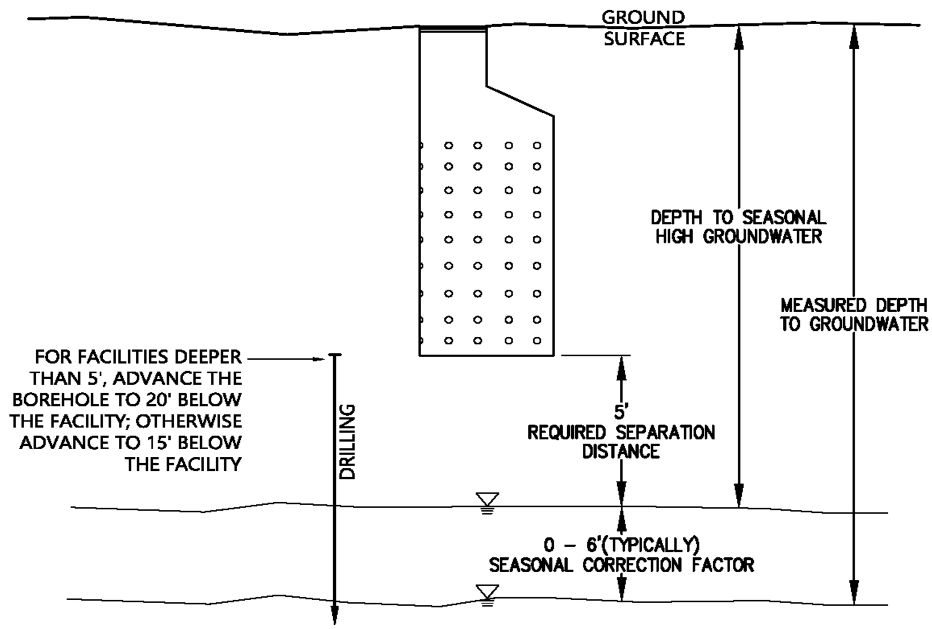
Table 2-2. Seasonal Correction Factors for Groundwater Measurements

Season when Depth to Groundwater was Measured	Seasonal Correction Factor[1]
June through February	6 ft
March through May	0 ft

1 The qualified professional may increase these numbers using best professional judgment.

11. Abandon borings, piezometers, and wells in accordance with Oregon Administrative Rules Chapter 690, Division 240.

Figure 2-3. Depth to Groundwater Investigation



2.3.2 Infiltration Tests

Infiltration testing is used to determine the rate at which soil can absorb water and is measured as the change in depth of water over a period of time. BES reserves the right to observe testing. If the location or depth of the stormwater facility is revised during the design process, retesting may be required.

Testing Method: There are four infiltration testing methods: simple pit, open pit, encased, and double-ring infiltrometer (See Table 2-3 and Figure 2-4). The simple pit test is only allowed for Simplified Approach facilities. The open pit, encased, and double-ring infiltrometer tests are allowed for any facility (including a Simplified Approach facility). Except when using the simple pit test, an Oregon-licensed engineer, certified engineering geologist, or registered geologist must determine which testing method is appropriate and this selection must be supported by any associated subsurface investigation. BES may require a specific testing method.

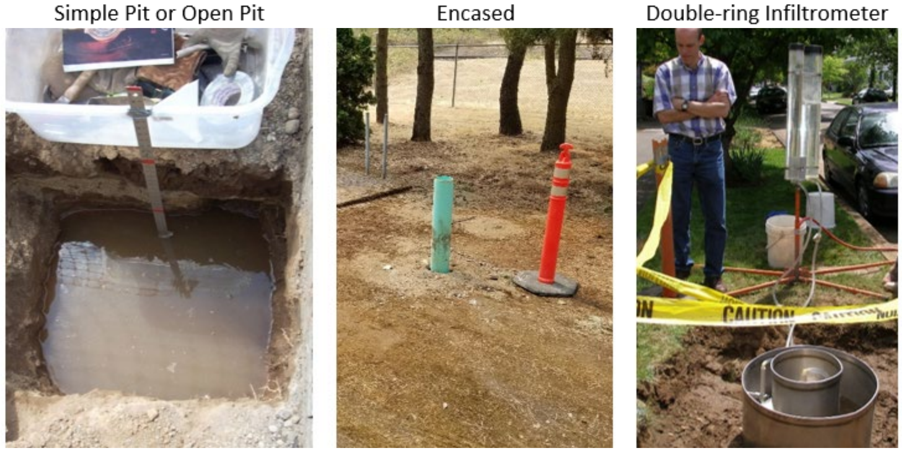
Design Professional: A nonprofessional may perform the simple pit test; for all other tests, BES requires an Oregon-licensed engineer, certified engineering geologist, or registered geologist to oversee the infiltration testing and related reporting.

Table 2-3. Infiltration Testing Methods

Testing Method	Design Approach Allowed	Qualified Professional Required to Perform Test
Simple Pit	Simplified Approach only	No
Open Pit	Any	Yes
Encased	Any	Yes
Double-Ring Infiltrometer	Any	Yes

Figure 2-4 Infiltration Testing Methods

Simple Pit or Open Pit | Encased | Double-ring Infiltrometer



Location of Tests: The test result reflects conditions at a single location. Tests must be taken at the proposed location of the stormwater facility or within its immediate vicinity. Exceptions can be made to the location of the test provided the qualified professional demonstrates the soil conditions are consistent at the stormwater facility and test location(s).

Depth of Tests: Except for the simple pit test, tests must be completed at the depth of the proposed stormwater facility. BES recommends conducting a test at each stratum used for infiltration. See Section 2.3.2.1 for the simple pit test depth.

Required Number of Test Locations: Except for subsurface public facilities, at least one test location is required for a site. For subsurface public facilities (e.g., sumps), These minimums may be adjusted by BES on a case-by-case basis considering site-specific conditions, soil variability, knowledge of the area, system capacity constraints, or other conditions. BES will require geotechnical research and investigation to determine the adequacy of infiltration; infiltration testing may be required based on the results of this research.

Additional testing beyond the minimum is often necessary to accurately characterize infiltration feasibility at varying depths and in different areas of a site, especially for large sites and subdivisions. The qualified professional should recommend a minimum number of test locations to accurately characterize the feasibility of onsite infiltration. BES may require more thorough infiltration testing for some projects (e.g., infiltration proposed into fill).

Factor of Safety: For the simple pit test, the measured infiltration rate (i.e., tested infiltration rate) is used to confirm which standard designs can be used. For all other test methods, the measured infiltration rate must be divided by a factor of safety to calculate the design infiltration rate. See Table 2-4 for the minimum allowable factor of safety. The qualified professionals overseeing the infiltration testing and design of the stormwater facility should collaborate to determine if a higher factor of safety should be used. If using a higher factor of safety, document the technical justification in the geotechnical or stormwater report.

Table 2-4. Design Infiltration Rate: Factor of Safety

Testing Method	Minimum Allowable Factor of Safety[1]
Open Pit	2
Encased	2
Double-Ring Infiltrometer	1

1 - These are minimums which can be increased, considering conditions such as soil variability, testing methods, consequences of facility failure, and the proposed project complexity.

2.3.2.1 Simple Pit Test

The simple pit test determines whether infiltration is required for Simplified Approach facilities. The test may be conducted by either design professionals or nonprofessionals, including private property owners and their representatives. A minimum of one infiltration test per development site is required. BES may require additional testing. Instructions for the simple pit test are provided here and on the Simplified Approach Form (See Section 3.4.2, Simplified Approach Form). Consider safety and protection measures if the pit is left unattended.

Simple Pit Test Procedure

1. Call the Oregon One-Call Center at 1-800-332-2344 to locate all underground utilities.
2. In or near the proposed stormwater facility, and avoiding underground utilities, excavate a pit with bottom dimensions of at least 2-ft x 2-ft to the following depth below the ground surface:
    - 2 ft below the ground surface for stormwater facilities up to 2 ft deep.
    - 3 ft below the ground surface for stormwater facilities deeper than 2 ft.
3. Check for standing water or hardpan soil (which prevents further excavation). If either is present, document the conditions on the Simplified Approach Form and do not proceed with the infiltration test. Otherwise, proceed with the test.
4. Remove any loose material from the bottom of the pit.
5. Fill the pit with at least 12 inches of water and record the initial water depth and the time when the test starts.
6. Check the water depth at regular intervals until all of the water has been absorbed or for 1 hour, whichever occurs first.
7. Record the time and final water depth at the end of the test on the Simplified Approach Form (see Section 3.4.2, Simplified Approach Form).
8. Repeat the test (steps 5-7) two more times in the same pit, in succession, for a total of three rounds of testing.
9. Replace the soil excavated from the pit when finished.
10. Calculate the measured infiltration rate for each test using an equation below:

$$\text{Measured Infiltration Rate}\left(\frac{\text{in}}{\text{hr}}\right) = \frac{60 \times [\text{Initial depth in inches} - \text{Final depth in inches}]}{\text{Duration of the Test in minutes}}$$

$$\text{Measured Infiltration Rate}\left(\frac{\text{in}}{\text{hr}}\right) = \frac{[\text{Initial Depth in inches} - \text{Final Depth in inches}]}{\text{Duration of the Test in hours}}$$

2.3.2.2 Open Pit Test

The open pit test is performed in an open excavation and can be conducted in any soil. It incorporates both vertical and lateral infiltration. The following steps describe the open pit test procedure.

1. Call the Oregon One-Call Center at 1-800-332-2344 to locate all underground utilities.
2. Excavate a test pit with bottom dimensions of at least 2 ft by 2 ft to the elevation of the bottom of the proposed stormwater facility. Excavate deeper to a confining layer or a layer with higher fines if, during the subsurface investigation, a confining layer or a layer with higher fines was encountered within 5 ft of the bottom of the proposed stormwater facility.
3. Remove any loose material from the bottom of the test pit.
4. Establish a fixed reference point for measurements (e.g., place a lath in the test pit or a sturdy beam across the top of the test pit).
5. Presoak the soil by filling the test pit with water to a minimum of 12 inches above the bottom. If the soil can maintain a water head, maintain this depth of water for 1 hour. If the water seeps away within 10 minutes, refill the test pit and if, after filling the test pit twice with 12 inches of water, the water seeps completely away within less than 10 minutes, document that the test pit cannot maintain a head.
6. Remove any soil that sloughed into the test pit during the soaking period.
7. Measure the infiltration rate using an appropriate testing method. If the test pit can maintain a head, perform a falling head or constant head test.

Direct Infiltration Test: (only if the test pit cannot maintain a head): Measure the volume of water discharged into the test pit (e.g., with a flow meter) using at least 250 gallons of water. Record the time in minutes it takes this water to drain from the test pit. Calculate the measured infiltration rate in inches per hour:

$$\text{Measured Infiltration Rate } \left(\frac{\text{in}}{\text{hr}}\right) = \frac{96 \times \text{Volume of Water Added in gallons}}{\text{Time in minutes} \times \text{Bottom Area in ft}^2}$$

Falling Head Test: Fill the test pit with water to a depth of 12 inches above the bottom. If the proposed facility’s ponding depth exceeds 24 inches, the test pit can continue to be filled with water to either the depth used in the presoak step or one-half of the water head during the design storm in the proposed stormwater facility, whichever is smaller. Record the exact time the test pit was filled. Take measurements to the nearest 1/8 inch (~0.01 ft) at regular time intervals over an appropriate duration to obtain a well-defined infiltration rate curve (e.g., using 20-

minute intervals until either all the water has drained or 2 hours has elapsed in slow-draining soils, or using 10-minute intervals until either all the water has drained or 1 hour has elapsed in medium-draining soils). Calculate the measured infiltration rate in inches per hour:

$$\text{Measured Infiltration Rate}\left(\frac{\text{in}}{\text{hr}}\right) = \frac{60 \times (\text{Start Depth in inches - End Depth in inches})}{\text{End Time in minutes – Start Time in minutes}}$$

Constant Head Test: Fill the test pit with water to a depth of 12 inches above the bottom. If the proposed facility's ponding depth exceeds 24 inches, the test pit can continue to be filled with water to either the depth used in the presoak step or one-half of the water head during the design storm in the proposed stormwater facility, whichever is smaller. Record the exact time the test pit was filled. Maintain this depth over a period of at least ½ an hour and measure the volume of water added. Calculate the measured infiltration rate in inches per hour:

$$\text{Measured Infiltration Rate }\left(\frac{\text{in}}{\text{hr}}\right) = \frac{96 \times \text{Volume of Water Added in gallons}}{\text{Time in minutes} \times \text{Bottom Area in ft}^2}$$

8. Enter the measurements into the data table. See Tables 2-5 and 2-6, respectively, for an example infiltration test table and a blank table.
9. In the same test pit, repeat steps 7-8 at least two more times (for a total of at least three rounds of testing) and continue as needed until there is no more than a 10% change in the measured infiltration rate between two successive trials. Discount any trial where the measured infiltration rate is greater than the previous trial.
10. Calculate the design infiltration rate in inches per hour by dividing the measured infiltration rate from the last trial by a factor of safety of at least 2.

$$\text{Design Infiltration Rate} = \frac{\text{Measured Infiltration Rate}}{\text{Factor of Safey}}$$

11. Backfill the test pit upon completion of testing.

2.3.2.3 Encased Test

The encased test is performed by embedding a casing into the soil and is only appropriate in soils where a good seal with the casing can be established (e.g., not in gravelly soils). The casing is intended to minimize lateral infiltration during the procedure. The following steps describe the encased procedure.

1. Call the Oregon One-Call Center at 1-800-332-2344 to locate all underground utilities.
2. Excavate a hole to the elevation of the proposed stormwater facility bottom.
3. Embed a solid casing approximately 6 inches into the soil at the bottom of the excavation, ensuring a good seal so that infiltration will be limited to the

bottom plug of material within the casing (see Figure 2-5). A hollow stem auger can be used as the casing, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger. For excavations less than 20 ft deep, the interior diameter of the casing must be a minimum of 6 inches; for excavations 20 ft or deeper, the interior diameter of the casing must be a minimum of 4.25 inches.

4. Establish a fixed reference point for measurements (e.g., the top of the pipe).
5. Presoak the soil by filling the pipe with water to a minimum of 12 inches above the bottom and a maximum of 1 inch less than the depth of the first section of the pipe to prevent water from escaping through the pipe joints (pipe sections are typically 5 ft). If the soil can maintain a water head, maintain this depth of water for 1 hour. If the water seeps away in 10 minutes, refill the pipe and if, after filling the pipe twice with 12 inches of water, the water seeps completely away in less than 10 minutes, document that the excavation cannot maintain a head.
6. Measure the infiltration rate using an appropriate testing method. If the excavation can maintain a head, perform a falling head or constant head test.

Direct Infiltration Test (only if the excavation cannot maintain a head): Measure the volume of water discharged into the pipe (e.g., with a flow meter) using at least 250 gallons of water. Record the time in minutes it takes the water to drain from the pipe. Calculate the measured infiltration rate in inches per hour:

$$\text{Measured Infiltration Rate } \left(\frac{\text{in}}{\text{hr}}\right) = \frac{96 \times \text{Volume of Water Added in gallons}}{\text{Time in minutes} \times \text{Bottom Area in ft}^2}$$

Falling Head Test: Fill the pipe with water to a depth of 12 inches above the bottom. If the proposed facility's ponding depth exceeds 24 inches, the test pit can continue to be filled with water to either the depth used in the presoak step or one-half of the water head during the design storm in the proposed stormwater facility, whichever is smaller. Record the exact time the pipe has been filled. Take measurements to the nearest 1/8 inch (~0.01 ft) at regular time intervals over an appropriate duration to obtain a well-defined infiltration rate curve (e.g., 20-minute intervals until either all the water has drained or 2 hours has elapsed in slow-draining soils or 10-minute intervals until either all the water has drained or 1 hour has elapsed in medium-draining soils). Calculate the measured infiltration rate in inches per hour:

$$\text{Measured Infiltration Rate } \left(\frac{\text{in}}{\text{hr}}\right) = \frac{60 \times \text{Start Depth in inches - End Depth in inches}}{\text{End Time in minutes - Start Time in minutes}}$$

Constant Head Test: Fill the pipe with water to a depth of 12 inches above the bottom. If the proposed facility's ponding depth exceeds 24 inches, the test pit can continue to be filled with water to either the depth used in the presoak step or one-half of the water head during the design storm in the proposed stormwater facility, whichever is smaller. Record the exact time the pipe was filled. Maintain this depth over a period of at least ½ an hour and measure the volume of water added. Calculate the measured infiltration rate in inches per hour:

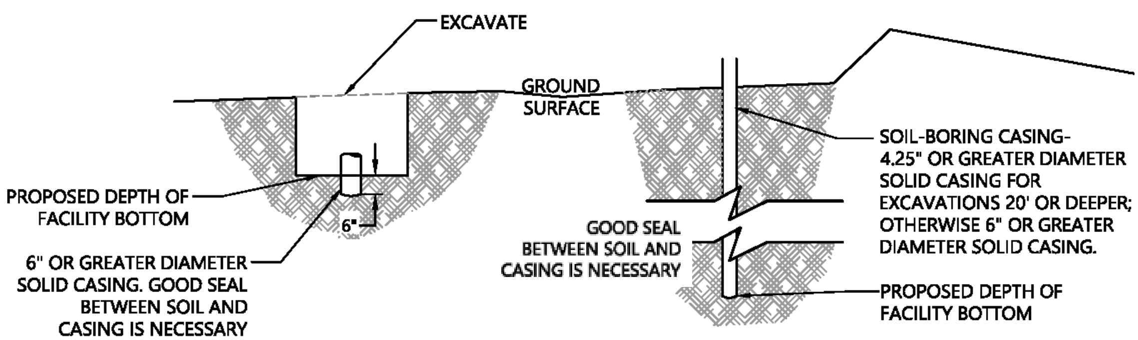
$$\text{Measured Infiltration Rate}\left(\frac{\text{in}}{\text{hr}}\right)=\frac{96\times\text{Volume of Water Added in gallons}}{\text{Time in minutes}\times\text{Bottom Area in ft}^2}$$

7. Enter the measurements into the data table. See Table 2-5 and Table 2-6, respectively, for an example infiltration test table and a blank table.
8. In the same excavation, repeat steps 6-7 at least two more times (for a total of at least three rounds of testing) and continue as needed until there is no more than a 10% change in the measured infiltration rate between two successive trials. Discount any trial where the measured infiltration rate is greater than the previous trial.
9. Calculate the design infiltration rate in inches per hour by dividing the measured infiltration rate from the last trial by a factor of safety of at least 2.

$$\text{Design Infiltration Rate}=\frac{\text{Measured Infiltration Rate}}{\text{Factor of Safety}}$$

10. Pull out the casing.
11. Backfill the excavation upon completion of testing.

Figure 2-5. Encased Test Illustration



2.3.2.4 Double-Ring Infiltrometer Test

The double-ring infiltrometer test is performed within two concentric casings embedded into the soil and is appropriate only in soils where an adequate seal can be established and a constant head can be maintained. A volume of water is maintained in the outer ring to diminish the potential of lateral infiltration through the center casing.

1. Call the Oregon One-Call Center at 1-800-332-2344 to locate all underground utilities prior to excavating.
2. Excavate a hole to the elevation of the proposed stormwater facility bottom.
3. Follow the ASTM D3385 procedures for the double-ring infiltrometer test.
4. Divide the measured infiltration rate by a factor of safety of at least 1 to calculate the design infiltration rate.

$$\text{Design Infiltration Rate} = \frac{\text{Measured Infiltration Rate}}{\text{Factor of Safey}}$$

2.3.3 Stormwater and Geotechnical Reports

Submit a geotechnical report along with the stormwater report if required by the proposed stormwater design. The stormwater and geotechnical report(s) must describe results and conclusions from infiltration testing and include adequate information to support the design infiltration rate; they should include the following:

- ☐ Project description (proposed stormwater facility/facilities).
- ☐ Either a recommendation for forgoing infiltration testing, with supporting information to the satisfaction of BES, or a summary and results of infiltration testing, including the items below.
    - ☐ Name, contact information, and qualifications of the person conducting the infiltration test, including professional license information.
    - ☐ The number and method(s) of infiltration tests performed.
    - ☐ A site plan showing the location(s) of infiltration tests.
    - ☐ A description of each presoak test, including the depth of water used and whether the excavation could maintain a head.
    - ☐ A description of each infiltration test, including the method used, the dimensions of the excavation (e.g., the test pit dimensions or pipe interior diameter and depth), and the depth and volume of water used.
    - ☐ Infiltration test data tables (see Table 2-5 for an example data table and see Table 2-6 for a blank data table).

- ☐ Infiltration testing results, including the final measured infiltration rate in inches per hour.
- ☐ Recommended design infiltration rate and the factor of safety used to develop this recommended design infiltration rate.

☐ Either a recommendation for forgoing boring work, with supporting information to the satisfaction of BES, or a summary of subsurface conditions encountered during the boring work, as part of a geotechnical report. If a geotechnical investigation is performed for a project, the geotechnical report(s) must describe results and conclusions from any additional subsurface investigations required by the City, including the items below:

- ☐ A statement of whether groundwater was encountered. If groundwater was encountered, the measured depth to groundwater, groundwater observations, estimated depth to seasonal high groundwater, and the seasonal correction factor used to derive this depth.
- ☐ Boring or test pit logs that use a soil classification consistent with ASTM D2488, Standard Practice for Classification for Description and Identification of Soils (Visual-Manual Procedure).
- ☐ A description of the pertinent subsurface information including depth and description of native soil or fill; range of particle size (i.e., grainsize) and gradation; presence of debris (e.g., asphalt, concrete, brick, organic material, metal, garbage); soil particle angularity and shape; soil consistency, stiffness, or density; soil moisture condition; soil color, mottling and staining; soil odor; soil structure and cementation; and the depth of contact between soil types.
- ☐ Laboratory gradation testing showing the combined silt and clay content of the soils located either at or up to 5 ft below the bottom of the stormwater facility where infiltration is proposed.

The City may require additional test reports, such as the following:

- For infiltration proposed within standard setbacks, a geotechnical report signed and stamped by an Oregon-licensed geotechnical engineer and, if within a setback for a structure, also signed and stamped by an Oregon-licensed structural engineer, that adequately demonstrates infiltration within these setbacks is not reasonably likely to result in adverse impacts.
- For infiltration proposed through fill, a geotechnical report signed and stamped by an Oregon-licensed professional engineer or certified

engineering geologist that adequately demonstrates long-term infiltration through fill is feasible and not reasonably likely to result in adverse impacts.

- For infiltration proposed above or through contaminated soil or contaminated groundwater, an environmental investigation report signed and stamped by an Oregon-licensed professional engineer, certified engineering geologist, or registered geologist that adequately demonstrates the proposed infiltration is protective of public health and the environment.
- For infiltration proposed in areas with groundwater concerns (e.g., shallow groundwater), a groundwater investigation report that demonstrates long-term infiltration is feasible and that is signed and stamped by an Oregon-licensed professional engineer, certified engineering geologist, or registered geologist with experience in hydrogeologic investigations.

Table 2-5. Example Infiltration Test Table

<table>
<tr><td colspan="3">Location: Lot 105,
Point Heights Subdivision</td><td colspan="2">Date: 6/28/2008</td><td>Test Hole Number: 3</td></tr>
<tr><td colspan="3">Depth to bottom of hole: 57 inches</td><td colspan="2">Dimension of hole: 0.5 feet diameter</td><td>Test Method: Encased Falling Head</td></tr>
<tr><td colspan="6">Tester's Name: C.J. Tester
Tester's Company: Tester Company
Tester's Contact Number: 555-1212</td></tr>
<tr><td colspan="3">Depth (feet):</td><td colspan="3">Soil Texture:</td></tr>
<tr><td colspan="3">0-0.5</td><td colspan="3">Black Top Soil</td></tr>
<tr><td colspan="3">0.5-1.0</td><td colspan="3">Brown SM</td></tr>
<tr><td colspan="3">1.0-2.2</td><td colspan="3">Brown ML</td></tr>
<tr><td colspan="3">2.2-5.1</td><td colspan="3">Brown CL</td></tr>
<tr><td colspan="6">Presaturation Start Time:
Presaturation End Time:</td></tr>
<tr><td>Time:</td><td>Time interval (minutes):</td><td>Measure ment, (feet):</td><td>Drop in water level, (feet):</td><td>Infiltration rate, (inches per hour):</td><td>Remarks:</td></tr>
<tr><td>9:00</td><td>0</td><td>3.75</td><td>-</td><td></td><td>Filled with 6"</td></tr>
<tr><td>9:20</td><td>20</td><td>3.83</td><td>0.08</td><td></td><td></td></tr>
<tr><td>9:40</td><td>20</td><td>3.91</td><td>0.08</td><td>2.88</td><td></td></tr>
<tr><td>10:00</td><td>20</td><td>3.98</td><td>0.07</td><td>2.52</td><td></td></tr>
<tr><td>10:20</td><td>20</td><td>4.04</td><td>0.06</td><td>2.16</td><td></td></tr>
<tr><td>10:40</td><td>20</td><td>4.11</td><td>0.07</td><td>2.52</td><td></td></tr>
<tr><td>11:00</td><td>20</td><td>4.17</td><td>0.06</td><td>2.16</td><td></td></tr>
<tr><td>11:20</td><td>20</td><td>4.225</td><td>0.055</td><td>1.98</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Adjusted to 6" level for Trial #2</td></tr>
</table>

Table 2-6. 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):**	**Measure ment, (feet):**	**Drop in water level, (feet):**	**Infiltration rate, (inches per hour):**	**Remarks:**

2.4 Conceptual Design Development

Stormwater should be considered during the conceptual design phase, with a site design incorporating stormwater facilities into the landscape. Stormwater is typically conveyed to facilities via gravity flow; consider facility placement when designing site grading and drainage. The site design must provide enough space for the facility.

2.4.1 Stormwater Facility Type and Configuration

2.4.1.1 Infiltration

Infiltration is required to the maximum extent practicable unless the site qualifies for the ecoroof exception per Chapter 3. The degree of infiltration depends upon the onsite infiltration rate and whether site constraints prevent infiltration. Depending upon the site characteristics, BES may require full infiltration facilities, partial infiltration facilities, or lined facilities. In limited circumstances, dispersal facilities may be used. See Table 2-7 and Figure 2-6.

Table 2-7. Stormwater Facility Options based on Site Characteristics

Site Characteristics		Stormwater Facility Options				
Infiltration Prohibited Due to Site Constraints[1]	Infiltration Rate[2]	Ecoroof	Full Infiltration Facility	Partial Infiltration Facility	Lined Facility	Dispersal Facility
No	≥ 2 in/hr	X	X			X (See note 3)
	< 2 in/hr	X	X (See note 4)	X		X (See note 3)
Yes	Any	X	(See note 5)	(See note 5)	X	

1 Site constraints may include insufficient space to meet setback requirements for infiltration facilities and subsurface conditions that could restrict infiltration (e.g., contamination, landslide risks, fill).
2 For stormwater facilities designed under the Simplified Approach, this is the tested infiltration rate (i.e., the measured infiltration rate); for all other stormwater facilities, this is the design infiltration rate.
3 Dispersal facilities are allowed in limited circumstances. See Section 2.4.1.2.
4 A full infiltration facility is not required when the site has a) a tested infiltration rate of less than 2 in/hr under the Simplified Approach and b) a design infiltration rate of less than 2 in/hr under the Presumptive or Performance Approaches. If full infiltration is the only disposal option, it may be authorized by BES.
5 Permeable pavement may be allowed in some conditions where other infiltration facilities are prohibited.

2.4.1.2 Facility Selection: Vegetation and Infiltration

Vegetated and infiltration facilities must be used to the maximum extent practicable. Subject to BES approval, structured detention and manufactured stormwater treatment technologies (MSTTs) may be considered where site constraints prevent the use of any reasonably located infiltration facilities or vegetated surface facilities.

Ecoroofs are built on structures and do not allow any infiltration to subsurface soils.

Full Infiltration Facilities fully infiltrate the 10-year design storm.

- **Surface Infiltration Facilities** fully infiltrate the 10-year design storm at the surface. Surface infiltration facilities include vegetated surface facilities such as rain gardens, planters, and basins and unvegetated surface facilities such as permeable pavement and surface sand filters.
- **Hybrid Facilities** combine a surface facility with a direct connection to a subsurface infiltration facility. Hybrid facilities may be appropriate for sites with well-draining soil but space limitations. Hybrid facilities are subject to DEQ's UIC regulations.
- **Subsurface Infiltration Facilities** fully infiltrate the 10-year design storm below the ground surface and include stormwater facilities such as sumps, drywells, soakage trenches, and subsurface sand filters. Subsurface infiltration facilities are subject to DEQ's UIC regulations.

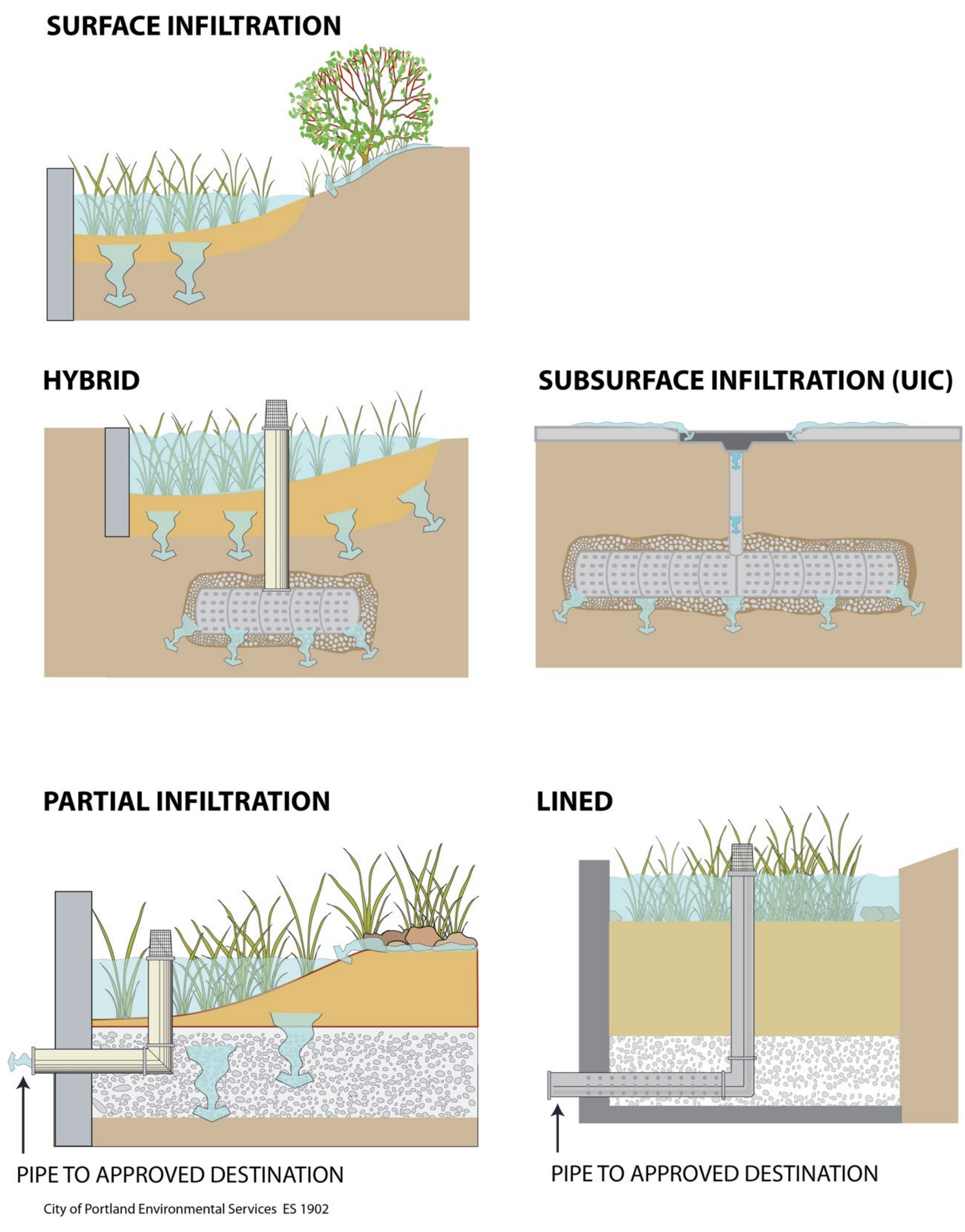
Partial Infiltration Facilities infiltrate some of the 10-year design storm at the surface. In areas with low infiltration rates, vegetated surface facilities such as planters and basins, and unvegetated surface facilities such as permeable pavement and surface sand filters may be designed as partial infiltration facilities.

Lined Facilities include an impervious bottom designed to prevent infiltration. Lined facilities include structured detention facilities, MSTTs, and lined versions of planters, basins, surface sand filters, subsurface sand filters, grassy swales, and ponds. BES will only approve lined versions of these facilities if site constraints make the liner a requirement.

Dispersal Facilities disperse stormwater or allow it to remain unconcentrated. While they may provide infiltration, infiltration is not quantified in the design of dispersal facilities. Dispersal facilities may only be used under limited circumstances:

- **Driveway Center Strips** are limited to the Simplified Approach with driveway track length and slope limitations specified in Chapter 3.
- **Filter Strips** are limited to receiving stormwater runoff in the form of sheet flow from narrow impervious areas (e.g., roads, sidewalks).
- **Downspout Extensions** are limited to receiving stormwater runoff from up to 500 ft^2 of existing roofs (i.e., retrofits only) where the infiltration rate of the receiving area's soil is at least 2 in/hr. Multiple downspout extensions may be used to manage up to 5000 ft^2 of existing roof area.

Figure 2-6. Stormwater Facility Configurations



2.4.2 Receiving System

The system to which stormwater runoff is directed is the receiving system. The receiving system may be an offsite location (e.g., a waterway, the combined sewer system, the separated storm system) or an onsite full infiltration facility.

2.4.2.1 Overflow/Underdrain

The following stormwater facilities require overflow pipes or underdrains that discharge stormwater to an approved receiving system:

- Ecoroofs;
- Lined facilities;
- Partial infiltration facilities;
- When designed using the Simplified Approach, planters, basins, and surface sand filters, unless otherwise approved; and
- Other facilities based on the site design.

Overflows are set at an elevation above the surface of the filtering media (e.g., blended soil, growing media, sand) while underdrains are set at an elevation below this media. A piped overflow conveys overflow water during larger events to an approved discharge point. A passive overflow conveys water that exceeds the design capacity of the facility to a downstream system. (In the public right-of-way, this may be a notch in the curb directing overflow to the gutter.) A piped underdrain drains flows that pass through the filtering media and cannot be infiltrated onsite.

2.4.2.2 Discharge Point

Identify the discharge point for the overflow and underdrain during normal operation of the facility. Sites without access to an approved offsite receiving system may need to construct a storm sewer extension or combined sewer extension. Full infiltration facilities are not allowed to connect to an offsite discharge point.

2.4.2.3 Emergency Escape Route

Consider an emergency escape route as part of the design for each stormwater facility. Emergency escape routes delineate where flows will be routed if the stormwater facility fails or if flows exceed the design capacity, maintaining public safety and preventing property damage. Emergency escape routes from stormwater facilities are not the same as a piped overflow and cannot be directly piped to public storm sewer systems or combined sewer systems. Recommended emergency escape routes include safe overland flow routes to parking lots, streets, landscaped areas, or drainageways. An emergency escape route can consist of onsite capacity for ponding that will hold runoff from a large storm event (e.g., the 100-year event).

2.4.3 Other Design Considerations

Stormwater management is complex and dependent on specific site constraints and opportunities. The following situations may impact the stormwater requirements or options available at a given site but are infrequent. Contact BES development review for guidance on these topics if these situations may be applicable. These requirements and allowances are subject to the approval of the Chief Engineer.

2.4.3.1 Conveyance Capacity

If BES determines the offsite receiving system has insufficient capacity to accept the proposed flows, BES may require public infrastructure upgrades, additional onsite flow control, or additional drainage reserve width.

2.4.3.2 Area Trading

If it is impracticable to manage stormwater runoff from a portion of the new or redeveloped impervious area, BES may, on a case-by-case basis, approve management of stormwater runoff from an equivalent onsite area instead.

2.4.3.3 Discharge to Existing Stormwater Facilities

Subject to BES approval, a development may discharge to an existing onsite stormwater facility if the applicant demonstrates that the conveyance system and existing stormwater facility are adequately designed to meet current requirements and meet certain conditions as specified in Chapter 1 (see Section 1.3.4 and Section 1.4.2).

2.4.3.4 Regional Facilities

Regional facilities are designed to manage runoff from multiple properties or several blocks of street runoff. These facilities should be designed to manage impervious area under anticipated future development conditions (see BES' *Sewer and Drainage Facilities Design Manual*). If this is not feasible, provide a bypass structure to direct design flows into the facility while diverting additional flows around the facility.

2.4.3.5 Private-Public Facilities

Stormwater facilities that are designed to manage stormwater runoff from both private property and the public right-of-way may be allowed only under rare circumstances and at the discretion of BES. If allowed by BES, private-public facilities will require review or permits from the City and require an agreement for a private-public facility to be recorded on the deed of all participating private properties.

2.4.3.6 Rainwater Harvesting

Property owners can collect and reuse stormwater runoff for non-potable uses such as landscape irrigation and toilet flushing (see Chapter 3).

2.5 Stormwater Facility Selection, Sizing, and Design

The design approach impacts facility selection and how facilities are sized to meet requirements. It is important to select an allowable design approach that fits the project requirements (see Section 2.1.2).

Each stormwater facility must be sized and designed to capture and manage stormwater runoff from the applicable impervious area and meet any infiltration, water quality, and flow control requirements (see Section 1.3 and Table 2-8). The sizing factors of Simplified Approach facilities are set to meet all requirements; Presumptive and Performance Approach facilities must be designed to meet specific requirements based on the design approach and hierarchy level (see Table 2-8, Table 2-12, and Table 2-13). Water quality requirements must be met for each sub-basin on the site. Flow control requirements must be met for the overall site, not each sub-basin within the site. All storm events in this manual are 24-hour events unless otherwise noted.

Table 2-8. Summary of How Requirements are Met

Design Approach	Hierarchy Level[1]	Requirements are Met By...	
		Water Quality[2]	**Water Quantity**
Simplified	Any	Meeting standard sizing factors and standard designs[3]	
Presumptive	1	Filtering the runoff from the water quality storm	Infiltrating the runoff from the 10-year design storm
	2	Filtering the runoff from water quality storm	Providing flow control per Table 2-13[4]
	3	N/A[5]	Providing flow control per Table 2-13
Performance	1	Infiltrating the runoff from the 10-year design storm (providing any required pretreatment) or installing a qualifying ecoroof	
	2	Providing treatment per Section 2.5.3.1	Providing flow control per Table 2-13[4]
	3	N/A[5]	Providing flow control per Table 2-13

1 Level 1 is full infiltration of the 10-year storm or a qualifying ecoroof; Level 2 is discharge to a drainageway, stream, or river via a storm-only pipe or overland flow; and Level 3 is connection to the combined system.
2 The water quality design storm is sized for 90% of the average annual rainfall (See Appendix A.2).
3 Simplified Approach sizing factors and requirements are set so that the stormwater facility is sized to treat the stormwater runoff from the water quality design storm and provide flow control.
4 Direct discharge to the Willamette River, Columbia River, or Columbia Slough may be exempt from flow control requirements if the storm sewer system has available capacity.
5 Treatment is provided by the wastewater treatment plant.

Selecting a Stormwater Facility

A stormwater facility selected to manage stormwater runoff from a site must be suitable for the type of project and the design approach and be able to meet the project's stormwater requirements (see Table 2-9). Specific design requirements and guidance are provided in Chapter 3 for stormwater facilities on parcels and Chapter 4 for stormwater facilities in the public right-of-way. Stormwater facilities in private streets should meet the design requirements and other requirements of Chapter 3, but may be based on the green street design details in Chapter 4.

Table 2-9. Summary of Generally Allowed Stormwater Facilities

Stormwater Facility Type	Project Type		Design Approach			Can be Designed to Meet		
						Quantity		Quality
	Parcel	Public Right-of-way	Simplified	Presumptive	Performance	Onsite Disposal[1] (Level 1)	Flow Control (Level 2 & 3)	Water Quality (Level 2)
Ecoroof[2]	•		•		•	See note 2	•	•
Permeable Pavement	•	•	•		•	•	•	•
Filter Strip	•	•	•		•	•	•	•
Driveway Center Strip	•		•			•	•	•
Green Street		•		•	•	•	•	•
Rain Garden[3]	•		•			•	See note 3	See note 3
Basin	•		•	•	•	•	•	•
Planter	•		•	•	•	•	•	•
Surface Sand Filter	•		•		•	•	•	•
Grassy Swale	•				•			•
Wet Pond	•				•			•
Extended Wet Pond	•				•		•	•
Dry Pond	•				•		•	
Sump		•			•	•		
Drywell	•		•		•	•		
Soakage Trench	•		•		•	•		
Subsurface Sand Filter	•				•	•	•	•
MSTT	•	•			•			•
Structured Detention	•	•			•		•	

1 Onsite disposal stormwater facilities meet both water quality and water quantity requirements.
2 Although ecoroofs do not provide onsite disposal, they can be designed to meet Level 1. Ecoroofs not designed to meet Level 1 can be designed to meet flow control and water quality requirements.
3 Rain gardens meet water quality and flow control requirements and are always designed as Level 1.

2.5.1 Simplified Approach

The Simplified Approach can be used to design the facilities shown in Table 2-10. Chapter 3 provides design requirements for each facility.

Infiltration

Sites with measured infiltration rates of 2 in/hr or more must only use infiltration facilities, filter strips, or driveway center strips. If infiltration is prohibited, ecoroofs or lined versions of the planter or surface sand filter may be used.

Impervious Area Limitations

Rain gardens and drywells can manage areas up to 5,000 ft^2 per individual facility and all other facilities can manage areas up to 10,000 ft^2. Driveway center strips can manage driveways up to a 15% longitudinal slope with length limitations as described in Chapter 3. Filter strips can manage up to 12 ft wide impervious areas on up to 10% cross slopes. Ecoroofs and permeable pavement manage only the area they cover; no run-on is allowed. Drywells may accept runoff from private, but not public, streets. No other Simplified Approach facility may accept runoff from streets.

Sizing

Table 2-10 shows how to size each facility type. Where a number is listed, facilities are sized by multiplying the sum of the new or redeveloped impervious areas by that number. The same sizing applies to both unlined and lined facilities of a given type.

Table 2-10 Simplified Approach Sizing and Design

Stormwater Facility Type	Sizing Factor (or Sizing Table)	Can be Designed as		Minimum Tested Infiltration Rate for Infiltration Facilities (in/hr)
		A Lined Facility	An Infiltration Facility	
Rain Garden	0.10		•	2
Planter	0.06	•	•	2
Basin	0.09		•	2
Surface Sand Filter	0.06	•	•	2
Filter Strip	See Table 3-4		•	No minimum
Soakage Trench	25 ft^2 of soakage trench for every 500 ft^2 of impervious area		•	2
Drywell	See Table 3-8		•	2
Ecoroof	1	•		N/A
Permeable Pavement	1		•	2
Driveway Center Strip	Minimum of 3 ft wide		•	No minimum

2.5.2 Presumptive Approach

The Presumptive Approach can be used by design professionals to size green streets, planters, and basins using the Presumptive Approach Calculator (PAC), an online calculator maintained by BES. Appendix A.5 describes the technical framework behind the PAC and includes allowed and recommended ranges for data entry fields. Chapter 3 provides design requirements for basins and planters on parcels and Chapter 4 provides design requirements for green streets in the public right-of-way.

Presumptive Approach Calculator (PAC)

The PAC is an online calculator accessed through Portland Online. Design professionals must have a portlandoregon.gov account to access the PAC. The PAC allows design professionals to save projects to their account and share design information by importing and exporting files.

PAC Water Quality, Infiltration, and Flow Control Analyses

The PAC uses the Santa Barbara Urban Hydrograph Method (SBUH) to calculate runoff flows from the impervious area for various design storms in 10-minute increments. The PAC routes the post-development runoff flow through the facility and calculates whether it meets the stormwater hierarchy level requirements for disposal of the 10-year design storm, flow control, and pollution reduction.

Water Quality

The PAC displays a “Pass” for pollution reduction if all of the runoff generated from the water quality storm event (1.61 inches) filters through the facility’s blended soil.

Infiltration

The PAC displays a “Pass” for infiltration if the runoff generated from the 10-year storm event is able to infiltrate and does not discharge from the facility.

Flow Control

The PAC displays a “Pass” for flow control if the runoff generated from the applicable storm event(s) meets the requirements for the hierarchy level selected (these are displayed in Table 2-13 of the Performance Approach section).

Data Entry Fields

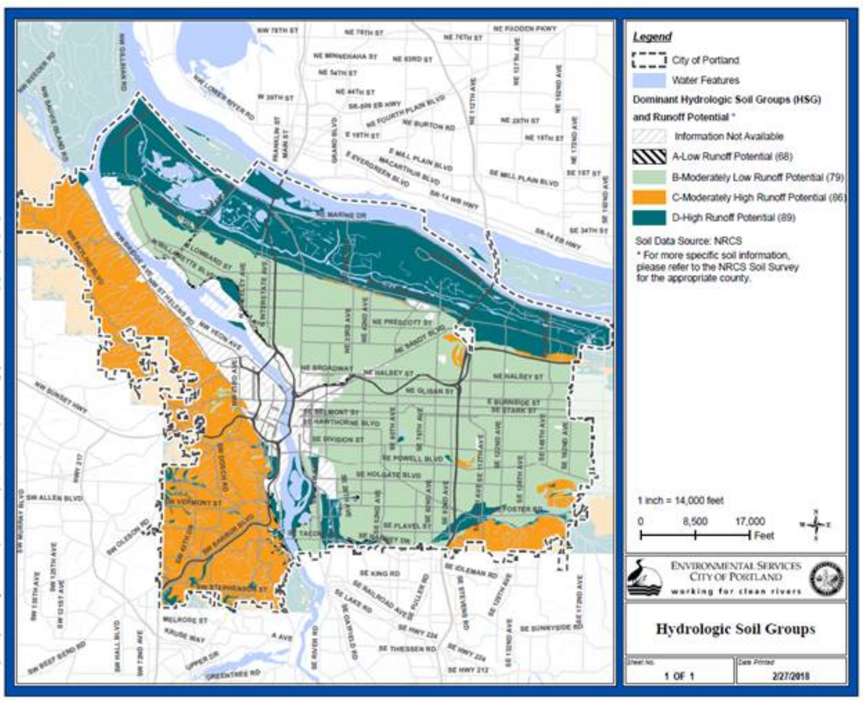
The user must input values for the site characteristics and the facility. These include the site’s time of concentration and curve number for both the pre-development and post-development condition, the measured infiltration rate, the infiltration test method, the impervious area, and the hierarchy level. See Appendix A.5 for a description of the different data entry fields to assist with user entry.

Curve Numbers

Use the pre-development curve numbers in Table 2-11 based on the site's soil type. These curve numbers are based on undeveloped, not existing, site conditions. Use post-development curve numbers of 98 for impervious surfaces and 61 for ecoroofs. The design professional may use a different curve number if adequate justification is provided. The [Sewer and Drainage Facilities Design Manual] provides post-development curve numbers for other surfaces.

Figure 2-7 shows soil types in the City and is for reference only; it is not for site design. For site design, enter an address into [Portland Maps] and check utilities →environment → stormwater management to find the soil type.

Figure 2-7. Soil Types in the City[1]



1 For reference only; not for site design

Table 2-11 Pre-Development Curve Numbers Based on Soil Type

Soil Type	Curve Number
A	65
B	72
C	79
D	81
Unidentified	81

Facility Category

The PAC can design flat planters and flat basins of any shape, and rectangular sloped facilities. In the PAC, the stormwater facilities are defined as follows:

- A **Flat Basin** has a flat bottom (<0.5% slope) with sloping sides comprised of blended soil planted with vegetation.
- A **Flat Planter** has a flat bottom (<0.5% slope) with vertical walls made of a durable material such as concrete.
- A **Sloped Facility** has a longitudinal slope of 0.5% or greater and can have sloped sides, vertical sides, or one sloped side and one vertical side.

When located within the public right-of-way, all of these facilities are also referred to as "green streets" in this manual and must meet the requirements of Chapter 4. For sloped facilities on parcels, the user must meet the design requirements in Chapter 3 for basins if it has only sloped sides, for planters if it has only vertical sides, and for both basins and planters if it has one sloped side and one vertical side.

Configurations

The PAC designs facilities with surface storage and blended soil. The design professional can select the following additional components to create the facility structure: a rock gallery, an underdrain, a liner, and three types of overflows. Configurations A and B can be designed as surface infiltration facilities or partial infiltration facilities. Configuration C is a partial infiltration facility. Configuration D is a lined facility. Configurations E and F are hybrid facilities.

Orifices

Orifices may be needed to meet flow control requirements. Under the Presumptive Approach, only Configuration C and D can be designed with an orifice on the underdrain, as the design is such that the orifice only receives filtered flow (i.e., flow that has been filtered through the blended soil). The smallest diameter orifice allowed in the PAC is 3/8 of an inch. Additional protection is not required.

Sizing

Facilities are sized by adjusting the facility parameters until the PAC shows that the facility passes all of the requirements for the hierarchy level. Sizing a facility typically involves increasing the surface storage of the facility (e.g., increasing the facility area or overflow height) or the subsurface storage (e.g., increasing the rock depth or rock area) until the facility is just large enough to meet the relevant requirements (i.e., the relevant combination of water quality, infiltration, and flow control requirements). For flow control, sizing may include adjusting an orifice diameter.

2.5.3 Performance Approach

The Performance Approach can be used to design any type of stormwater facility and allows the Oregon-licensed professional engineer flexibility to use an acceptable stormwater model of their choosing.

2.5.3.1 Designing for Water Quality Requirements

The water quality design storm depends upon whether the facility is rate-based, combination volume-rate based, or volume-based (See Appendix A.1 and Appendix A.2). Performance Approach stormwater facilities that must be designed to meet water quality requirements must use the applicable water quality design storm as shown in Table 2-12 (see Section 1.3) unless they are installed to comply with a non-SWMM regulatory requirement (see Section 1.2.4). Stormwater facilities installed to comply with a non-SWMM regulatory requirement (e.g., a 1200-Z National Pollutant Discharge Elimination System (NPDES) Permit) may have specific constituent removal requirements that are not addressed in this manual and may need to be specifically sized and designed to remove the targeted pollutants. Volume-based facilities (e.g., ponds) must also treat ½ the water quality design storm (i.e., ponds must treat both a 1.61-inch storm over 24-hours and a 0.805-inch storm over 24-hours). MSTTs may have additional requirements (see Section 3.2.5.1 and Section 4.2.3).

Table 2-12. Water Quality Storm[1,2]

Stormwater Facility Sizing Basis	Site's Time of Concentration (min)	Water Quality Storm	
		Rainfall Intensity (in/hr)	24-hr Storm Depth (in)
Combination Rate-Volume-Based Facilities and Volume-Based Facilities	N/A	N/A	1.61
Rate-Based Facilities	5	0.19	N/A
	10	0.16	
	20	0.13	

1 Stormwater facilities designed under the Performance Approach may be sized using continuous simulation in lieu of a design storm. If sizing using continuous simulation, a minimum of 20 years of Portland rainfall data must be used to demonstrate that the stormwater runoff generated from 90% of the average annual rainfall will be treated from the site's impervious area.

2 Facilities designed under the Performance Approach may be combination rate-volume-based, volume-based, or rate-based facilities. Facilities designed under the Presumptive Approach are combination rate-volume-based facilities.

2.5.3.2 Designing for Flow Control Requirements

Performance Approach stormwater facilities with an offsite discharge (i.e., Levels 2 and 3) must be sized and designed to meet flow control requirements as shown in Table 2-13. These requirements vary depending on the receiving system of the stormwater facility outfall and may require an orifice. Facilities with catchment areas too small to meet flow control requirements within the design parameters for the maximum ponding depth and minimum orifice size must instead be sized without an orifice to filter the post-development runoff from the 25-year design storm without overflow. Vegetated right-of-way facilities discharging to a storm-only system are not required to provide flow control for the 25-year design storm (the typical ponding depths of 9 inches or less make this design target infeasible for these facilities) but must meet flow control requirements for the other storm events. If over-detention is used, the sum of the post-development peak flows from the over-detained and un-detained areas must meet the flow control requirements.

Table 2-13. Flow Control Requirements[1]

Storm Recurrence Interval (years)	24-hr Rainfall Depth (inches)	Requirements by the Receiving System		
		Drainageway or Stream	Columbia Slough, Willamette River, or Columbia River[2]	Combined Sewer Pipe
2	2.4	Limit 1/2 the 2-year post-development peak flow to 1/2 the 2-year pre-development peak flow	Do not exceed pre-development peak flows	N/A
5	2.9	Do not exceed pre-development peak flows	Do not exceed pre-development peak flows	N/A
10	3.4	Do not exceed pre-development peak flows	Do not exceed pre-development peak flows	N/A
25	3.8	Do not exceed pre-development peak flows[3]	N/A	Limit the 25-year post-development peak flow to the 10-year pre-development peak flow

1 Facilities with catchment areas too small to meet these requirements within the design parameters must instead be sized to filter the post-development runoff from the 25-year design storm without overflow.
2 Projects may be exempt from flow control requirements if they discharge stormwater runoff to one of these waterbodies and the storm sewer system has available capacity.
3 This does not apply to vegetated surface facilities in the right-of-way with a ponding depth up to 9 inches.

2.5.3.3 Hydrologic Analysis Method

The Oregon-licensed professional engineer must use an appropriate hydrologic analysis method to meet the relevant infiltration, flow control, and pollution reduction requirements. Many hydrologic analysis methods are described in the City's Sewer and Drainage Facilities Design Manual (SDFDM). Unless BES preapproves an alternative method before the plans and calculations are submitted, one or more of the following hydrologic analysis methods must be used:

- For public culverts, outfalls, storm-only sewers, and other drainage facilities, use the acceptable methods identified in the City's SDFDM.
- For sumps in the public right-of-way, use the Rational Method with a rainfall intensity of 2.86 in/hr for a 5-minute time of concentration with a factor of safety of 2 applied.
- For other rate-based facilities (e.g., grassy swales, filter strips, MSTTs) use the Rational Method with the following rainfall intensities:
    - The 10-year design storm rainfall rate in the SDFDM (e.g., 2.86 in/hr for a 5-minute time of concentration) for infiltration facilities.
    - Rainfall intensities as shown in Table 2-12 for stormwater facilities designed for water quality treatment only.
- For all other designs, use either the Santa Barbara Urban Hydrograph (SBUH) Method, NRCS's TR-55, the Army Corps of Engineers' Hydrologic Modeling System (HEC-HMS) or HEC-1, or the Environmental Protection Agency's Storm Water Management Model (EPA-SWMM). If sizing using continuous simulation, a minimum of 20 years of Portland rainfall data must be used.

Santa Barbara Urban Hydrograph Method (SBUH)

If using the SBUH Method, see the pre-development curve numbers in Table 2-11 based on the site's soil type (see Figure 2-7 for reference only). Use post-development curve numbers of 98 for impervious surfaces and 61 for ecoroofs. The design professional may use a different curve number if adequate justification is provided. The Sewer and Drainage Facilities Design Manual provides post-development curve numbers for other surfaces.

If designing planters or basins using the SBUH Method, the Presumptive Approach Calculator (PAC) may be used (see Section 2.5.2). When using the Performance Approach to design stormwater facilities with the PAC, the designer can use parameters outside of the PAC recommended ranges with BES approval.

2.5.3.4 Drawdown Times

Combination volume-rate-based stormwater facilities and volume-based stormwater facilities need to be designed to drain enough between storm events to allow the subsequent storm to be properly managed. When full, the drawdown time to the reference point must not exceed 30 hours for the following facilities (with the reference point for measuring drawdown listed in parentheses after each facility):

- Surface vegetated facilities (the top of the growing media).
- Dry detention ponds (the bottom of the pond at the soil surface).
- Wet ponds and extended wet ponds (the top of the permanent pool).
- Soakage trenches and permeable pavement (the bottom of the aggregate, where it meets the native soil).
- Drywells (1 foot above the bottom of the drywell).
- Structured detention tanks (the top of the dead storage).

2.5.3.5 Flow Control and Orifices

Orifices may be required to meet flow control requirements. The following are the minimum diameters of orifices in stormwater facilities. In this context, filtered flow is flow that has traveled through a layer of blended soil or has been filtered to the water quality standards another way (e.g., in a MSTT); unfiltered flow has not.

- **Taking Any Unfiltered Flow**
  - 2 inches with protection for public facilities.
  - 1 inch with protection for private facilities. Smaller diameters are allowed at the discretion of the project designer.
- **Taking Only Filtered Flow**

  3/8 of an inch for both public and private facilities. Additional protection is not required.

2.5.3.6 Additional MSTT Requirements

BES maintains a list of approved manufactured stormwater treatment technologies (MSTTs) on the BES Stormwater Management Manual website. Subject to BES discretion, an MSTT not on the approved list may be authorized if site-specific pollutant reduction goals require an alternative design (e.g., to comply with a 1200-Z NPDES Permit from DEQ). MSTTs must be designed to treat the full contributing area, not just the applicable impervious surface and must be designed per any applicable conditions of use.

Chapter 3. Private Stormwater Facilities

This chapter provides requirements and guidance for designing private stormwater facilities to meet the requirements of Chapter 1.

3.1 Introduction

This chapter provides requirements and guidance for designing private facilities (i.e., parcel-based facilities and facilities serving private streets) to meet the requirements of Chapter 1. The chapter provides information about design and construction, operations and maintenance, and submittals. Design of these stormwater facilities will be reviewed by the Bureau of Environmental Services (BES) through the development review process.

3.2 Facility Design and Construction Requirements

This section groups facility-specific design and construction requirements into the following categories: ecoroofs and permeable pavement, bioretention facilities, dispersion facilities, subsurface infiltration facilities, and other facilities that do not fit into the first four categories. Refer to the preceding Table of Contents for a detailed list of the facilities included in these categories.

3.2.1 Ecoroofs and Permeable Pavement

This section provides design and construction requirements for ecoroofs and permeable pavement, both of which directly intercept the rainfall they manage.

3.2.1.1 Ecoroofs

Ecoroofs are lightweight green roof systems that intercept and absorb rainfall, slowing and filtering the stormwater as it passes through the growing medium. Standard ecoroofs include waterproofing material, a drainage system, growing medium, and vegetation. Shallow-rooted, drought-resistant species such as sedum usually dominate planting plans because of their minimal maintenance requirements. All ecoroofs provide some habitat for birds and insects, and alternative designs can be even more wildlife-friendly.

Ecoroofs Qualifying for the Infiltration Test Exemption
For a project proposing an ecoroof that meets the design standards of this manual and covers at least 60% of the roof, BES will not require an evaluation of infiltration feasibility unless the receiving system does not have sufficient capacity to accept the proposed flows or flows will cause adverse impacts. Ground-level impervious areas that are both adjacent to a building with a minimum ecoroof coverage of 60% and are incidental in size (e.g., small areas of the building's articulation at grade) are not expected to meet a stormwater hierarchy level that is different from that of the building. BES therefore does not require an evaluation of infiltration feasibility for those incidental areas either.

Building Code Requirements

The Bureau of Development Services (BDS) will review structural calculations evaluating the load-bearing capacity of the building for compliance with building code requirements. An Oregon-registered structural engineer must prepare the evaluation.

Planning and Zoning Requirements

A designer proposing an ecoroof to meet a provision of Portland City Code (PCC) Title 33 must meet all the requirements of this chapter, including operations and maintenance requirements. An ecoroof proposed to satisfy PCC Title 33 standards may not by itself be sufficient to meet all the requirements of this manual.

Ecoroof Requirement: PCC Title 33 may require an ecoroof for projects located in specific areas or zoning designations. BES will review the ecoroof for compliance with the standards outlined in this manual through the City's land use and/or building permit review process.

Bird-Friendly Design: Some projects in Portland's Central City must meet bird-safe glazing standards for windows adjacent to ecoroof areas (see PCC 33.510.223). BES recommends reducing or eliminating building features with the potential to increase bird-strike mortality for all projects. Portland's 2012 Resource Guide for Bird-friendly Building Design provides recommendations for glass and lighting near ecoroofs (e.g., adjacent to an ecoroof on a podium level).

Floor Area Ratio Bonus: In some areas PCC Title 33 may award bonus floor area to projects that include an ecoroof. Where called for in PCC Title 33, BES will issue a certification letter through the City's land use review process once the applicant provides materials confirming the ecoroof complies with the standards of this manual. To receive a BES letter of certification prior to issuance of a land use decision, the applicant should submit all the materials listed with the land use application (see Section 3.4.1).

Review of Rooftop Components That Aren't Part of the Ecoroof: Urban roofs are often designed for a wide variety of uses, including those needed for proper building function (e.g., fire, occupancy classifications, and tenant use). This manual does not regulate roof features associated with other uses, except to define whether those features can be included in the ecoroof area calculation. When an ecoroof is proposed to meet PCC Title 33 requirements, roof features not associated with the ecoroof may be subject to restrictions in that code, which is implemented by BDS.

Design

Ecoroofs can be designed under the Simplified and Performance Approaches.

Access: Provide safe access to the ecoroof and fixtures for maintenance and inspection activities. Access areas may be vegetated: many ecoroof plants can tolerate occasional foot traffic or will recolonize if plants are killed.

Pollution Prevention: Minimize use of copper, lead, galvanized metal, and other materials that can introduce pollutants to stormwater runoff.

Sizing

All ecoroofs meeting the 4" minimum depth requirement, including systems with >4" of growing medium, replace impervious surfaces at a 1:1 ratio.

Catchment Area and Inflow – Ecoroofs cannot receive stormwater runoff from other impervious surfaces except as reviewed and approved by BES under the Performance Approach.

Measuring Ecoroof Area – The calculated ecoroof area includes the following:

- All rooftop features that are integral components of the ecoroof system within its boundary, including gravel drainage paths and roof drains;
- Code-required firebreaks;
- De minimis features such as fall protection anchors and solar panels if vegetation extends under the panels;
- Unplanted areas intended solely for human access and contiguous with planted ecoroof areas (e.g., gravel ballast, pavers bordering mechanical units, or parapets), up to a maximum of 10% of the total ecoroof; and
- Other non-vegetated components may be allowed, subject to BES review.

Rooftop features that cannot be considered components of an ecoroof include the following: mechanical equipment and solar panels (unless vegetation is extended beneath elevated units), elevator overruns, stairwell enclosures, penthouses, and skylights. All rooftop features that cannot be considered non-vegetated components of the ecoroof must meet the provisions of this manual.

Roof gardens planted for food production will not be credited for stormwater management due to watering and fertilizer needs that could compromise the performance of the system.

Calculating Flow Control for Ecoroofs with Partial Coverage: Ecoroofs that cover a portion of the roof can be credited for flow control performance using the following methods. For catchments with a mix of ecoroof and conventional roof, use the Santa Barbara Urban Hydrograph method with a time of concentration of five minutes and a weighted curve number (CN) for the entire roof area, calculated as follows.

$$Roof\ CN = \frac{(Area\ of\ Conventional\ Roof\ \times 98) + (Area\ of\ Ecoroof\ \times 61)}{Area\ of\ Conventional\ Roof + Area\ of\ Ecoroof}$$

Use the weighted curve number to demonstrate that peak flows from the entire roof meet the flow control criteria for Hierarchy Level 2 or 3. Additional flow control may be needed to meet the requirements of the site. Non-ecoroof areas must be treated for water quality as required.

Slope: The maximum allowable roof slope is 25%, unless the applicant documents adequate runoff control and the project is reviewed and approved under the Performance Approach.

Drainage System and Overflow: The drainage layer may consist of geotextile fabric or gravel, or be the growing medium itself on steeper, fast-draining ecoroofs. Ecoroofs must have a roof drainage system with roof drains that connect to an approvable discharge location.

Waterproofing: Use waterproofing materials approved by the manufacturer.

Root Barrier (Optional): A root barrier may be required by the manufacturer of the roof membrane. Root barriers incorporating pesticides, herbicides, metals, or other chemicals that may leach into stormwater runoff are prohibited, unless the applicant can provide documentation showing that leaching will not occur for the life of the roof. Extend root barriers under gravel ballast, under the growing medium, and up the sides of vertical elements.

Header/Separation Board (Optional): A header or separation board may be placed between the gravel ballast and adjacent elements (e.g., soil, drains), although in many cases a header board is unnecessary. Pressure-treated lumber is prohibited.

Protection Boards and Materials (Optional): These protect the waterproof membrane from damage during construction and over the life of the facility. They are usually made of soft, fibrous materials and may not be needed, depending on the roof membrane.

Growing Media: A long-term depth of at least 4 inches of growing media is required for the vegetated portions of an ecoroof. Designers seeking stormwater credit for ecoroofs with less than 4 inches of growing media must provide BES with documentation demonstrating the design provides stormwater management benefits, per the Chapter 1 requirements, that meet or exceed the performance of a standard 4-inch ecoroof. BES will only credit roofs with 6 inches or more of growing media for stormwater management with the submittal of a custom O&M Plan that limits the application of irrigation water as described below in the irrigation section.

<u>Growing Media Composition:</u> The composition of the growing media affects the hydraulic performance of the roof and its ability to support vegetation. Ecoroof growing media vary in composition, but the material must be light-weight and it must adequately infiltrate, detain, and retain rainfall. Ecoroof growing media is typically comprised of 80% to 90% lightweight aggregate, by volume. In the Pacific Northwest, pumice and perlite are common aggregates. The remaining 10% to 20% is composed of stable organic matter such as mature yard-debris compost or aged fiber. Compost must be sourced from a member of the U.S. Composting Council Seal of Testing Approval program and be compliant with the council's standards. BES approves other media on a case-by-case basis. Media additives such as herbicides, pesticides, and fertilizer are prohibited.

Mulch: Use of mulch is recommended but not required as part of ecoroof designs. Cinder rock or an alternative mulch helps retain moisture and protects exposed soil from erosion. Mineral mulch has been shown to promote the growth of sedum in Portland.

Vegetation:

Vegetation must cover 90% of the vegetated portion of the ecoroof within 2 years. It must be the following:

- Low maintenance;

- Drought-tolerant, requiring little or no irrigation after establishment;
- Self-sustaining, without the need for fertilizers, pesticides, or herbicides;
- Able to withstand heat and cold;
- Perennial or self-sowing;
- Shallow-rooted to avoid damage to the membrane; and
- Comprised of species that are at least 50% evergreen.

Plant Lists – Suggested vegetation for ecoroofs is listed in the Portland Ecoroof Plant List (see Section 3.5). Designers can propose plants not included on the Portland Ecoroof Plant List provided they are suited to the specific conditions on the ecoroof and meet the requirements in this chapter. See the Portland Plant List for additional plants for consideration. BES prohibits plants on the Portland Nuisance Plant List and the Required Eradication List (see Portland Plant List).

Irrigation – Irrigation is needed during the establishment period for the health of the plants. Water-efficient irrigation systems such as rotating nozzle spray systems are recommended. Drip irrigation systems are not recommended given evidence they become ineffective over time.

Irrigation must not exceed the following depths per 4 inches of media, regardless of the water source:

- During the establishment period (up to 3 years): ½ inch of water per week
- After the establishment period: ¼ inch of water every 10 days

Irrigation is prohibited November through April. For depths greater than 4 inches, additional irrigation is allowed at rates of 1/8 inch of water per 1 inch of media per week during establishment and 1/16 inch of water every 10 days after establishment.

Pesticides, Herbicides, and Fertilizer – Pesticides and herbicides are prohibited because of the potential for chemical damage to ecoroof elements and leaching of pollutants to runoff. BES strongly discourages fertilizer use because of concerns about the water quality of runoff. Sedum do not require fertilizer. Never apply fertilizer before testing the fertility of the growing medium. If using fertilizer, use only organic, slow-release fertilizers listed by the Organic Materials Review Institute (OMRI) Products List. Product use must be in accordance with the restrictions described in the OMRI products list.

Habitat Design (Optional): BES encourages designs benefitting urban wildlife. Variations in soil type, soil depth, and vegetation create microclimates, increasing the number of species that use the ecoroof. Small areas of sand, gravel, or native topsoil can benefit birds and ground-nesting pollinators, and a mix of plant types, plant sizes, flower shapes, and bloom times help attract birds and insects. Native pollinators are attracted to drought-tolerant native species and some non-native species. Small areas of woody material and rock create microhabitats. Woody material and rock must be secured to the roof or placed in locations where there is no risk of movement. A summer water container such as a basin can be included to collect condensate from rooftop units. See detail SW-101 at the end of this section for an example of a wildlife-friendly ecoroof.

Submittal Requirements

See Section 3.4 for general submittal requirements and facility-specific submittal requirements that apply for ecoroofs.

Construction Requirements

Follow the manufacturer's requirements for construction. Minimize compaction of the growing media by limiting foot traffic to designated pathways. Install media as needed to allow for settlement during planting and the first watering or rain events. It is common for media suppliers and designers to call for the installed media depth to exceed the desired long-term depth by 15% (e.g., an installed depth of 4.5 inches is needed for compliance with the 4-inch minimum standard). The finished (i.e., settled) depth should be checked in multiple locations across the roof. Add media wherever the finished depth is less than required by the plans. BES inspectors will measure the depth of the media at 3 or more locations, confirming the average depth is within ¼-inch of the design depth.

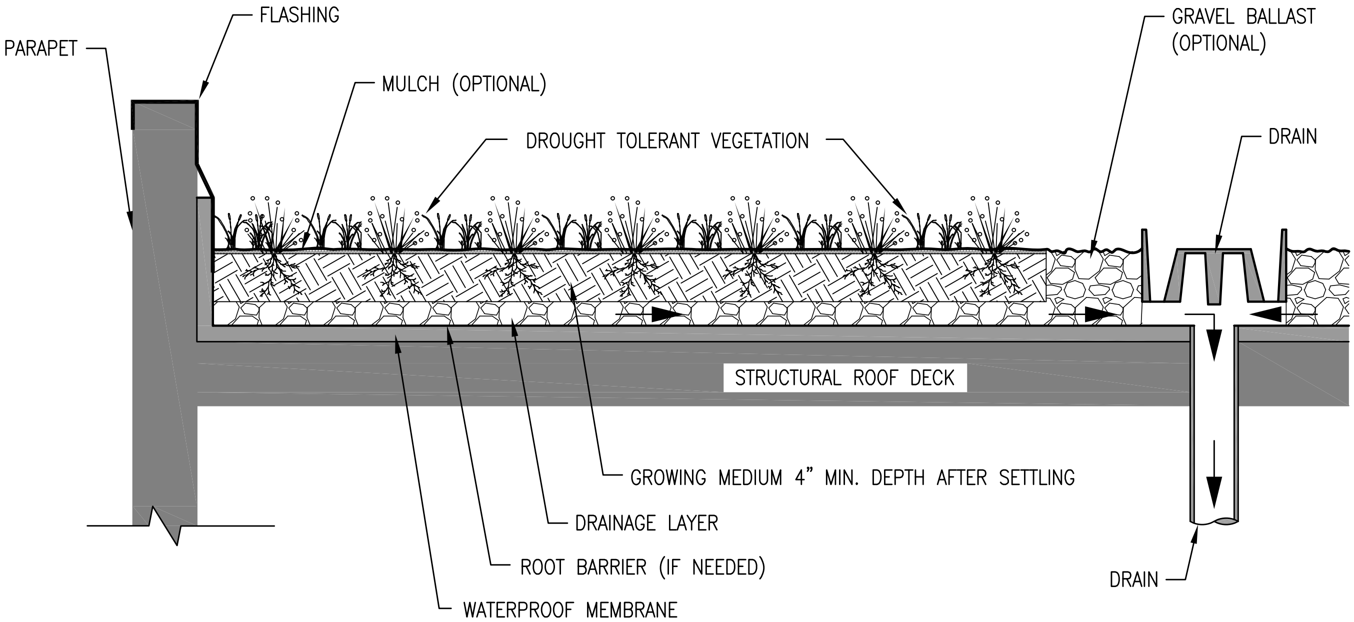
BES recommends ecoroof construction contracts that include a two or three-year warranty period (i.e., establishment period) for the plants.

Typical Details

The table below lists the detail drawings that follow.

Detail Sheet	Name	Simplified Approach	Performance Approach
SW-100	Ecoroof	X	X
SW-101	Habitat Ecoroof	X	X

ECOROOF WITH DRAINAGE LAYER



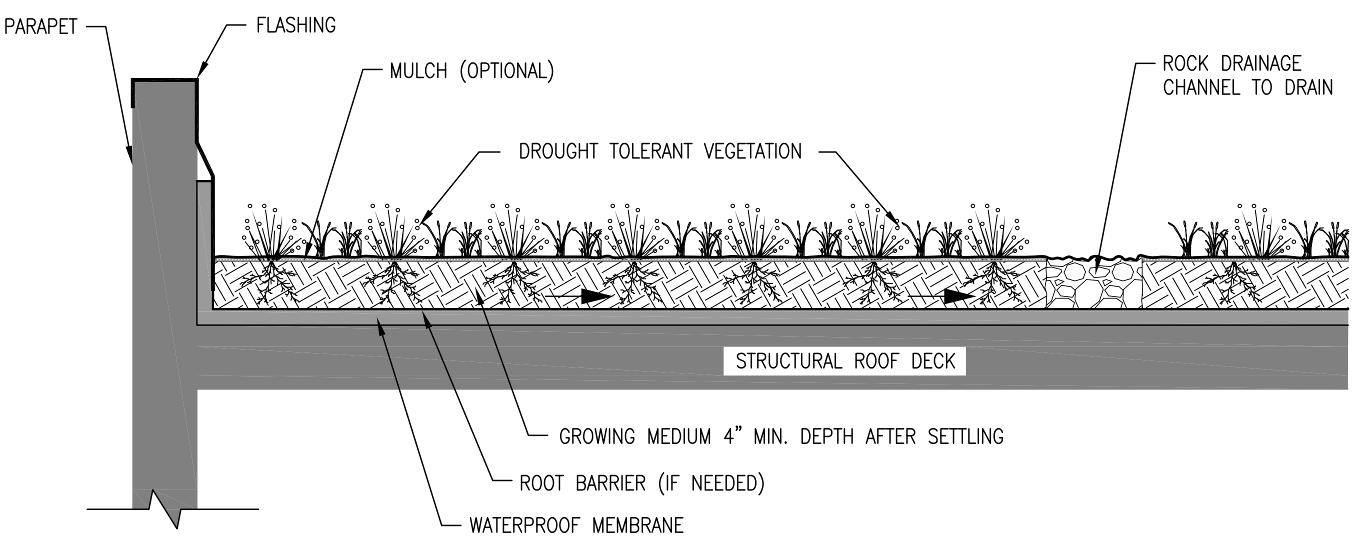
NOTE: Building elements such as glass and lighting placed near ecoroofs have the potential to exacerbate bird-srike mortality. Glass treatments may be required. See City code 33.510.223 and the Resource Guide for Bird-Friendly Building Design: http://www.portlandoregon.gov/bps/article/446308

1. Inspections: Call BDS IVR inspection line, (503) 823-7000. Request 487.3 inspections required.

CONSTRUCTION REQUIREMENTS

Follow the manufacturer's requirements for installation of the membrane. Install enough medium to achieve the design depth, allowing for initial settling. Minimize compaction of the growing media after placement - limit foot traffic to pathways designated for that use.

ECOROOF WITH DRAINAGE CHANNELS



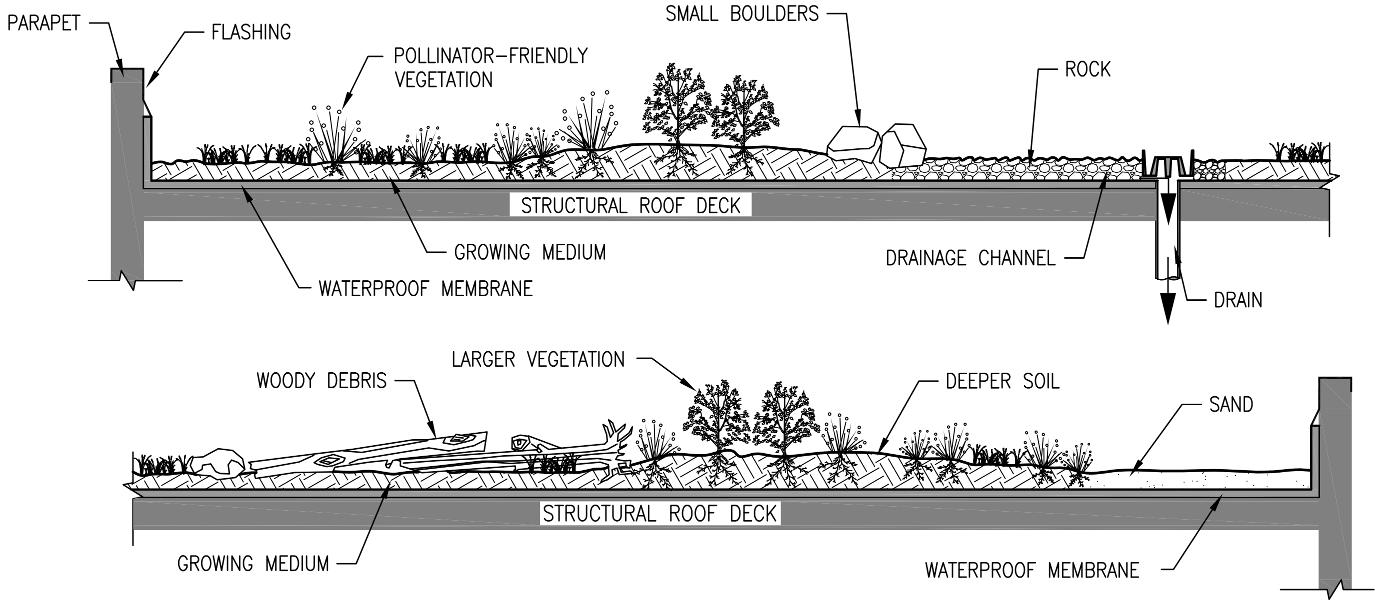
- DRAWINGS NOT TO SCALE -

Bureau of Environmental Services	STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY	ECOROOF	SW-100

9-2-20

– DRAWINGS NOT TO SCALE –

HABITAT ECOROOF EXAMPLE SECTIONS



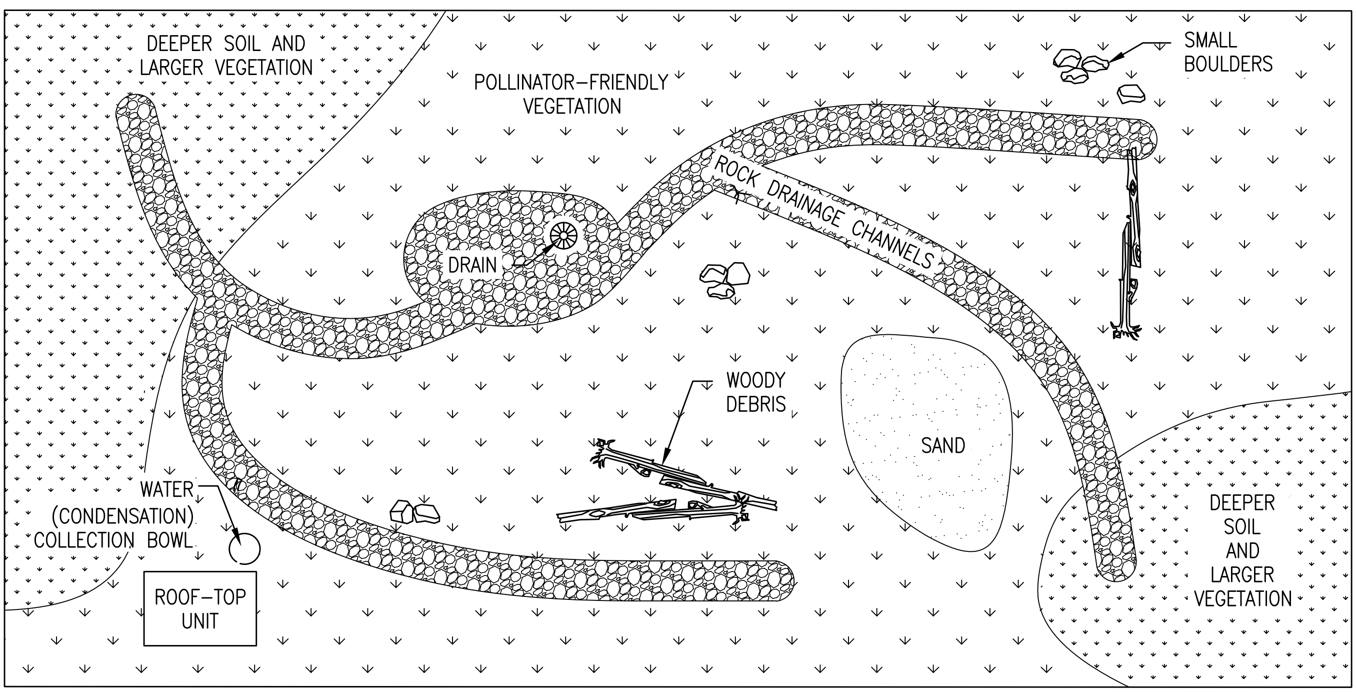
NOTE: Building elements such as glass and lighting placed near ecoroofs have the potential to increase bird–srike mortality. Glass treatments may be required. See City code 33.510.223 and the Resource Guide for Bird–Friendly Building Design: http://www.portlandoregon.gov/bps/article/446308

1. Inspections: Call BDS IVR inspection line, (503) 823–7000. Request 487.3 inspections required.

CONSTRUCTION REQUIREMENTS

Follow the manufacturer's requirements for installation of the membrane. Install enough medium to achieve the design depth, allowing for initial settling. Minimize compaction of the growing media after placement - limit foot traffic to pathways designated for that use.

HABITAT ECOROOF WITH DRAINAGE CHANNELS – EXAMPLE PLAN



3.2.1.2 Permeable Pavement

Permeable pavement is a general term for a group of permeable, load-bearing paved surfaces that intercept and manage rainfall. Permeable pavement has a base system designed to manage stormwater while providing structure for the permeable pavement and design loads.

Examples of permeable pavement include porous asphalt, pervious concrete, and permeable pavers. Porous asphalt and pervious concrete are similar to conventional asphalt and concrete in structure and form, but the aggregate fines content is lower in the permeable versions and the total void space is substantially higher. Porous asphalt and pervious concrete are poured in place, while permeable pavers are individually set in place. Paver systems are permeable either due to the porosity of the pavers themselves, or gaps between the pavers that allow passage of water.

Design

Permeable pavement can be designed under the Simplified or Performance Approaches. For permeable pavement designed under the Simplified Approach, soils must have a tested infiltration rate of at least 2 in/hr. The Performance Approach can be used to design permeable pavement over soils with any infiltration rate.

Site Suitability: A minimum distance of 5 ft from the excavated bottom of the system to seasonally high groundwater is required. Do not locate permeable pavement over cisterns, utility vaults, or underground parking.

Setbacks: BES does not require setbacks, but the designer may opt to install a partial liner when permeable pavement is located within 5 ft of structures or infrastructure.

The liner can extend up to 5 ft under the pavement course from the edge of the permeable surface, or up to 15% of the width of the surface, whichever is smaller.

Catchment Area and Inflow: The pavement cannot receive stormwater runoff from adjacent impervious surfaces.

Sizing: Permeable pavement replaces impervious surfaces at a 1:1 ratio.

Slope:

The subgrade adjacent to structures should slope away from the structures.

Simplified Approach – Under the Simplified Approach, a maximum slope of 5% is allowed.

Performance Approach—Under the Performance Approach, a maximum slope of 10% is allowed. For slopes exceeding 5%, the design must be engineered to slow the movement of water and promote infiltration. Install impermeable check dams at regular intervals in the storage layer to create infiltration cells, placing overflow points at the locations with maximum ponding.

Drainage and Overflow:

Simplified Approach–An underdrain is not required under the Simplified Approach.

Performance Approach –

- For a design infiltration rate of at least 2 in/hr: the system must store the 10-yr storm event without saturating the pavement wearing-course and infiltrate the storm in less than 30 hours.
- For a design infiltration rate of less than 2 in/hr: the aggregate layer must have an underdrain discharging to a facility sized to manage runoff from the permeable pavement or discharging to another approved discharge point, unless there is enough storage to infiltrate the 10-yr storm event with a drawdown time of less than 30 hours.

Edge Restraints for Pavers: For private streets and commercial projects, edge restraints must be permanent (e.g., cast-in-place or precast concrete curbs) and a minimum of 6 inches wide and 12 inches deep. Edge restraints for residential projects such as driveways may be plastic and set with spikes.

Geotextile Fabric: The designer may opt to separate the layer of aggregate from the native subgrade beneath it with a geotextile fabric. Follow the specifications provided by a geotechnical professional or the manufacturer. Note that some designers advise against the use of geotextile fabric in this application.

Aggregate Base:

Simplified Approach – For the Simplified Approach, use a minimum of 6 inches of washed, crushed 2- to ¾-inch or No. 57 rock. See Table 3-1 below for top-lift requirements under the Simplified Approach.

Table 3-1. Top-lift Requirements (Simplified Approach)

Type of Material	Depth (in)	Minimum Air Voids (%)	Compaction Required?
Pervious Concrete	4	15	No
Porous Asphalt	2.5	15	No
Permeable Pavers	Varies	N/A	No

Performance Approach – For the Performance Approach, the aggregate material and depth must be engineered to meet the requirements of the design.

Piping: Oregon Plumbing Specialty Code (OPSC) requirements apply for pipe materials, sizing, grading and load-bearing strength.

Submittal Requirements

See Section 3.4 for general submittal requirements and facility-specific submittal requirements that apply for permeable pavement.

Construction Requirements

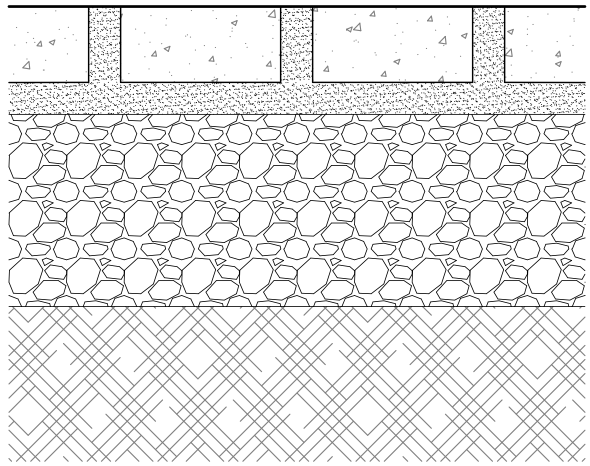
Protect the subgrade from over-compaction during excavation. Do not grade or compact the native subgrade in wet conditions.

Details

The table below lists the detail drawings that follow.

Detail Sheet	Name	Simplified Approach	Performance Approach
SW-110	Permeable Pavement	X	
SW-210	Permeable Pavement		X

SIM approach is applicable only for residential driveways and pedestrian-only areas.



PERMEABLE CONCRETE PAVER SYSTEMS

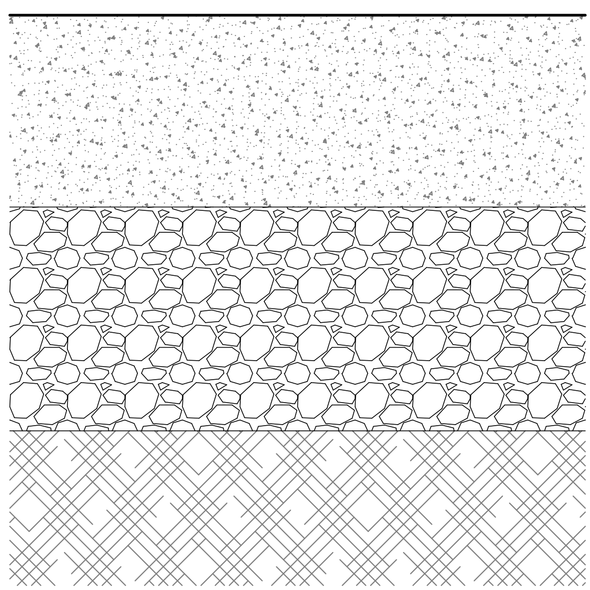
	RESIDENTIAL DRIVEWAY OR PEDESTRIAN ONLY
CONCRETE	4"
ASPHALT	2 ½"
PAVERS	Varies
COMPACTION REQ'D	NO

REQUIRED TOP LIFT DEPTH

CONSTRUCTION REQUIREMENTS

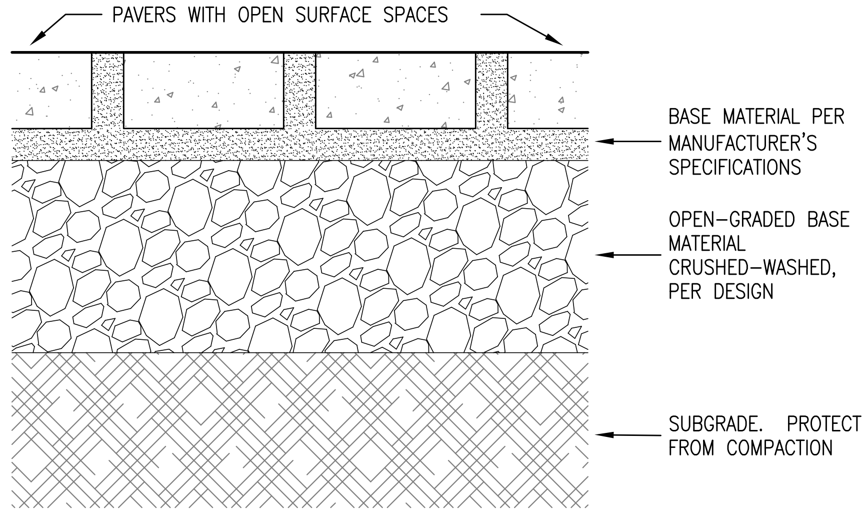
Protect subgrade from over-compaction during construction; do not construct or compact the subgrade in wet conditions. Sequence the work to avoid traffic on the subgrade and protect the finished pavement from construction traffic and sediment accumulation. A permeable pavement protection plan may be required.

1. Inspections: Call BDS IVR inspection line, (503) 823–7000. Request 487.3 inspections required.



PERVIOUS CONCRETE AND POROUS ASPHALT SYSTEMS

– DRAWINGS NOT TO SCALE –

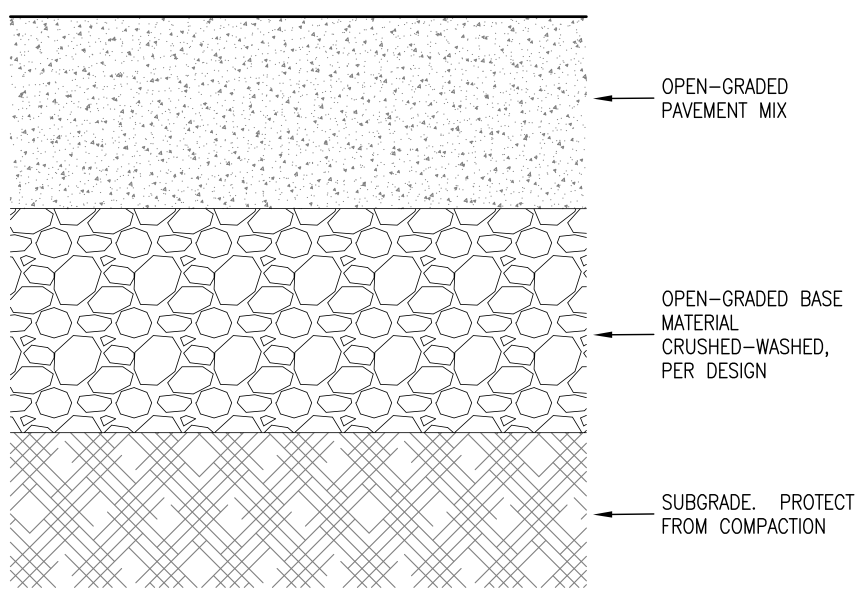


PERMEABLE CONCRETE PAVER SYSTEMS

1. Detail intended as an example. Detail must match design report.
2. For all applications, pavement designs must be prepared by a registered professional engineer.
3. Inspections: Call BDS IVR inspection line, (503) 823–7000. Request 487.3 inspections required.

CONSTRUCTION REQUIREMENTS

Protect subgrade from over-compaction during construction; do not construct or compact the subgrade in wet conditions. Sequence the work to avoid traffic on the subgrade and protect the finished pavement from construction traffic and sediment accumulation. A permeable pavement protection plan may be required.



PERVIOUS CONCRETE AND POROUS ASPHALT SYSTEMS

– DRAWING NOT TO SCALE –

3.2.2 Bioretention Facilities

This section provides design and construction requirements for bioretention facilities including rain gardens, basins, and planters.

3.2.2.1 General Design Requirements

This section provides general design requirements for bioretention facilities. Facility-specific design requirements begin with Section 3.2.13.

Overall Site Design: Integrate bioretention facilities into the overall site design.

Access Requirements: The design must provide safe access for maintenance of the facility and access to adjacent buildings or infrastructure. Paths, gates, and covers must be safely accessible. Access routes must be wide enough to allow vehicle passage where maintenance requires vehicles.

Pollution Prevention Requirements: Do not use chemically-treated products with the potential for leaching pollutants (e.g., railroad ties, treated lumber, recycled crushed asphalt, and galvanized metals). Minimize the need for toxic or potentially polluting materials such as herbicides, pesticides, fertilizers, or petroleum-based fuels. These materials create the risk of spills, misuse, and draining or leaching of pollutants into facilities and surrounding areas.

Dimension Measurements:

- The ponding depth is the vertical distance between the top of the soil and the elevation of the overflow point.
- The freeboard is the vertical distance between the overflow elevation and the top of the facility (top of wall for planters).
- The basin area is measured at the elevation of the overflow.
- The planter area is measured between the inside of the planter walls.

Facility Configurations:

Simplified Approach facilities must be designed using the standard configurations described in this chapter and shown in the facility-specific typical details.

Presumptive Approach facilities must be designed to meet the Presumptive Approach Calculator (PAC) criteria. The PAC can be used to design six types of configurations for basins and planters, with selectable components including a rock gallery, an underdrain, a liner, and overflow to rock storage. See Appendix A-5 for more information.

Performance Approach facilities can incorporate PAC configurations and use the PAC within or outside of Presumptive Approach ranges, although a design infiltration rate of 6 in/hr is required for the blended soil. Designers can also use other configurations or sizing methods per Chapter 2.

Walls, Liners, and Waterproofing: For planters, BES requires a monolithic single-pour concrete shell, including the bottom and sides, with no joints in the shell. BES approves alternatives on a case-by-case basis. Designers may opt to add a secondary liner to the concrete shell (e.g., liquid-applied, spray-on, or geomembrane liner). Geomembrane liners should be 30-mil EDPM, HDPE, or equivalent. Partial liners such as curtain liners may be needed in some cases. Check state structural requirements for foundations when designing facilities with walls adjacent to foundations.

Piping: Oregon Plumbing Specialty Code (OPSC) requirements apply for pipe materials, sizing, and grading.

Underdrain System:

Simplified Approach facilities require a perforated PCV underdrain pipe that extends the full length of the facility. Encase the underdrain in a four-inch layer of ¾- to 1½-inch washed drain rock. Install 2-3 inches of ¼”-No.10 washed angular aggregate as the filter layer between the blended soil and drain rock. The layers of drain rock and filter aggregate must extend the full length and width of the facility. See detail SW-190 in Typical Details at the end of this section.

Presumptive Approach facilities require an underdrain system per the sizing criteria and options of the PAC. The pipe for the underdrain must be Schedule 40 PVC slotted well-casing pipe with 0.050-inch slots, 6 per row, at ¼-inch spacing. Surround the underdrain pipe with ¼”-No.10 washed angular aggregate. Place the pipe in the layer of aggregate, with a minimum cover depth of 4 inches and a bedding depth of 4 inches. See details SW-242 and SW-243 in Typical Details at the end of this section.

Performance Approach facilities allow designers to use the underdrain configuration and materials described for the Presumptive Approach, but designers can also use other configurations and materials with BES approval. Examples of alternative materials include cellular systems, drainage mats and boards, and non-standard aggregates. Filter fabric (geotextile) can be used as the filter layer, but it is not recommended as there are concerns about clogging in this application.

Pipe Overflow Configuration: Details for pipe overflows are contained in detail SW-190 for Simplified Approach facilities and in detail SW-242 for Presumptive and Performance Approaches. See Typical Details at the end of this section.

Flow Control Orifices: Orifices are simple fixtures used to restrict flow and control the rate of discharge from stormwater facilities. Orifices are typically a circular opening of a prescribed diameter. The flow rate depends on the height of the water above the opening, the size of the orifice, and shape of the orifice edge.

Simplified Approach – Orifices are not included in facilities designed under the Simplified Approach.

Presumptive/Performance Approaches – Orifices are required for some projects under the Presumptive and Performance Approaches to meet flow control requirements. The PAC provides orifice sizes. Equations for orifice control and weir calculations can be found in Chapter 8 of the BES Sewer and Drainage Facilities Design Manual. See Chapter 1 for design standards and general sizing requirements that apply to projects using orifices.

Minimum Diameter and Clogging Protection – The minimum diameter for orifices is based on the potential for clogging. Filtered flow (e.g., flow that has been filtered through blended soil, filter sand, or an MSTT) is less likely to clog orifices and therefore orifices taking only filtered flow can be smaller. Unfiltered flow (e.g., flow from overflow pipes, ponds, or hybrid facility underdrains) is more likely to contain material that can clog orifices and therefore orifices taking any unfiltered flow must be larger. The following requirements apply to orifices:

- Minimum size for orifices taking only filtered flow: 3/8-inch diameter. Additional protection against clogging is not required.
- Minimum size for orifices taking some unfiltered flow: 1-inch diameter, with protection against clogging such as stainless-steel screening around the orifice (e.g., hardware cloth) with a mesh of ¾-inch or less.

Materials: Use a strong, thin material such as stainless steel, HDPE, or PVC for the orifice plate with an orifice that is less than 3 inches in diameter. The thickness of the orifice plate must be less than the diameter of the orifice. Secure the plate to the structure.

Configuration/Details and Access: Examples of potential configurations for orifices are contained in detail SW-244 in the Typical Details at the end of this section.

House orifice structures in a catch basin, maintenance hole, or vault that is easily accessible for maintenance in case the orifice clogs. The designer is responsible for selecting a suitable orifice configuration for the engineering requirements of the project and to ensure maintainability.

Orifices managing some unfiltered flow may be constructed on a traditional “tee” riser section or as part of a baffle system.

Check Dams: Check dams are required in some designs to slow runoff, prevent erosion, and promote infiltration. Construct check dams of durable, nontoxic materials such as rock, brick, concrete, rot-resistant wood, or wood composite. See details SW-152 and SW-245 in Typical Details at the end of this section.

Blended Soil: The imported soil blend plays many roles: it filters runoff, helps detain and retain runoff, and provides a substrate for plant roots and microbes that are important for processing pollutants and maintaining infiltration. Use one of the blends that meets BES' Blended Soil Specification for Stormwater Management Facilities and is listed on BES’ Soil Vendor List, unless otherwise approved by BES staff.

Blended Soil Volume Estimates – The blended soil settles during transport and placement: designers must plan accordingly when estimating the soil volume needed to meet the minimum depth requirements in this manual.

Blended Soil Depth – The depth must meet the following requirements:

- Stormwater facilities with underdrains or subsurface storage (e.g., rock galleries) require a minimum of 24 inches of blended soil. For facilities with partial subsurface storage (i.e., Presumptive or Performance Approach facilities where the subsurface storage does not extend over the entire bottom of the facility), this depth is calculated as the depth of blended soil over the area without subsurface storage. The layer of blended soil over the top of the subsurface storage must be at least 12 inches deep.
- For infiltration facilities without underdrains or subsurface storage (i.e., where the blended soil sits directly on top of native soil) the maximum depth of blended soil is 12 inches to allow plant roots to penetrate the native soil.
- Where BDS landscape screening requirements apply, the layer of blended soil over the top of any subsurface storage must be at least 24 inches deep to support larger plants.

Mulch: Areas above the high-water line may be covered with 2 inches of woody mulch to improve soil moisture retention, prevent weeds, and control erosion. Use medium hemlock mulch or an equivalent material. Manure-based compost is prohibited. Mulch should be weed-free and applied 2 to 3 inches thick to fully cover the soil between plants. Do not over-apply mulch. If mulch is applied below the water line, use mulches that aren't likely to float and clog outlets. Examples include rock mulch or a high-density organic mulch such as aged (dark) medium hemlock or coarse yard-debris compost.

Flow Dissipators: For facilities over 20 ft in length with underdrains or liners, designers are encouraged to install flow dissipators to spread flow throughout the facility and to help limit short-circuiting along the walls. Short-circuiting occurs when the blended soil dries and shrinks away from the walls. See detail SW-161 in Typical Details at the end of this section for an example.

Erosion Control at Stormwater Entrances: Install a layer of river rock or flagstones at stormwater entrances to dissipate the energy of incoming runoff in cases where inflow is concentrated. Plastic splash blocks are not allowed.

Vegetation:

Plant Selection – The planting design must meet the following criteria:

- Be appropriate for site-specific conditions (e.g., soil, hydrology);
- Minimize the need for herbicides, fertilizers, and pesticides during construction and the life of the facility;
- Minimize the need for mowing, pruning, and irrigation;
- Include appropriate species from the Private Facilities Plant List Section 3.5 or the latest edition of the Portland Plant List;
- Not include plant species on the Nuisance Plants List or the Required Eradication List, which are contained in the Portland Plant List; and
- For facilities with liners, do not include plants that can damage liners due to root size or structure.

Consider adding a tree and reducing the number of herbaceous plants and shrubs in unlined bioretention facilities over 200 ft^2. Refer to Title 11.50.050 for guidance on selecting an appropriately-sized tree for the space.

Vegetation Zones and Densities – Plant the entire surface area of the facility with vegetation. The facility surface area includes the bottom and all non-vertical side slopes, as determined in the sizing calculations. Plant at equal triangular spacing on-center (O.C.) to avoid creating channels in the facility. See Figure 3-1.

For planting, the stormwater facility is divided into two zones: Zone A is the wetted bottom of the facility and Zone B is the upland area. The line between the two is the elevation of either the inlet elevation of the outlet or the top of the check dam, whichever is lower. Planting requirements vary depending upon the zone. Planters have a single planting zone (Zone A). See Table 3-2 and Table 3-3 below for zone vegetation requirements.

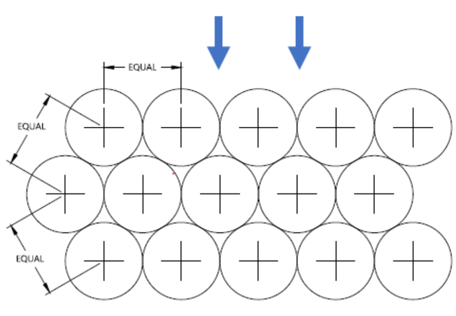
Table 3-2. Zone A Vegetation (Inundated Area), Plants Per 100 Ft²

Total Plants	Number of Plants	Vegetation Type	Plant Size	Spacing Density (Ft on Center)
80	80	Herbaceous	#1 container	1.25
		OR		
76	72	Herbaceous	#1 container	1.25
	4	Small Shrubs	#1 container	1

Table 3-3. Zone B Vegetation (Upland Area), Plants Per 100 Ft²

Total Plants	Number of Plants	Vegetation Type	Plant Size	Spacing Density (Ft on Center)
77	7	Large/Small Shrubs	#2 container	2
	70	Groundcover	#1 container	1

Figure 3-1. Triangular Plant Spacing



Landscape screening requirements from BDS may apply to stormwater systems adjacent to property lines or structures (City Code Chapter 33.248). The applicant must coordinate with BDS and BES to meet their requirements.

Irrigation Systems*:* Permanent irrigation systems are allowed, but designers are encouraged to minimize the need for permanent irrigation by selecting plants suited to the specific site conditions. BES also encourages innovative irrigation systems, including systems using cisterns for storage of roof runoff.

3.2.2.2 General Construction Requirements

This section provides general construction requirements for bioretention facilities.

Grading: Grading may be required to ensure positive drainage away from foundations and property lines.

Management of Existing Vegetation:

- Clearly mark and protect vegetation that is to be preserved in-place.
- Salvage and store native plants for replanting after construction.
- Use appropriate equipment for the removal of vegetation.

Protection of Native and Imported Soils:

- Mark the location of future stormwater facilities before site work begins.
- Fence or cover facility locations.
- For infiltration facilities, do not allow vehicular traffic, foot traffic, or heavy equipment within 10 ft of the area after site clearing and grading have been completed, except as needed to construct the facility.
- Do not allow temporary storage of construction waste or materials in facility excavations or in the finished facilities.
- Do not allow entry of runoff or sediment during construction.
- Follow all tree protection requirements in PCC Title 11.

Preparation of Native Soil in Infiltration Facilities with Imported Soil:

- Scarify or rip the native subsoil before installing blended soil.
- Install the blended soil within 1 day of preparing the native subsoil.
- Do not allow disturbance in a tree root zone per the tree plan developed in compliance with PCC Title 11.

Placement of the Blended Soil:

- Do not place the blended soil in wet weather.
- Do not install blended soil that is saturated.
- Place the blended soil in loose lifts of up to 8 inches, boot-compacting each lift or compacting with a water-filled roller prior to placing the next lift.
- Prior to calling for inspection, verify the required minimum soil depth is met.

Preparation of Native Soil in Rain Garden Facilities:

- Clear the soil surface of plant material and debris.
- Place 2-3 inches of yard-debris compost on the surface of the native soil.
- Rip or till the soil, amending the soil to a depth of 12 inches below grade.

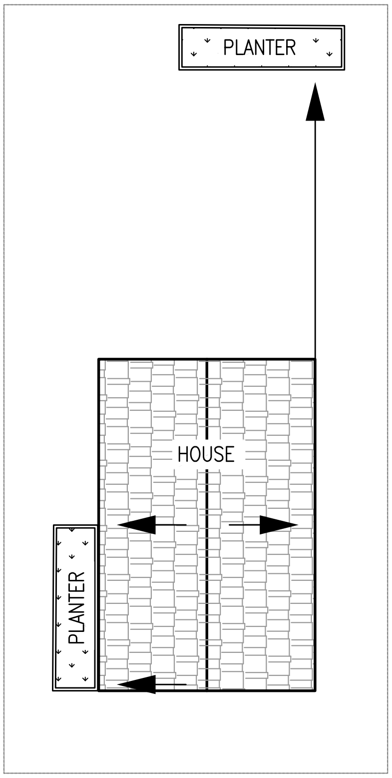
Planting: Planting should occur during the dormant season, depending on when stormwater will be routed to the facility. For best results, plant between February 1 and May 1 or between October 1 and December 1. Plants must be healthy and vigorous.

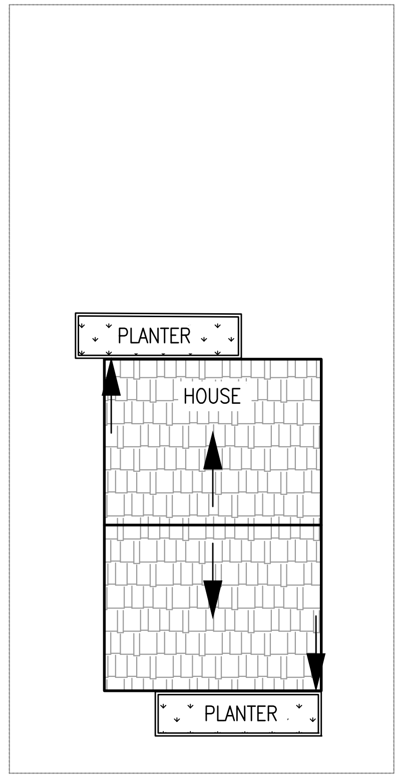
Erosion Control:

- The contractor is responsible for protecting the facility from erosion before the facility is put into service.
- Follow the erosion control measures described in the City's Erosion and Sediment Control Manual.
- Create and follow an erosion and sediment control plan. Indicate the locations of stormwater facilities, protected vegetation, fencing, stockpiles, and erosion control measures.

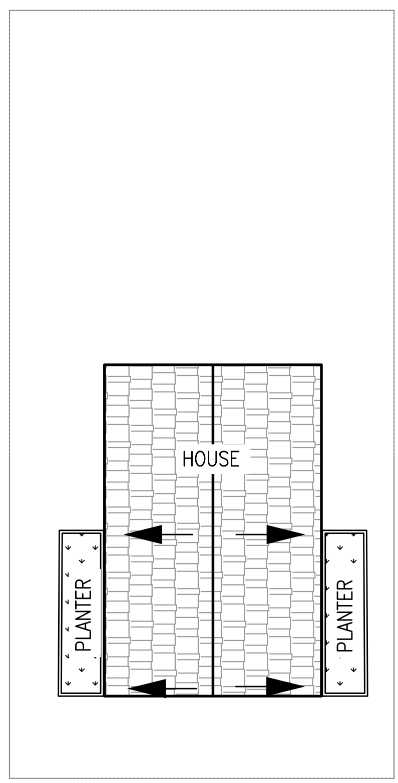
Typical Details:
The table below lists the detail drawings that follow.

Detail Sheet	Name	Simplified Approach	Presumptive or Performance Approach
SW-144	Site Configurations	X	
SW-152	Basin Check Dam	X	
SW-161	Flow Dissipator	X	
SW-190	Underdrain & Overflow	X	
SW-243	Underdrain Configuration		X
SW-244	Orifice Configurations		X
SW-245	Planter Check Dam		X
SW-242	Hierarchy X-Sections		X
SW-291	Overflow Configuration E		X
SW-292	Overflow Configuration F		X





1. Drainage areas and corresponding facilities can be divided to accommodate site and building configurations. Configurations are shown as examples.
2. Design professional is responsible for verifying that grades will allow piped conveyance to facility.



– DRAWINGS NOT TO SCALE –

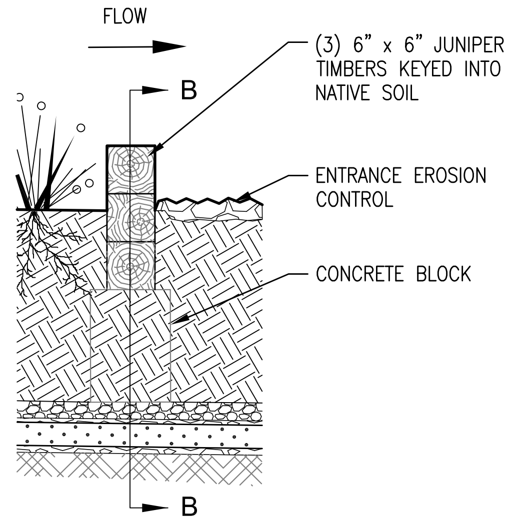
Bureau of Environmental Services

STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

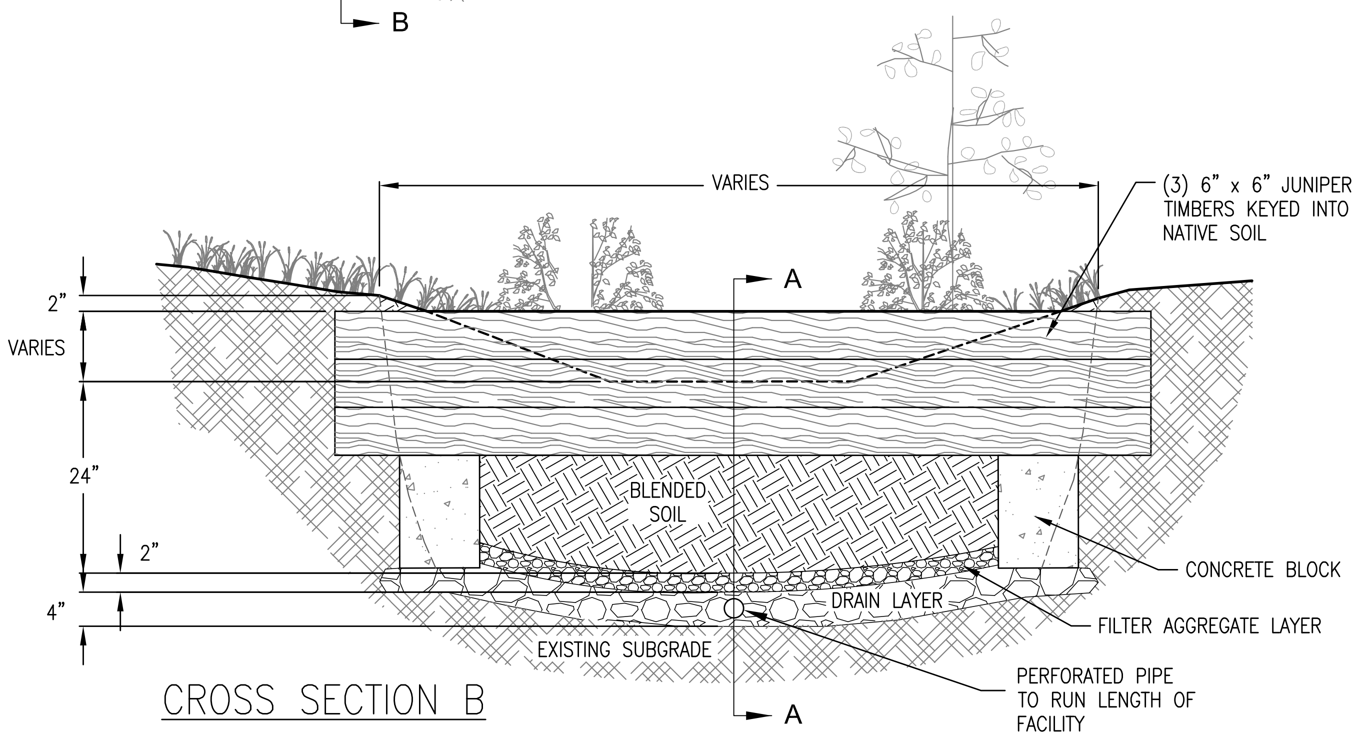
LINED PLANTER AND SAND FILTER SITE CONFIGURATIONS

SW–144

9–2–20



CROSS SECTION A



CROSS SECTION B

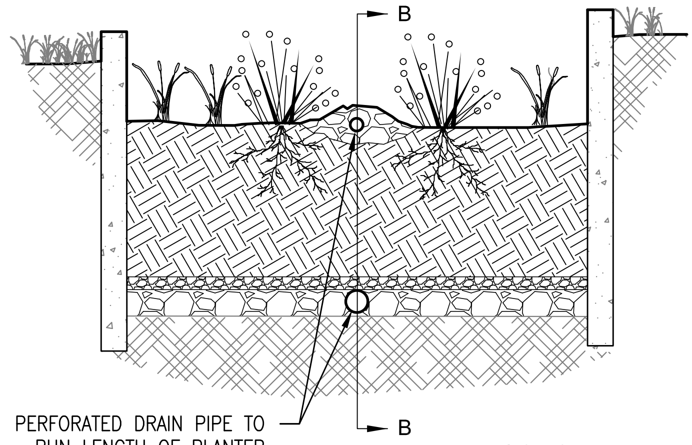
1. Check Dam Overflow: Overflow elevation must meet required ponding depth and allow for 2" of freeboard, minimum.

2. Spacing: Place check dams every 10' where slope exceeds 4%. Ends to be keyed into native soil a minimum of 12".

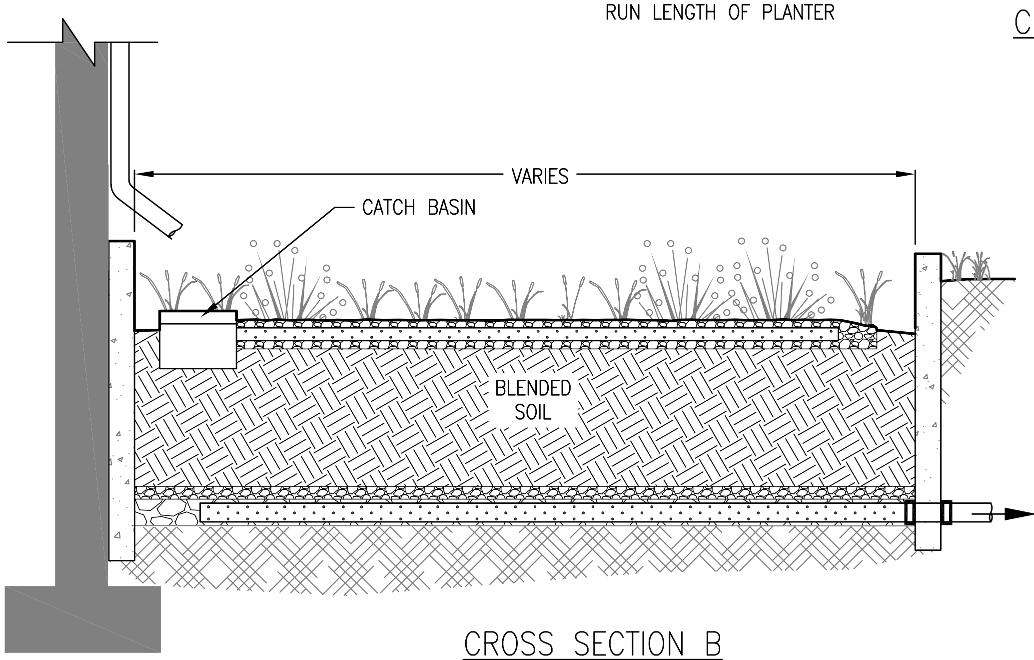
3. Materials: Check dams can be constructed of other rot resistant materials such as cedar and concrete. Treated lumber is not acceptable.

– DRAWINGS NOT TO SCALE –

Bureau of Environmental Services	STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY	**BASIN CHECK DAM**	SW–152 9–2–20



CROSS SECTION A



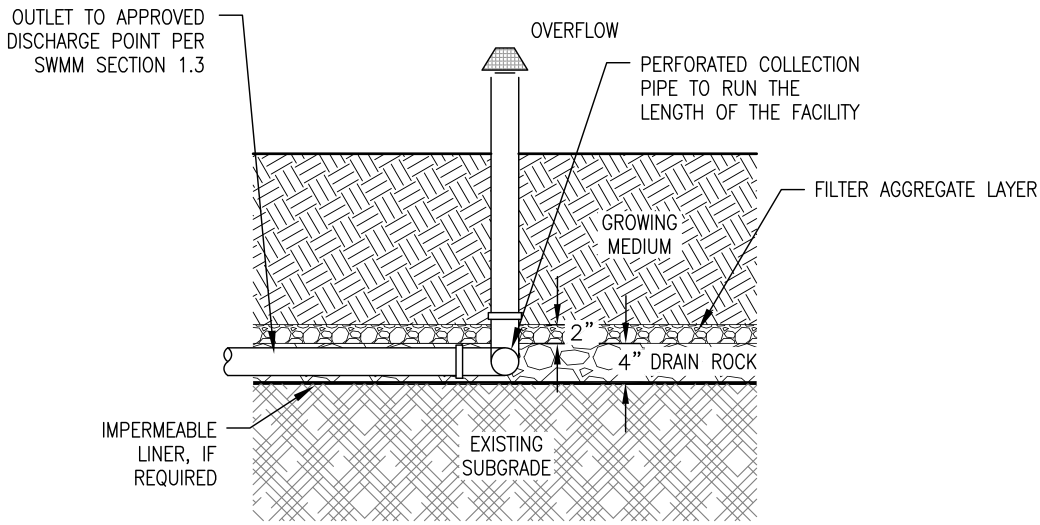
CROSS SECTION B

1. Catch Basin: Install NDS Spee–D Basin or equal beneath downspout to collect debris or sediment.

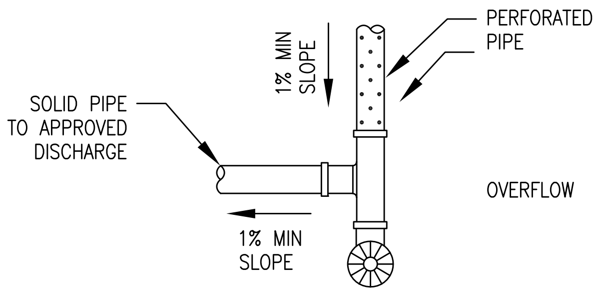
2. Perforated drain pipe must be embedded in coarse, free–draining aggregate.

3. Perforated drain pipe must be level.

– DRAWINGS NOT TO SCALE –



SECTION



PLAN

PIPE W/ UNDERDRAIN & DISCHARGE POINT

– DRAWING NOT TO SCALE –

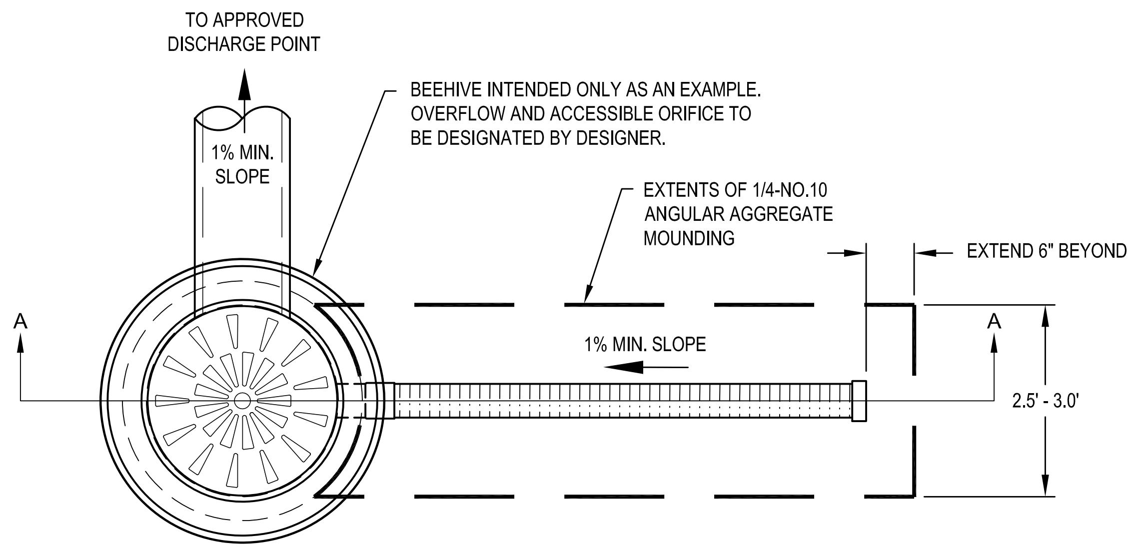
Bureau of Environmental Services

STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

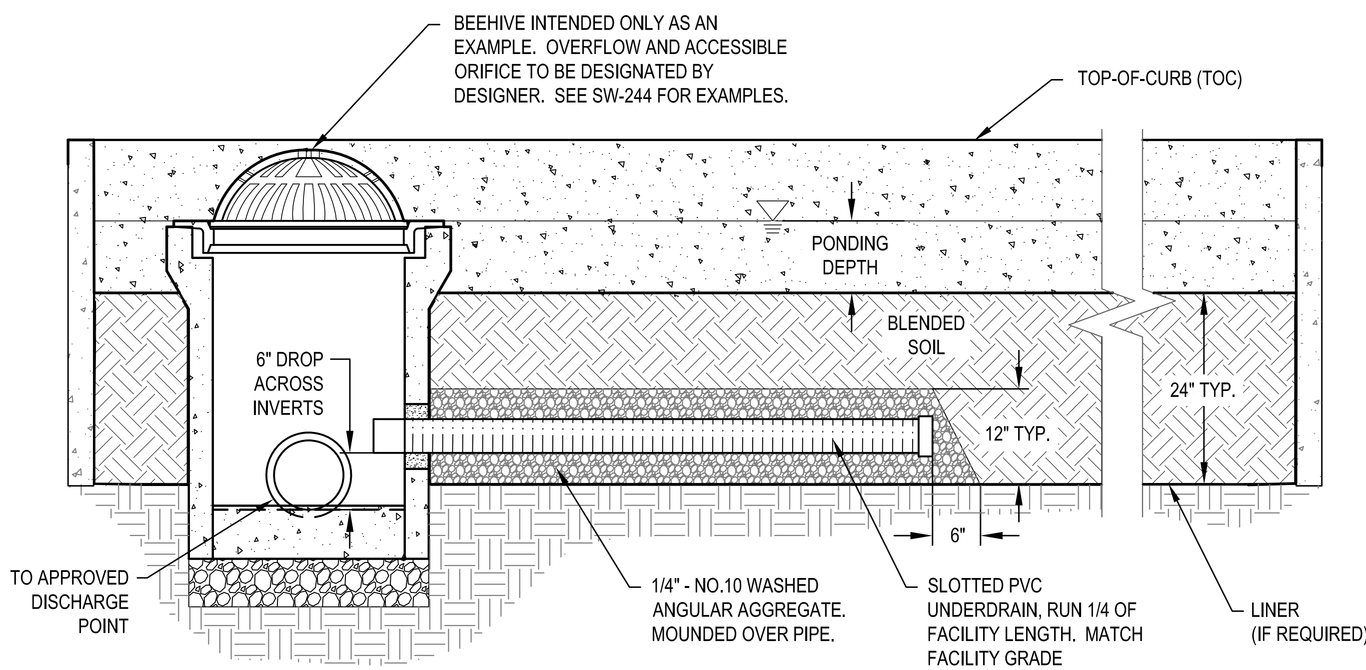
UNDERDRAIN AND OVERFLOW CONFIGURATIONS

SW–190

9–2–20



FACILITY WITH UNDERDRAIN
PLAN VIEW



FACILITY WITH UNDERDRAIN
LONGITUDINAL SECTION A–A

– DRAWINGS NOT TO SCALE –

Bureau of Environmental Services

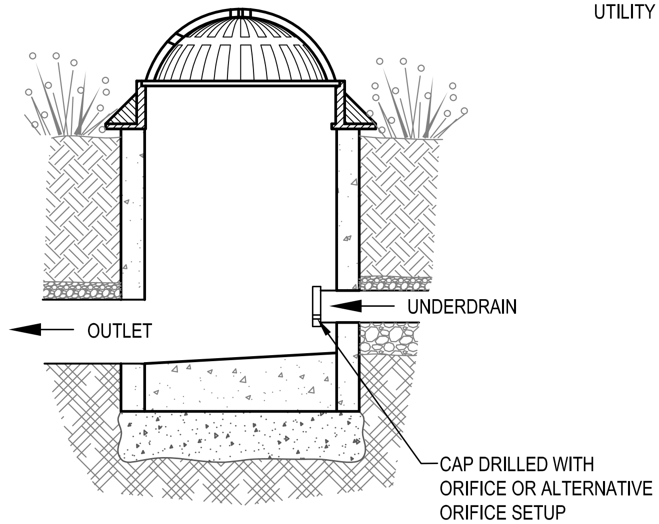
STORMWATER MANAGEMENT
TYPICAL DETAILS FOR
PRIVATE PROPERTY

UNDERDRAIN
CONFIGURATION

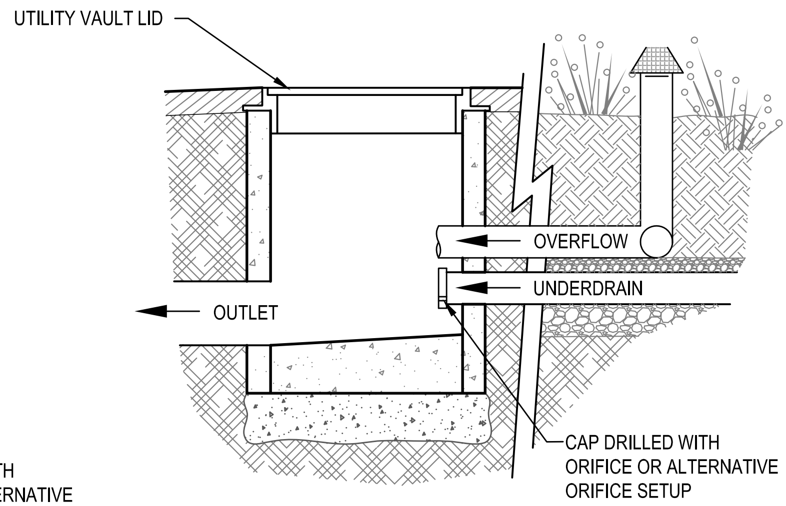
SW–243

9–8–20

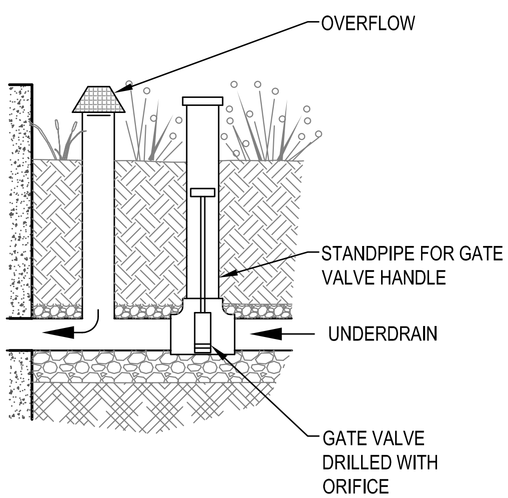
A CAPPED UNDERDRAIN DISCHARGING INTO OVERFLOW STRUCTURE



B CAPPED UNDERDRAIN DISCHARGING INTO JUNCTION BOX

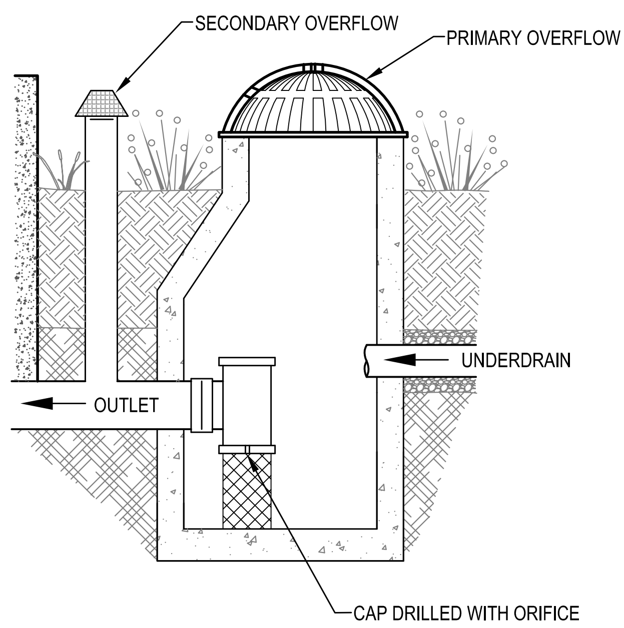


C INLINE GATE VALVE



D EXTENDED DETENTION WITH PIPE TEE IN MAINTENANCE HOLE

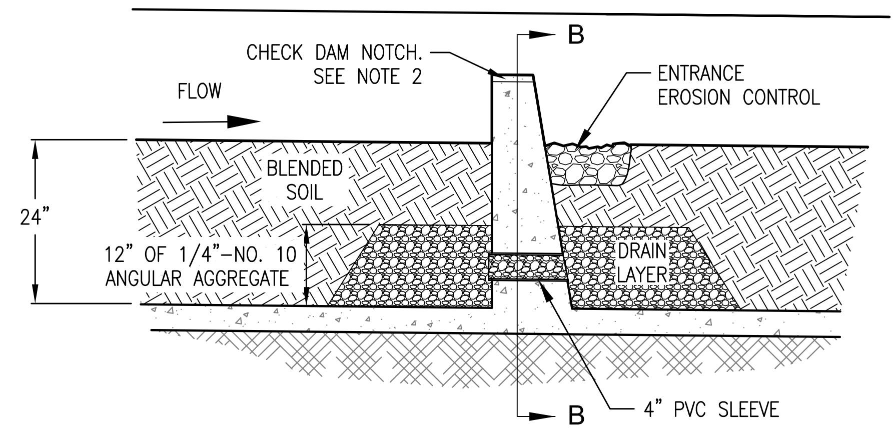
ORIFICE TAKES SOME UNFILTERED FLOW



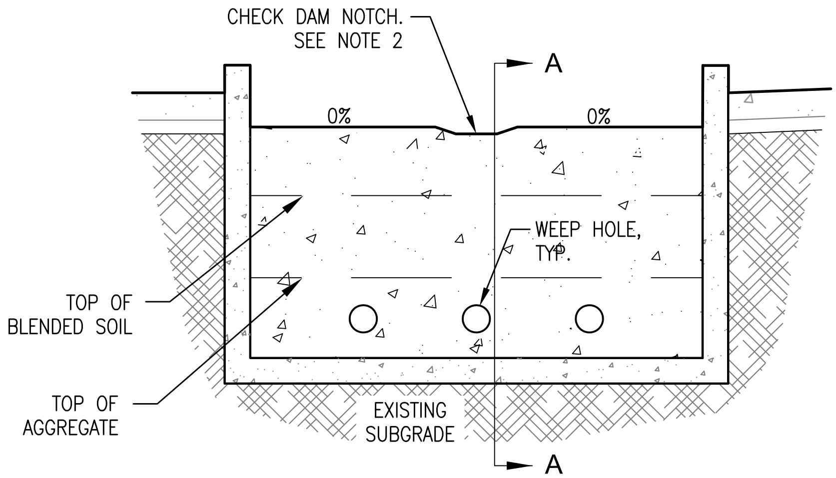
1. The minimum diameter for orifices taking only filtered flow is 3/8". This applies to examples A, B, C. The minimum diameter for orifices taking some unfiltered flow is 1", with additional measures required to prevent clogging. See example D.

2. Material: For orifices <3" in diameter, the orifice plate must be a strong, thin material such as stainless steel, HDPE, or PVC. The thickness of the orifice plate must be less than the orifice diameter.

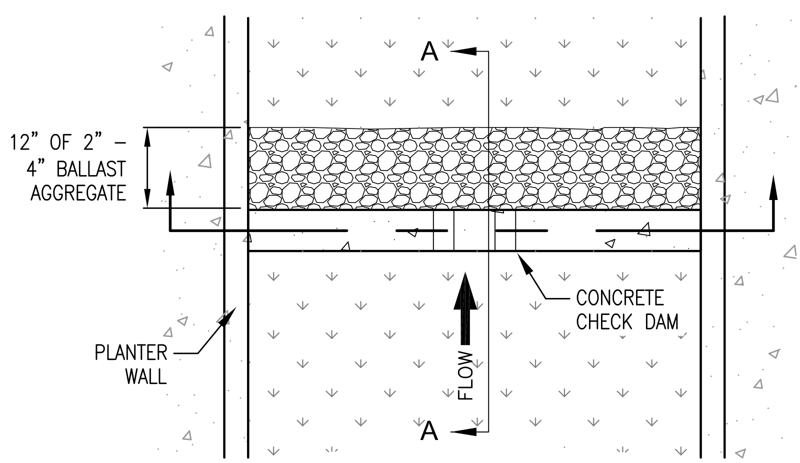
– DRAWINGS NOT TO SCALE –



CROSS SECTION A



CROSS SECTION B



PLAN

1. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.

2. Materials: Check dams can be constructed of other resistant materials such as cedar and juniper. Treated lumber is not acceptable.

– DRAWINGS NOT TO SCALE –

Bureau of Environmental Services

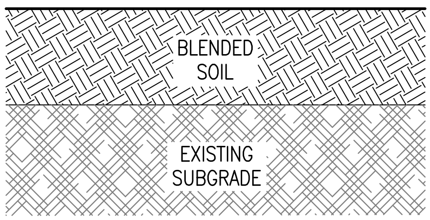
STORMWATER MANAGEMENT
TYPICAL DETAILS FOR
PRIVATE PROPERTY

PLANTER
CHECK DAM

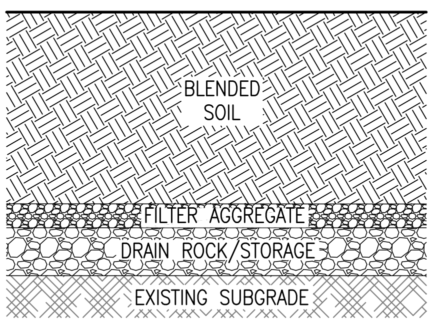
SW–245

9–8–20

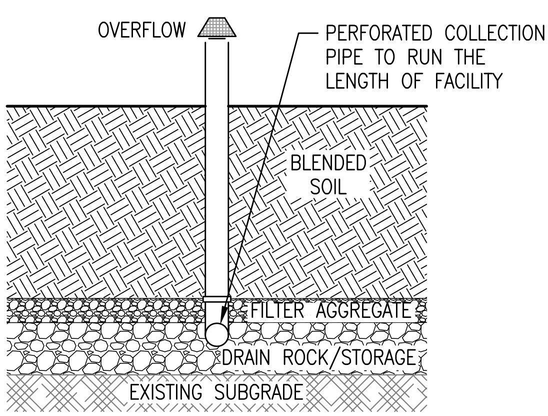
FULL INFILTRATION - LEVEL 1



INFILTRATION
PAC CONFIGURATION A, B



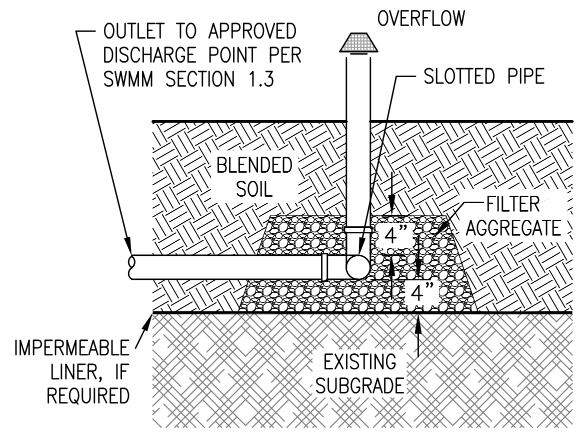
INFILTRATION W/ ROCK GALLERY
PAC CONFIGURATION A, B



HYBRID
OVERFLOW DIRECTED TO DRAIN ROCK. PAC CONFIGURATION E, F. SEE SW-291 OR SW-292 FOR MORE INFORMATION

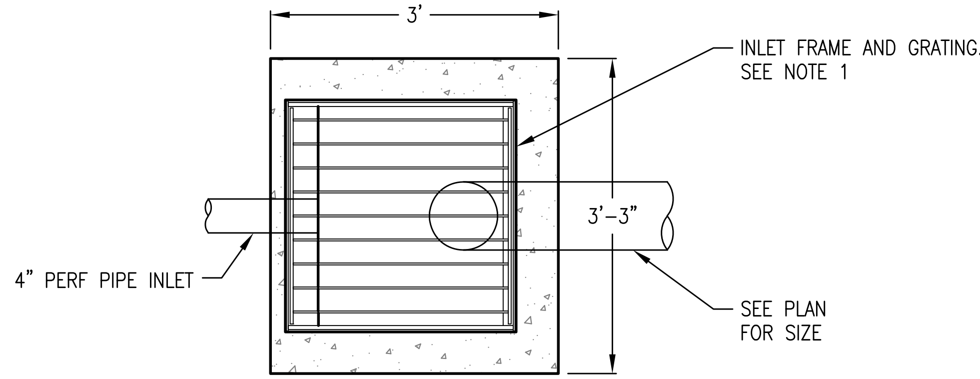
Hybrid facility must be registered as a UIC.

OFFSITE DISPOSAL - LEVEL 2 & 3

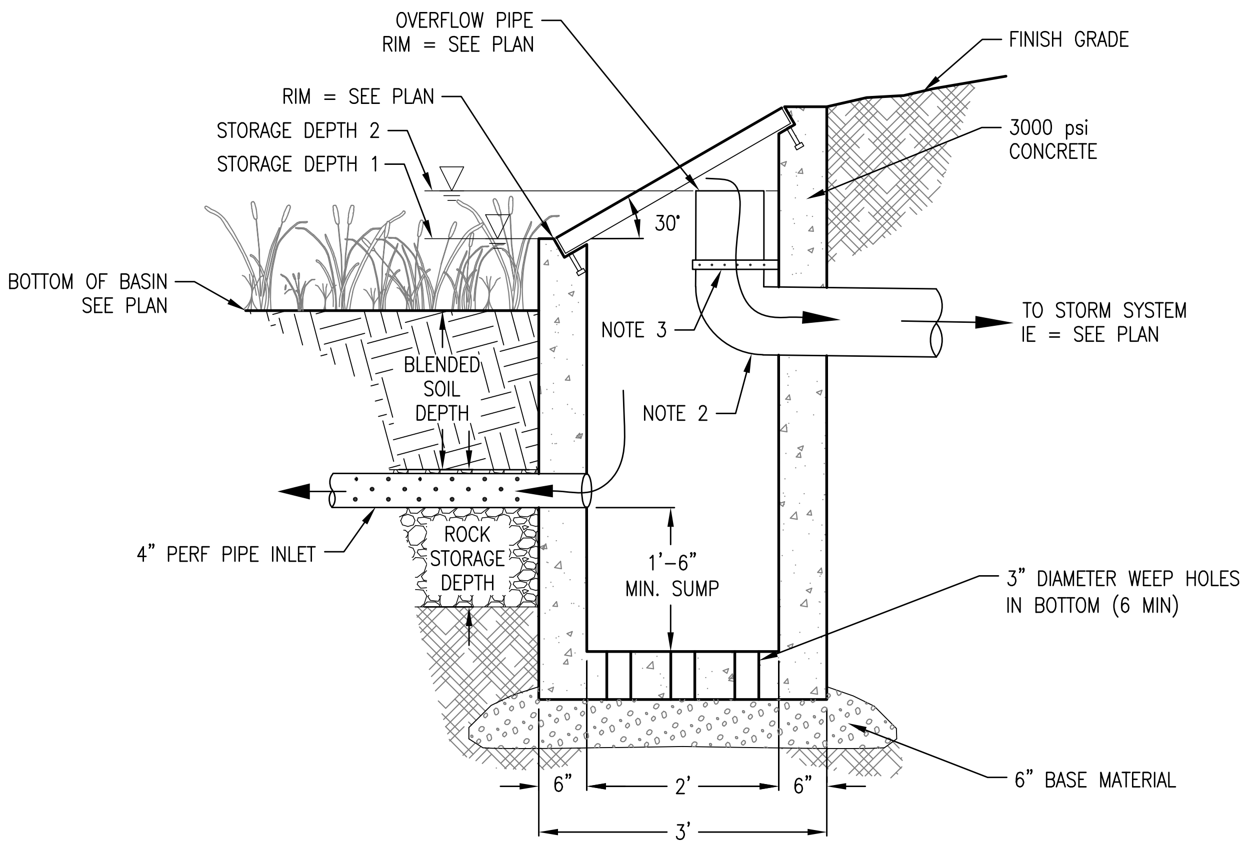


PARTIAL INFILTRATION OR LINED
OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN WITHIN DRAIN ROCK.
PAC CONFIGURATION C AND D
SEE SW-243 FOR PLAN AND LONGITUDINAL SECTION

- DRAWINGS NOT TO SCALE -



PLAN



SECTION

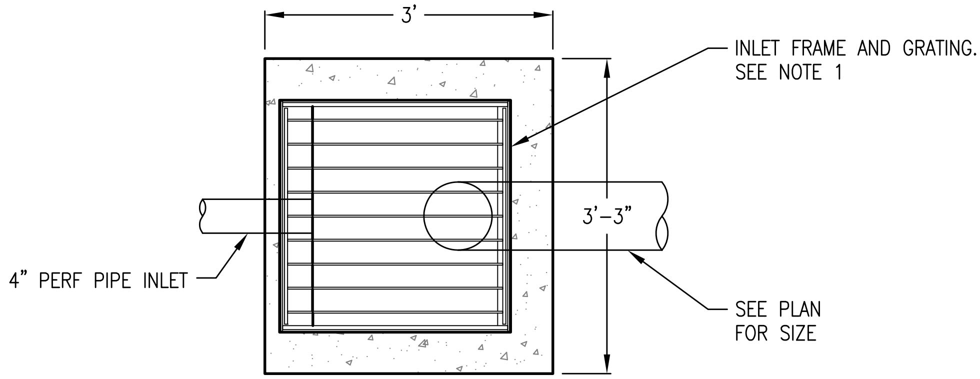
1. Grating and frame must be galvanized steel medium duty.
2. 8" dia. outlet pipe with upturned elbow.
3. Secure outlet pipe with s/s band embedded 2" in wall.

- DRAWINGS NOT TO SCALE -

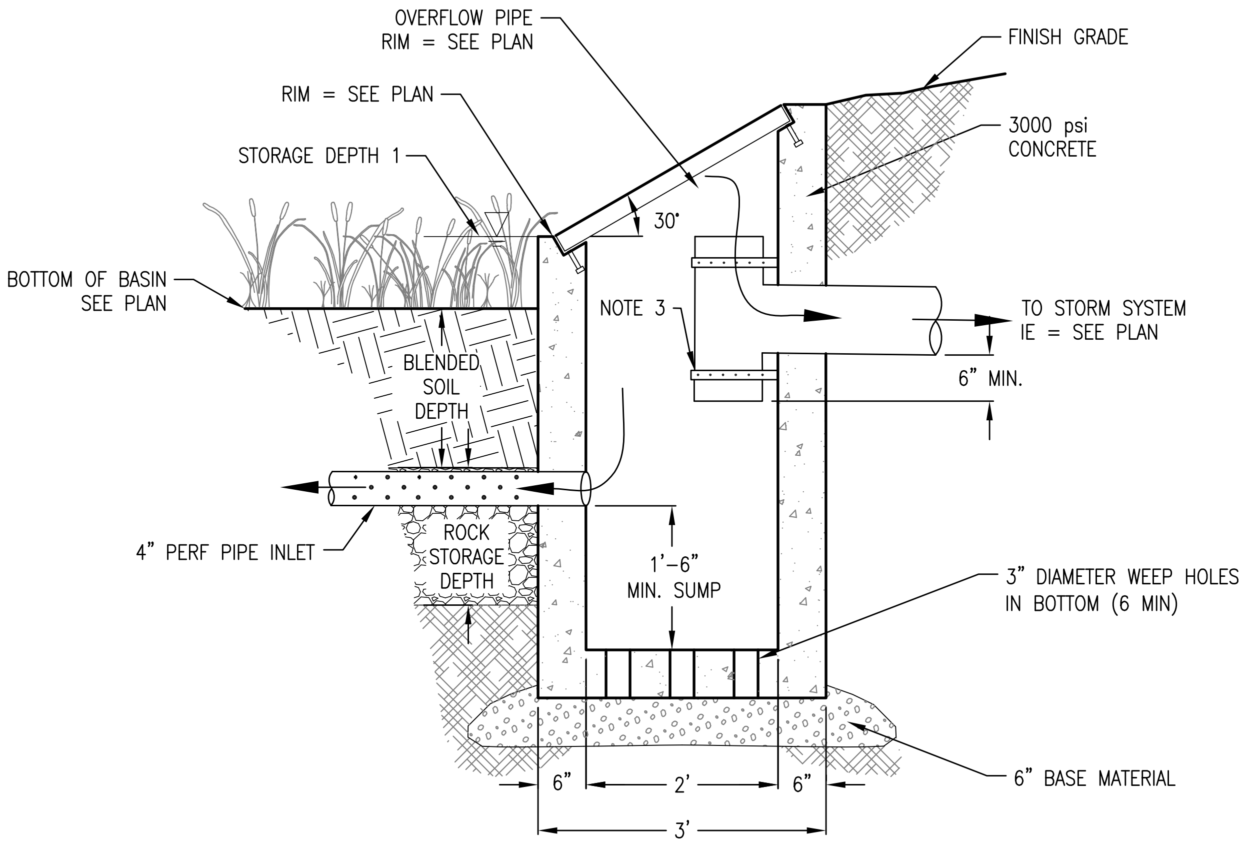
FACILITY OVERFLOW CONFIGURATION E

SW-291

9-8-20



PLAN



SECTION

1. Grating and frame must 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.

– DRAWINGS NOT TO SCALE –

Bureau of Environmental Services

STORMWATER MANAGEMENT
TYPICAL DETAILS FOR
PRIVATE PROPERTY

FACILITY OVERFLOW
CONFIGURATION F

SW–292

9–8–20

3.2.2.3 Rain Gardens

Rain Gardens are landscape depressions designed to capture, store, and infiltrate stormwater runoff. They do not include underdrains, liners, or formal walls, and the native soils are amended rather than replaced with an imported soil blend.

Design

Rain gardens must be designed under the Simplified Approach. The tested infiltration rate of the soil must be at least 2 in/hr.

Setbacks: See Section 2.2.4 for standard setback requirements.

Catchment Area and Inflow: The maximum impervious area that can drain to a rain garden is 5,000 ft^2. Conveyance of stormwater runoff to the rain garden through flexible downspout extensions is prohibited. Options include the following:

- An aboveground, gutter-grade downspout extension that drains directly to areas that can accommodate stormwater flows. The extension cannot cross walkways or drain onto driveways, patios, or other impervious surfaces.

- An underground downspout extension, daylighting into the facility, that is watertight within the 2-ft or 6-ft setback.
- A rock-filled drainage channel that is lined with waterproof sheeting (e.g., 30-mm EPDM) within the 2-ft or 6-ft setback.

Access: See access requirements in Section 3.2.2.1.

Pollution Prevention: See pollution prevention requirements in Section 3.2.2.1.

Sizing: The footprint of the rain garden, including side slopes, must be at least 10% of the impervious area draining to it.

Dimensions and Slopes:

- Ponding depth: 12 inches
- Maximum side slope: 3 horizontal to 1 vertical (3:1). A side slope of 2:1 may be allowed if there are erosion-control protections such as vegetative cover and larger boulders
- Minimum bottom width: 2 ft
- Grades must slope away from foundations and neighboring properties.

Drainage and Overflow:
The design must indicate where excess runoff will safely flow in heavy rainfall. Overflow routes should be planted or covered in rock to prevent erosion. A piped overflow is allowed if an overflow route is not feasible.

Components/Materials:
Section 3.2.2.2 provides requirements for the following components that are common to rain gardens: vegetation, entrance erosion control, and mulch.

Soil Amendment: Amend the soil with 3 inches of compost, blend to a depth of 12 inches below grade.

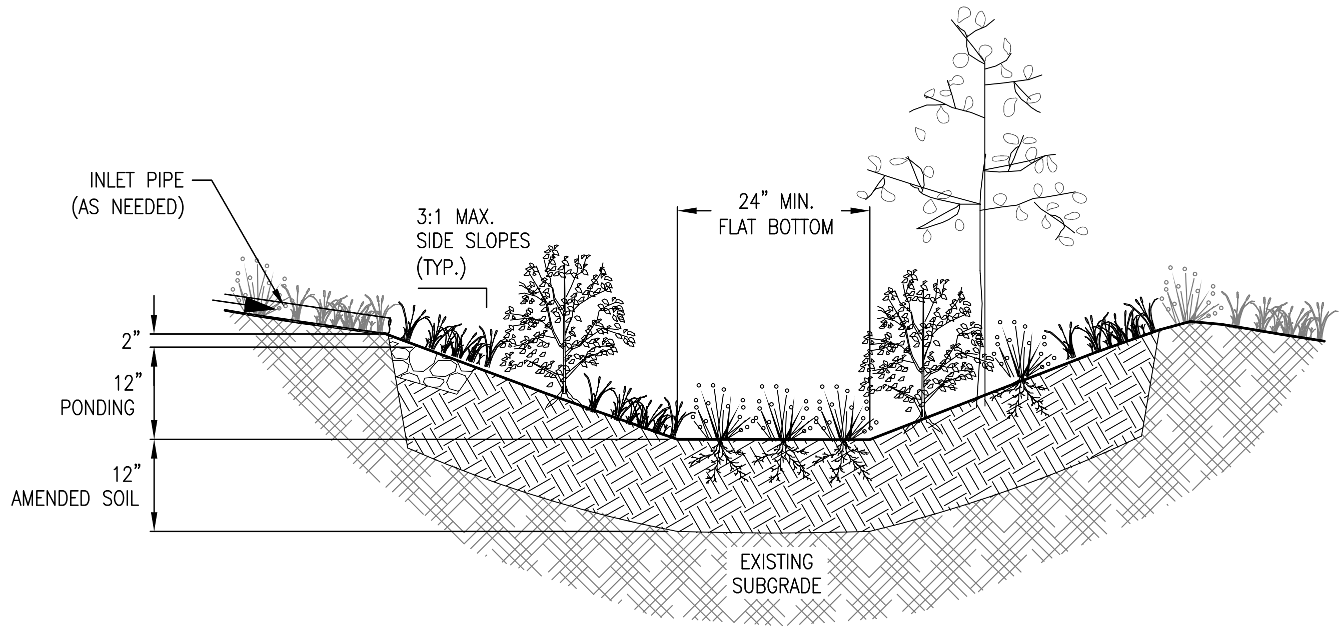
Construction Requirements

See standard construction requirements for bioretention facilities in Section 3.2.2.2.

Typical Detail

The table below lists the detail drawing that follows.

Detail Sheet	Name	Simplified Approach	Presumptive or Performance Approach
SW-121	Rain Garden	X	



1. Setbacks: 2' from any onsite building without a basement; 6' from any onsite building with a basement; the deepest point must be 10' from all structures; 5' from property lines except next to the right-of-way; 5' from base of retaining walls > 3' high; 10' from top of retaining walls > 3' high.
2. Overflow: A rain garden must include an overflow route that safely directs runoff to a disposal point in heavy rainfall. Overflow routes must drain away from building foundations and adjacent properties. Overflow routes must be planted or covered with rock to limit erosion.
3. Piping: Must conform with the requirements of the Oregon Specialty Plumbing Code.
4. Amended Soil: Amend native soil with 3" of yard debris compost, blend to a depth of 12".
5. Vegetation: Refer to plant list in SWMM Section 3.5. Minimum container size is 1 gal. Number of plantings per 100sf of facility area: 80 herbaceous plants OR 72 herbaceous plants and 4 small shrubs.
6. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.
7. Mulch: The surface can be mulched with 2" of dark (aged) medium hemlock mulch.
8. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

CONSTRUCTION REQUIREMENTS

Mark the location of future facilities, and fence or cover facility locations after excavation. Do not allow vehicular traffic, foot traffic, material storage, or heavy equipment within 10 feet of the infiltration area except as needed to excavate, grade, and construct the facility. Do not allow entry of runoff or sediment during construction.

- DRAWING NOT TO SCALE -

3.2.2.4 Basins

Basins are shallow landscape depressions designed to capture, store, and filter stormwater runoff. They can be designed for total or partial infiltration depending on soil infiltration rates. They can be lined if conditions do not allow for infiltration. The footprint of a basin can be round, or long and narrow like that of a swale. Note that vegetated swales are no longer part of the SWMM as a separate facility type; they are included in this manual as basins with enough slope to require check dams.

Design

The Simplified Approach can be used for infiltration basins where the soils have a tested infiltration rate of at least 2 in/hr. The Presumptive and Performance Approaches can be used on soils with any infiltration rate to design infiltration basins, partial-infiltration basins, and lined basins.

Setbacks: See Section 2.2.4 for setback requirements.

Access: See access requirements in Section 3.2.2.1.

Pollution Prevention: See pollution prevention requirements in Section 3.2.2.1.

Sizing:

Simplified Approach – Basins designed under the Simplified Approach must have a sizing ratio of 9% relative to the impervious area draining to them.

Presumptive/Performance Approaches – Basins designed under the Presumptive or Performance Approaches must be sized to meet any applicable water quality, flow control, and disposal requirements.

Dimensions and Slopes:

All basins –

- Maximum side slope: 3 horizontal to 1 vertical (3:1)
- Maximum side slope next to pedestrian areas: 4 horizontal to 1 vertical (4:1)
- Minimum freeboard: 2 inches

Simplified Approach –

- Ponding depth: 12 inches
- Minimum top width: 9 ft
- Minimum bottom width: 2 ft
- Maximum longitudinal slope: 6%
- A check dam is required every 10 ft if the longitudinal slope is 4% or greater.

Presumptive and Performance Approaches –

- Maximum ponding depth: 18 inches

Drainage and Overflow:

Simplified Approach – The basin must have an underdrain and overflow pipe unless otherwise approved.

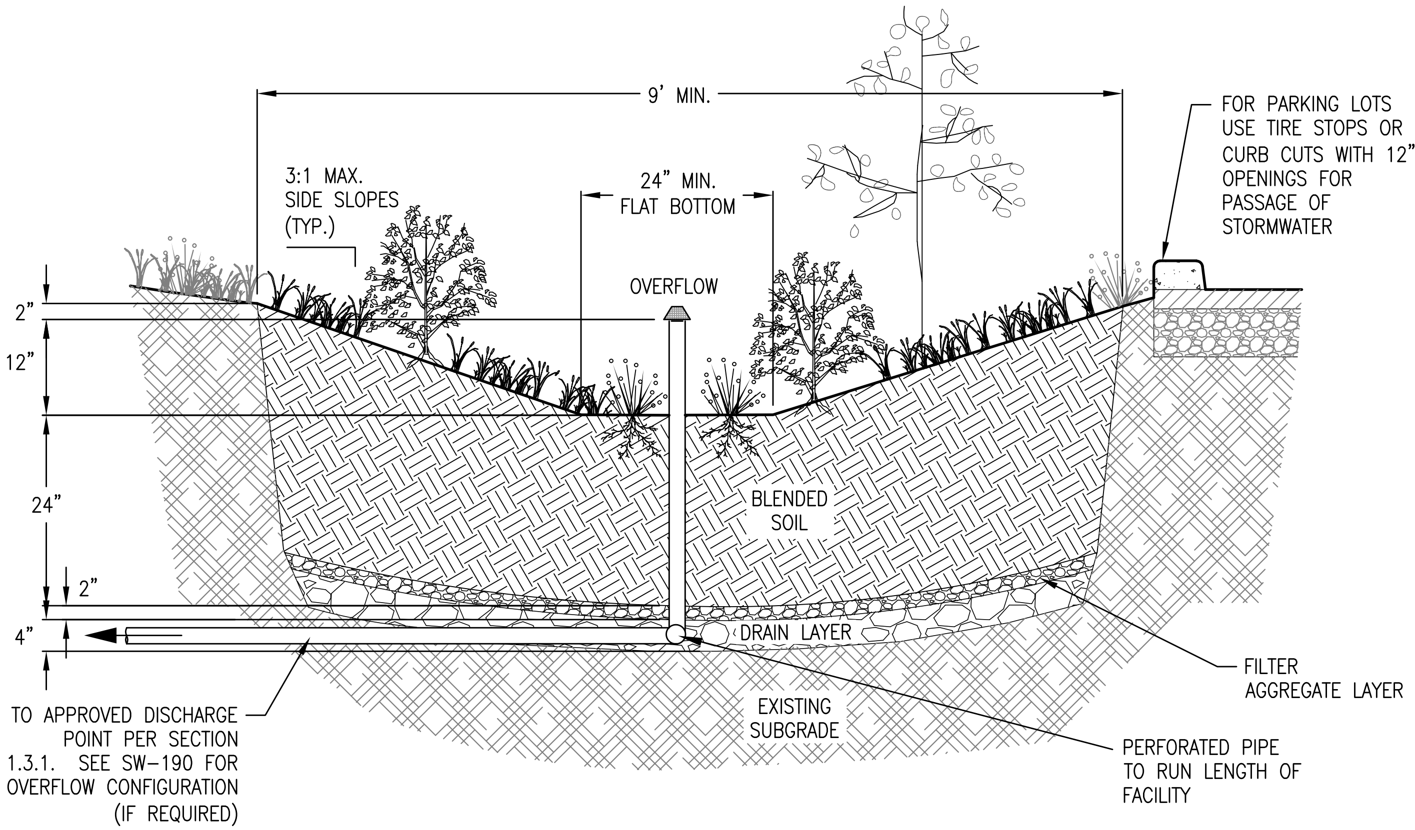
Presumptive and Performance Approaches – The basin must have an underdrain system and/or an overflow pipe unless it infiltrates the 10-year event.

Components/Materials: Section 3.2.2.1 provides requirements for the following components and materials that are common to basins: liners; piping; drain aggregate; pipe overflow configurations; flow control orifices; check dams; flow dissipators; entrance erosion control; blended soil; vegetation; mulch; and irrigation systems.

Construction Requirements
See standard construction requirements for bioretention facilities in Section 3.2.2.2.

Typical Details
The table below lists the detail drawings that follow.

Detail Sheet	Name	Simplified Approach	Presumptive or Performance Approach
SW-150	Unlined Basin	X	
SW-240	Basin w/o Underdrain		X
SW-241	Basin with Underdrain		X



1. Setbacks: 5' along property lines except next to right-of-way; 10' from building foundations.
2. Slope: Maximum slope of 6% (facility bottom).
3. Overflow: Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.
4. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.
5. Drain Layer: 4" of $\frac{3}{4}$"–1 $\frac{1}{2}$" washed drain rock. Filter aggregate layer: 2–3" of $\frac{1}{4}$"–No.10 washed angular aggregate.
6. Blended Soil: Use BES' standard soil blend for stormwater facilities (SWMM Section 6.3) unless otherwise approved. Install minimum of 24" of blended soil.
7. Vegetation: Refer to plant list in SWMM Section 3.5. Minimum container size is 1 gal. Number of plantings per 100sf of facility area:
   - Zone A (wet): 80 herbaceous plants OR 72 herbaceous plants and small shrubs.
   - Zone B (moderate to dry): 7 large to small shrubs AND 70 groundcover plants.

   The delineation between zone A and B shall be either at the outlet elevation or the check dam elevation, whichever is lowest.
8. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.
9. Check Dams: Place check dams every 10' where slope exceeds 4%. Check dam ends must be keyed into the native soil a minimum of 12" (see SW-152).
10. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

CONSTRUCTION REQUIREMENTS

Mark the location of future facilities, and fence or cover facility locations after excavation. Do not allow vehicular traffic, foot traffic, material storage, or heavy equipment within 10 feet of the infiltration area except as needed to excavate, grade, and construct the facility. Do not allow entry of runoff or sediment during construction.

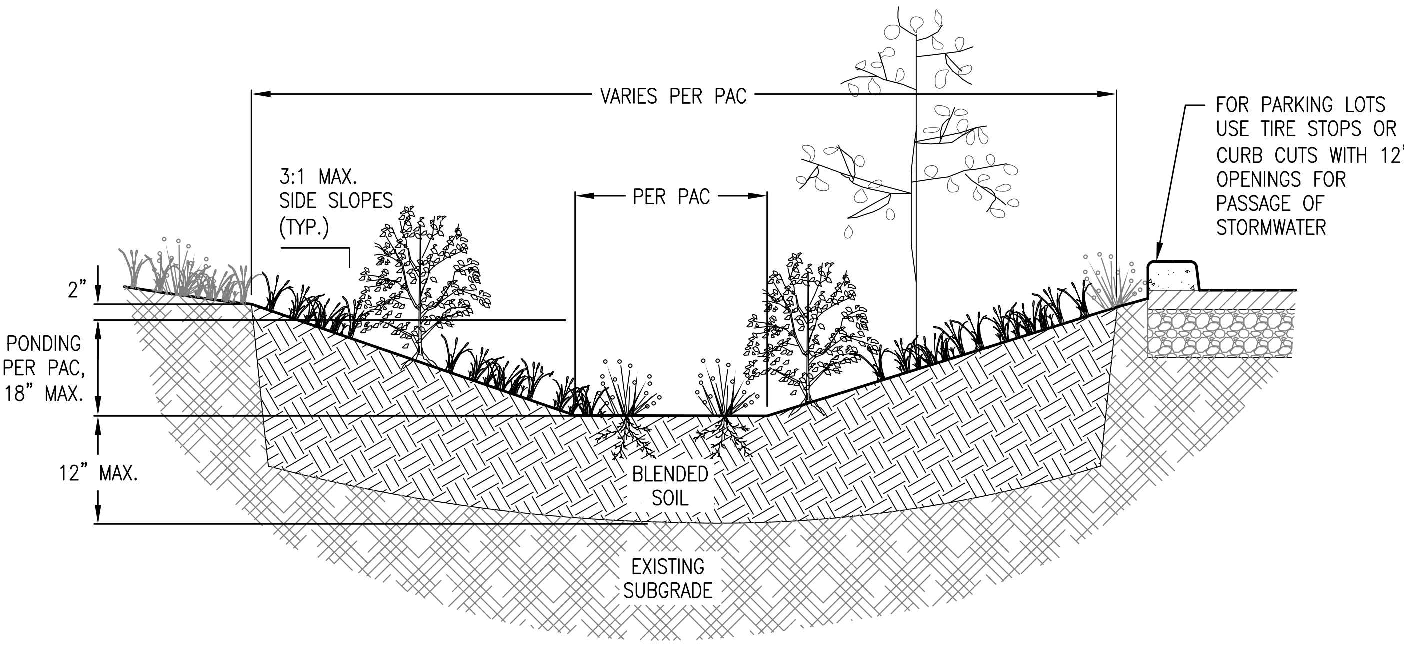
– DRAWING NOT TO SCALE –

Bureau of Environmental Services

STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

UNLINED BASIN SW–150

9-2-20



1. Detail intended as an example. Detail must match PAC assumptions and/or design report.

2. Setbacks: 5' from property lines except next to right-of-way; 10' from building foundations.

3. Rock Gallery/Storage Layer, as required: Size per the PAC. Construct rock galleries of $\frac{3}{4}$" washed drain rock overlain by a 3–4" filter layer of $\frac{1}{4}$" No.10 washed angular aggregate. Alternative configurations and materials such as cellular storage systems, drainage mats, and non-standard aggregates may be used under the Performance Approach, with BES approval.

4. Overflow: Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.

5. Blended Soil: Use BES standard soil blend for stormwater facilities (SWMM Section 6.3) unless otherwise approved. Install minimum of 12" on native soil. Install minimum of 24" if there's a drainage layer or storage layer below the imported soil.

6. Vegetation: Refer to plant list in SWMM Section 3.5. Minimum container size is 1 gal. Number of plantings per 100sf of facility area:
   - Zone A (wet): 80 herbaceous plants OR 72 herbaceous plants and 4 small shrubs.
   - Zone B (moderate to dry): 7 large or small shrubs AND 70 groundcover plants.

   The delineation between Zone A and B shall be either at the outlet elevation or the check dam elevation, whichever is lowest. If project area is over 200sf consider adding a tree.

7. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.

8. Check Dams: Spacing per the PAC. Check dam ends must be keyed into the native soil a minimum of 12".

9. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

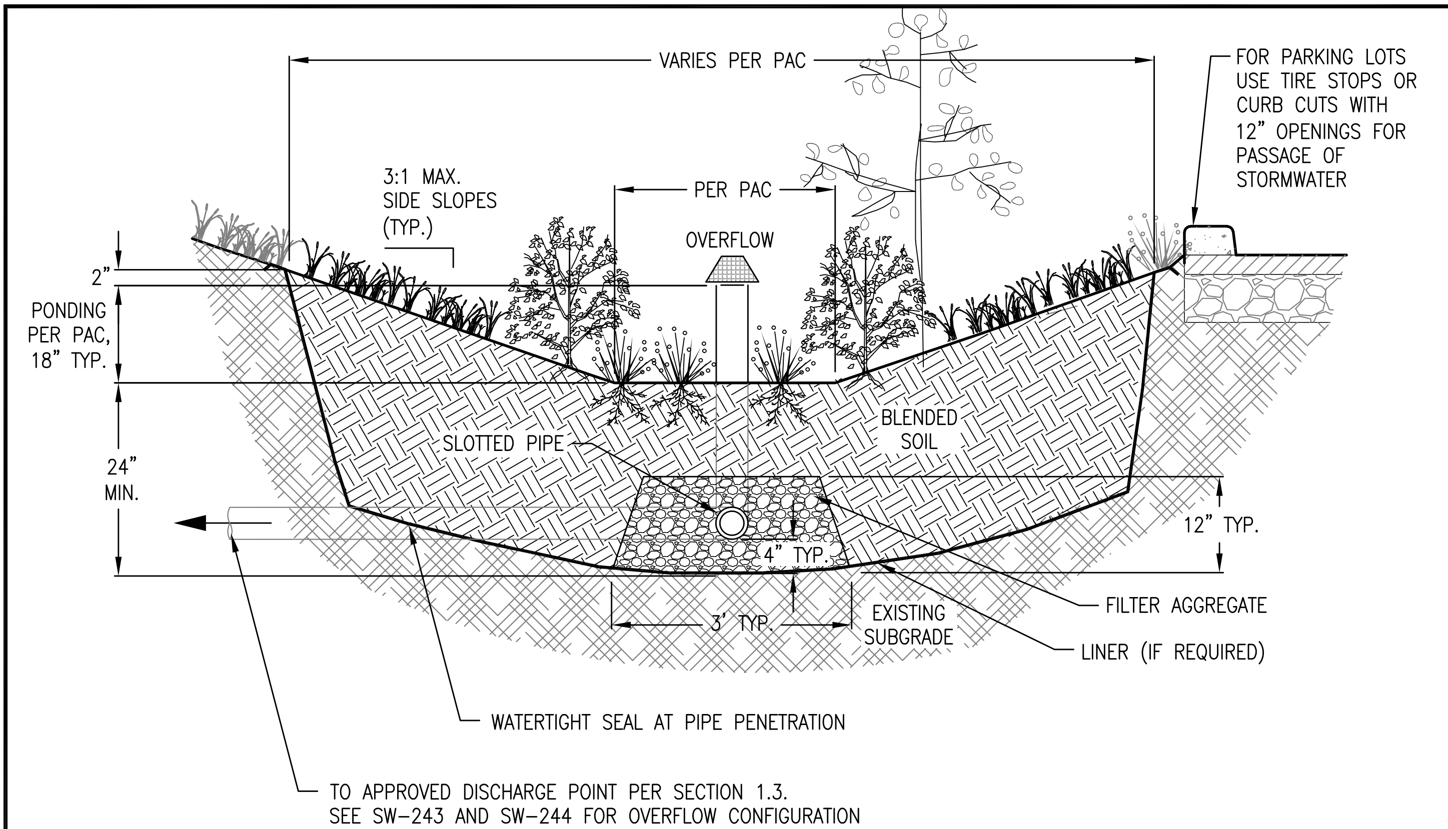
CONSTRUCTION REQUIREMENTS

Mark the location of future facilities, and fence or cover facility locations after excavation. Do not allow vehicular traffic, foot traffic, material storage, or heavy equipment within 10 feet of the infiltration area except as needed to excavate, grade, and construct the facility. Do not allow entry of runoff or sediment during construction.

– DRAWING NOT TO SCALE –

Bureau of Environmental Services	STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY	BASIN WITHOUT UNDERDRAIN	SW–240 9-8-20

PRESUMPTIVE AND **PERFORMANCE** DESIGN APPROACH



1. Detail intended as an example. Detail must match PAC assumptions and/or design report.

2. Setbacks: None required.

3. Overflow: Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.

4. Underdrain System: Sizing is per the PAC. The underdrain must be 4" slotted schedule 40 PVC well casing pipe manufactured with .050" slots, 6 slots per row. See SW-243 for longitudinal section and SW-244 for orifice examples. Conform with Oregon Plumbing Specialty Code (OPSC) requirements. Alternative configurations and materials such as cellular storage systems, drainage mats, and non-standard aggregates may be used under the Performance Approach, with BES approval.

5. Vegetation: Refer to plant list in SWMM Section 3.5. Minimum container size is 1 gal. Number of plantings per 100sf of facility area:
   - Zone A (wet): 80 herbaceous plants OR 72 herbaceous plants and 4 small shrubs.
   - Zone B (moderate to dry): 7 large or small shrubs AND 70 groundcover plants.

   The delineation between Zone A and B shall be either at the outlet elevation or the check dam elevation, whichever is lowest. If project area is over 200sf consider adding a tree.

6. Blended Soil: Use BES standard soil blend for stormwater facilities (SWMM Section 6.3) unless otherwise approved. Install minimum of 24" of blended soil. Waterproof Liner: 30 mil EPDM, HDPE or approved equivalent.

7. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.

8. Check Dams: Spacing per the PAC. Check dam ends must be keyed into the native soil a minimum of 12".

9. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

CONSTRUCTION REQUIREMENTS

Do not allow temporary storage of construction waste or materials in the facilities. Do not allow entry of runoff or sediment during construction.

- DRAWING NOT TO SCALE -

Bureau of Environmental Services

STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

BASIN WITH UNDERDRAIN

SW-241

9-8-20

PRESUMPTIVE AND PERFORMANCE DESIGN APPROACH

3.2.2.5 Planters

Planters are walled landscape areas that capture, store, and filter stormwater runoff. They can be designed for full or partial infiltration depending on soil infiltration rates. They can be lined if conditions do not allow for infiltration.

Design

The Simplified Approach can be used for planters where the soils have a tested infiltration rate of at least 2 in/hr. The Presumptive and Performance Approaches can be used on soils with any infiltration rate to design infiltration planters, partial-infiltration planters, and lined planters.

Setbacks: See Section 2.2.4 for setback requirements.

Access: See access requirements in Section 3.2.2.1.

Pollution Prevention: See pollution prevention requirements in Section 3.2.2.1.

Sizing:

Simplified Approach – Planters designed under the Simplified Approach must have a sizing ratio of 6% relative to the impervious area draining to them.

Presumptive/Performance Approaches – Planters designed under the Presumptive or Performance Approaches must be sized to meet any applicable water quality, flow control or disposal requirements.

Dimensions and Slopes:

All planters –

- Minimum width: 2 ft, measured from the insides of the walls
- Minimum freeboard: 2 inches

Simplified Approach –

- Ponding depth: 12 inches
- Maximum slope of the planted floor: 0.5% in any direction

Presumptive and Performance Approaches –

- Maximum ponding depth: 18 inches

Drainage and Overflow:

Simplified Approach – All planters designed under the Simplified Approach must have an underdrain with an overflow pipe unless otherwise approved.

Presumptive/Performance Approaches – The planter must have an underdrain system and/or an overflow pipe unless it infiltrates the 10-year event.

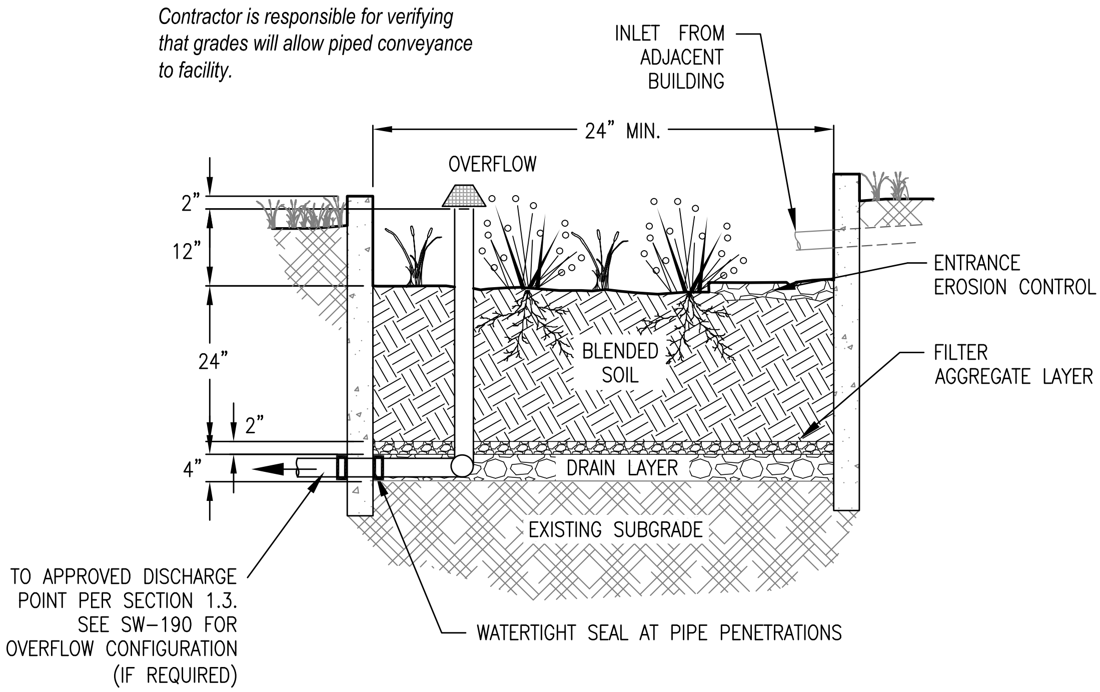
Components/Materials: Section 3.2.2.1 provides requirements for the following components that are common to planters: walls, liners, and waterproofing; piping; drain aggregate; pipe overflow configurations; flow control orifices; check dams; flow dissipators; entrance erosion control; blended soil; vegetation; mulch; and irrigation systems.

Construction Requirements

See standard construction requirements for bioretention facilities in Section 3.2.2.2.

Typical Details

Detail Sheet	Name	Simplified Approach	Presumptive or Performance Approach
SW-140	Unlined Planter	X	
SW-141	Lined Planter	X	
SW-230	Planter w/o Underdrain		X
SW-231	Planter with Underdrain		X



1. Setbacks: 10' from building foundations; 5' along property lines except next to right-of-way. Walls can't exceed 30" height above grade if within 5' of property line including right-of-way.

2. Facility Slope (planted floor): Maximum of 0.5% in all directions.

3. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.

4. Drain Layer: 4" of $\frac{3}{4}$"–1 $\frac{1}{2}$" washed drain rock. Filter aggregate layer: 2–3" of $\frac{1}{4}$"–No.10 washed angular aggregate.

5. Overflow: Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.

6. Blended Soil: Use BES' standard soil blend for stormwater facilities (SWMM Section 6.3) unless otherwise approved. Install minimum of 24" of blended soil.

7. Vegetation: Refer to plant list in SWMM Section 3.5. Minimum container size is 1 gal. Number of plantings per 100sf of facility area: 80 herbaceous plants OR 72 herbaceous plants and 4 small shrubs.

8. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.

9. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

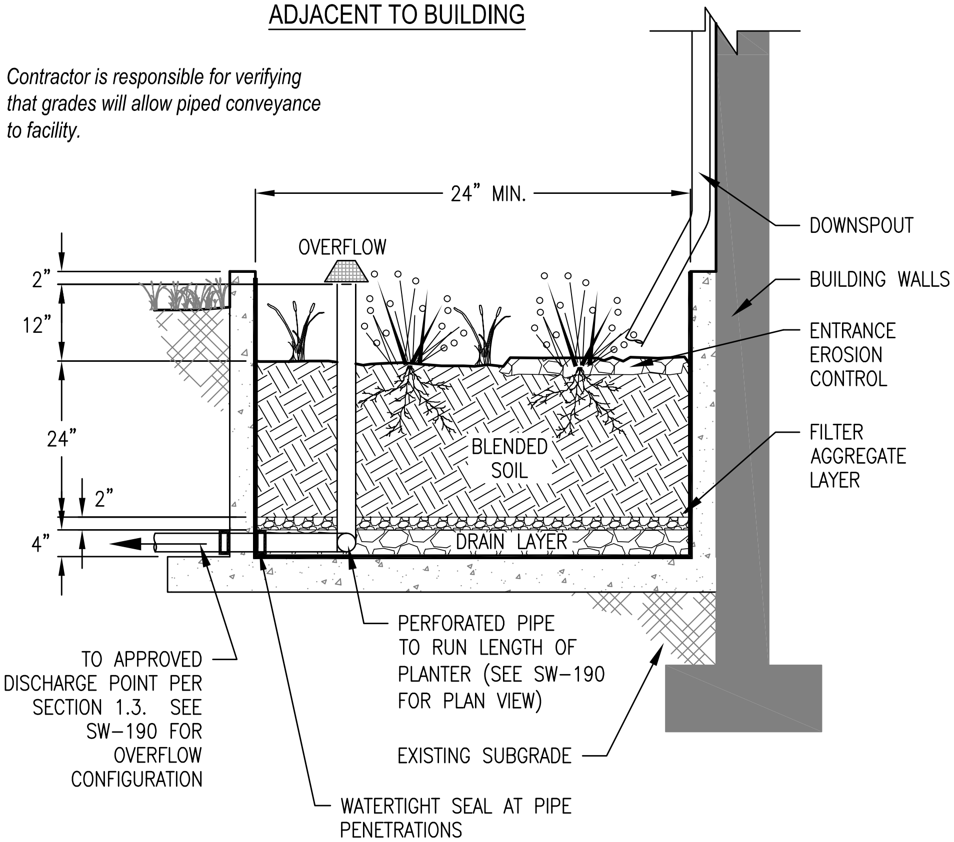
CONSTRUCTION REQUIREMENTS

Mark the location of future facilities, and fence or cover facility locations after excavation. Do not allow vehicular traffic, foot traffic, material storage, or heavy equipment within 10 feet of the infiltration area except as needed to excavate, grade, and construct the facility. Do not allow entry of runoff or sediment during construction.

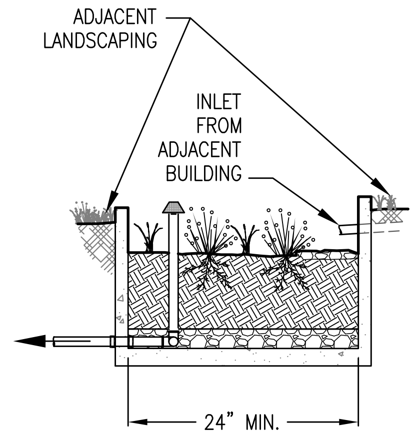
- DRAWING NOT TO SCALE -

ADJACENT TO BUILDING

Contractor is responsible for verifying that grades will allow piped conveyance to facility.



FREESTANDING PLANTER



1. Setbacks: No setback is required for lined planters. Walls can't exceed 30" height above grade if within 5' of property line including right-of-way.

2. Facility Slope (planted floor): Maximum of 0.5% in all directions.

3. Planter Structure: A single-pour monolithic concrete shell, without cold joints, is required to avoid the requirement for liner. Include walls on foundation plans. Check state structural standards for foundations.

4. Waterproofing: No additional waterproofing is needed if structure is monolithically poured.

5. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.

6. Drain Layer: 4" of $\frac{3}{4}$"–1 $\frac{1}{2}$" washed drain rock. Filter aggregate layer: 2–3" of $\frac{1}{4}$"–No.10 washed angular aggregate.

7. Overflow: Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.

8. Blended Soil: Use BES' standard soil blend for stormwater facilities (SWMM Section 6.3) unless otherwise approved. Install minimum of 24" of blended soil.

9. Vegetation: Refer to plant list in SWMM Section 3.5. Minimum container size is 1 gal. Number of plantings per 100sf of facility area: 80 herbaceous plants OR 72 herbaceous plants and 4 small shrubs.

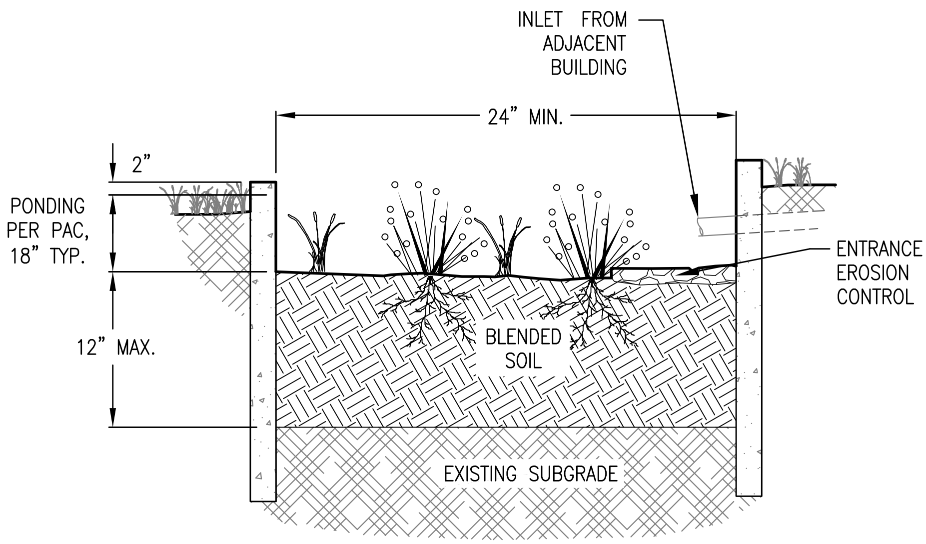
10. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.

11. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

CONSTRUCTION REQUIREMENTS

Do not allow temporary storage of construction waste or materials in the facilities. Do not allow entry of runoff or sediment during construction.

– DRAWINGS NOT TO SCALE –



1. Detail intended as an example. Detail must match PAC assumptions and/or design report.

2. Setbacks: 10' from building foundations; 5' along property lines except next to right-of-way. Walls can't exceed 30" height above grade if within 5' of property lines including right-of-way.

3. Planter Walls: Material must be concrete, unless otherwise approved. Walls must be included on foundation plans.

4. Rock Gallery/Storage Layer, as required: Size per PAC calculations. Construct rock galleries of 3/4" washed drain rock overlain by a 3-4" filter layer of $\frac{1}{4}$"-No.10 washed angular aggregate. Alternative materials such as filter fabric, cellular storage systems, and non-standard aggregates may be used under the Performance Approach, with BES approval.

5. Overflow (if needed): Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.

6. Blended Soil: Use BES standard soil blend for stormwater facilities (SWMM Section 6.3) unless otherwise approved. Install minimum of 12" on native soil. Install minimum of 24" if there's a drainage layer or storage layer below the imported soil.

7. Vegetation: Refer to plant list in SWMM Section 3.5. Minimum container size is 1 gal. Number of plantings per 100sf of facility area: 80 herbaceous plants OR 72 herbaceous plants and 4 small shrubs.

8. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.

9. Check Dams: Spacing per the PAC. Check dam length must equal the full width of the planter.

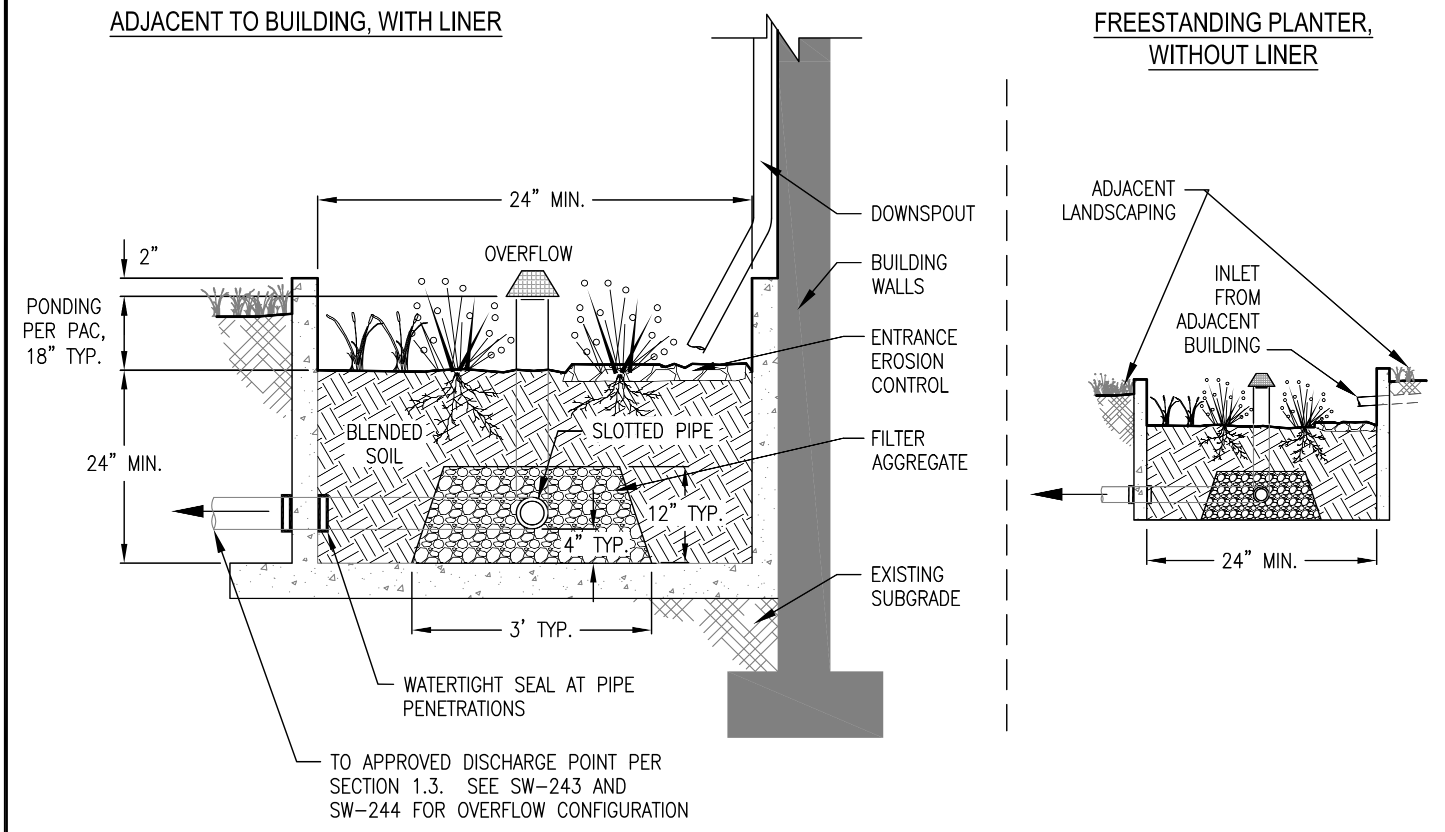
10. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

CONSTRUCTION REQUIREMENTS

Mark the location of future facilities, and fence or cover facility locations after excavation. Do not allow vehicular traffic, foot traffic, material storage, or heavy equipment within 10 feet of the infiltration area except as needed to excavate, grade, and construct the facility. Do not allow entry of runoff or sediment during construction.

– DRAWING NOT TO SCALE –

Bureau of Environmental Services	STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY	PLANTER WITHOUT UNDERDRAIN	SW-230 9-8-20



1. Detail intended as an example. Detail must match PAC assumptions and/or design report.

2. Setbacks: No setback is required for lined planters. For infiltration planters the setbacks are 5' from property lines except next to right-of-way, and 10' from building foundations. The planter wall height must be less than 30" above finished grade if within 5' of property line.

3. Planter Structure: A single pour, monolithic concrete shell without cold joints is required unless otherwise approved.

4. Waterproofing: No additional waterproofing is needed if the structure is a single pour, monolithic concrete shell.

5. Blended Soil: Use BES standard soil blend for stormwater facilities (SWMM Section 6.3) unless otherwise approved. Install minimum of 24" of blended soil.

6. Underdrain System: Sizing is per the PAC. The underdrain must be 4" slotted schedule 40 PVC well casing pipe manufactured with .050" slots, 6 slots per row. Embed the underdrain in $\frac{1}{4}$" No.10 washed angular aggregate. See SW-243 for longitudinal section and SW-244 for orifice examples. Conform with Oregon Plumbing Specialty Code (OPSC) requirements. Alternative configurations and materials such as cellular storage systems, drainage mats, and non-standard aggregates may be used under the Performance Approach, with BES approval.

7. Overflow: Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.

8. Vegetation: Refer to plant list in SWMM Section 3.5. Minimum container size is 1 gal. Number of plantings per 100sf of facility area: 80 herbaceous plants OR 72 herbaceous plants and 4 small shrubs.

9. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.

10. Check Dams: Spacing per the PAC. Check dam length must equal the full width of the planter.

11. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

CONSTRUCTION REQUIREMENTS

Do not allow temporary storage of construction waste or materials in the facilities. Do not allow entry of runoff or sediment during construction.

- DRAWING NOT TO SCALE -

Bureau of Environmental Services

STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

PLANTER WITH UNDERDRAIN

SW-231

9-8-20

3.2.3 Dispersion Facilities

Dispersion facilities spread runoff across pervious areas that typically are vegetated, using surface grading to maintain sheet flow across both the impervious surface contributing stormwater runoff to the facility and the facility itself.

3.2.3.1 Filter Strips

Filter strips are gently-sloped, vegetated areas designed to treat and manage sheet flow from narrow adjacent impervious surfaces such as walkways. The vegetation slows and filters the runoff, allowing some or all of it to soak into the ground.

Design

Filter strips can be designed under the Simplified and Performance Approaches.

Site Suitability: Filter strips are appropriate for all soil types.

Setbacks: See Section 2.2.4 for standard setback requirements.

Catchment Area and Inflow: Stormwater runoff entering a filter strip must be in the form of sheet flow. To help ensure sheet flow, the maximum slope of the impervious area draining to the filter strip is 10% and the maximum width of the impervious area is 12 ft. To ensure runoff enters the filter strip, provide a 1-inch drop at the transition from the impervious area to the filter strip.

Sizing:

Filter strips can be sized for water quality, flow control, and disposal.

Simplified Approach – Filter strips designed under the Simplified Approach must meet the sizing criteria in the Table 3-4.

Table 3-4. Simplified Approach Sizing Criteria

Slope	Infiltration Rate	Sizing Ratio*
≤10%	≥2 in/hr	2/3
	<2 in/hr	3

*Ratio of the width of the filter strip to the width of the surface draining to it.

Performance Approach – Filter strips can be sized under the Performance Approach for water quality and flow control or disposal if they meet one of the following conditions (summarized in Table 3-5):

- Hierarchy Level 1: If the infiltration rate of the native soil is at least 2 in/hr, the filter strip must be at least 2/3rd the width of the impervious area draining to it and the filter strip slope must not exceed 10%. (No discharge point is required.)
- Hierarchy Level 2 and 3: If the filter strip has an identified discharge point, the filter strip must be at least twice the width of the impervious area draining to it and the filter strip slope can be as steep as the slope in the natural condition, provided that sheet flow is maintained. (This does not require a specific soil infiltration rate but may require geotechnical review if the slope exceeds 15%.)
- Hierarchy Level 2 and 3: The filter strip must be at least three times the width of the impervious area draining to it and the filter strip slope can be as steep as the slope in the natural condition, provided that sheet flow is maintained. (This requires neither a specific soil infiltration rate nor a discharge point but may require geotechnical review if the slope exceeds 15%.)

Table 3-5. Performance Approach Filter Strip Sizing – General[1]

Sizing Factor (Width)	Sheet Flow Required	Infiltration Requirement	Slope Requirement	Discharge Point Required
2/3	Yes	≥2 in/hr	≤ 10%	No
2	Yes	None	No greater than existing slope[2]	Yes
3	Yes	None	No greater than existing slope[2]	No

1 Filter strips sized for flow control meet requirements for water quality treatment.
2 May require a geotechnical review if slope exceeds 15%.

Filter strips designed under the Performance Approach are credited for water quality treatment if they meet the sizing criteria in Table 3-6.

Table 3-6. Performance Approach Filter Strip - Water Quality[1]

Filter Strip Cross Slope (%)	Minimum Filter Strip Width (ft)
2	5.5
5	7
10	8.5
15	9.5

1 This table is valid only for filter strips up to 12 ft in width.

Slope: For a filter strip to be effective, sheet flow must be maintained across the slope of the filter strip. The maximum slope of a water quality filter strip is 15%. If sizing for flow control using the 2/3rds sizing factor, the maximum slope of the filter strip is 10%. If sizing for flow control using a sizing factor of 2 or 3, the filter strip slope is not to exceed the existing slope and the design may require geotechnical review if the slope exceeds 15%.

Soil: Existing vegetated areas can be used for filter strips. If a new vegetated area is constructed as a filter strip, amend the native soil with 3 to 4 inches of yard-debris compost and mix to a depth of 12 inches before planting.

Vegetation: The entire surface area must be covered by plants, preferably natives such as native wildflower blends, native ground covers, or any combination thereof. Forested filter strips are also allowed. A forested filter strip must be fully covered by existing tree canopy with an accumulation of forest duff. See Section 3.5 for plant lists.

Construction Requirements

The following construction requirements apply:

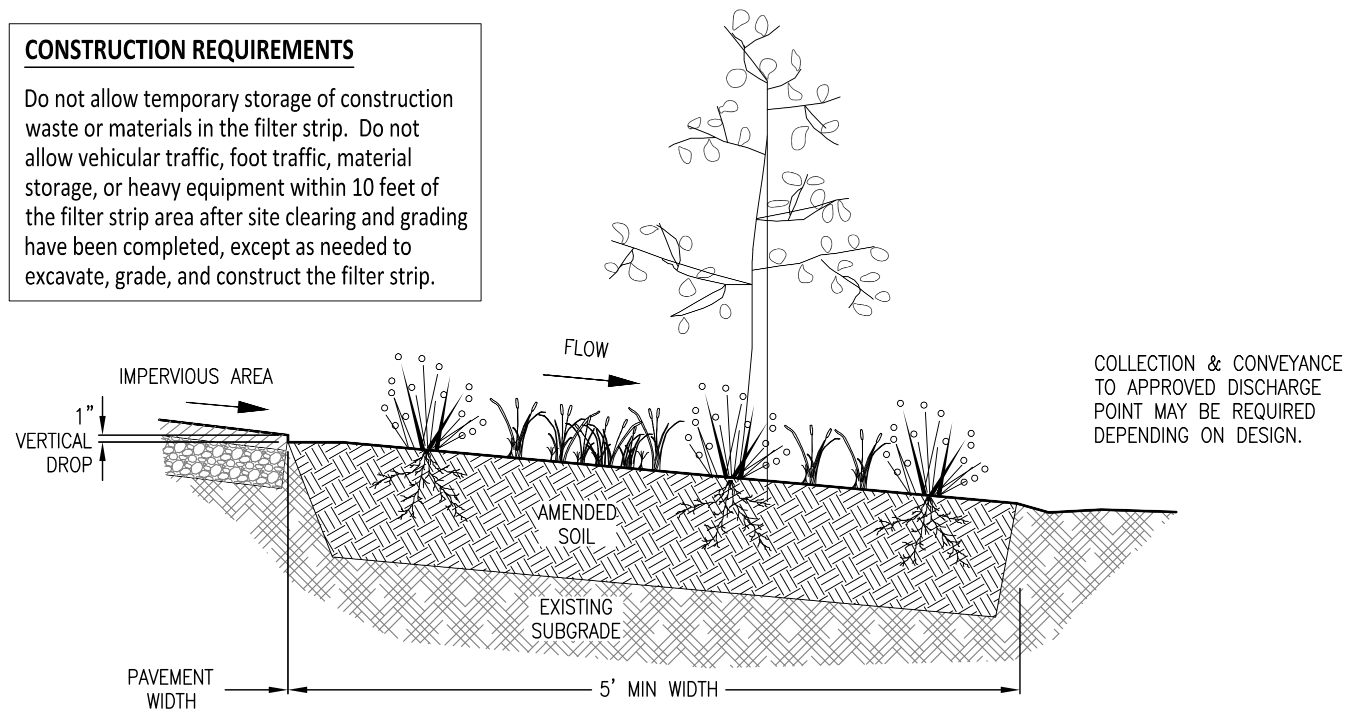
- Mark the location of future filter strips before site work begins.
- Fence or cover filter strip areas.
- Do not allow vehicular traffic, foot traffic, or heavy equipment within 10 ft of the area after site clearing and grading have been completed, except as needed to construct the filter strip.
- Do not allow temporary storage of construction waste or materials in cleared areas or in the finished filter strips.

- Do not allow entry of runoff or sediment during construction.
- Follow all tree protection requirements in PCC Title 11.

Typical Details

The table below lists the detail drawing that follows.

Detail Sheet	Name	Simplified Approach	Performance Approach
SW-160	Filter Strip	X	X



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 and Limits: See sizing table below. Minimum flow line length is 5'
3. Impervious Area Limits: The maximum width that can be managed with a filter strip is 12', and the maximum slope of the impervious area is 10%.
4. Setbacks: 2' from any onsite building without a basement; 6' from any onsite building with a basement; 5' from property lines, except next to the right–of–way.
5. Amended Soil: If area isn't already vegetated, amend native soil by adding 3 inches of yard–debris compost and blending to a depth of 12 inches.
6. Vegetation: The filter strip must have at least 90% coverage by native vegetation, grass or tree canopy.
7. Inspections: Call BDS IVR Inspection Line, (503) 823–7000. Request 487.3 inspections required.

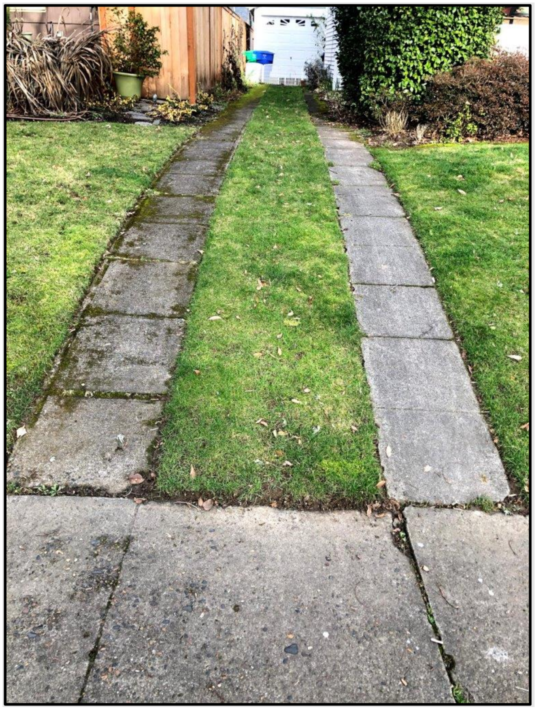
Filter Strip Sizings for the Simplified Approach

Slope	Infiltration Rate	Sizing Ratio*
<10%	≥2"/hr	2/3
	<2"/hr	3

*Ratio of the width of the filter strip to the width of the surface draining to it.

– DRAWING NOT TO SCALE –

3.2.3.2 Driveway Center Strips




A driveway center strip is a pervious center strip that manages sheet flow from the adjacent wheel tracks, filtering the runoff and allowing some or all of the water to soak into the ground. Driveway center strips can be covered with vegetation or gravel.

Design

Driveway center strips must be designed under the Simplified Approach.

Site Suitability: Driveway center strips are appropriate for all soil types.

Catchment Area and Inflow: The wheel tracks must slope toward the center strip and the center strip must be a minimum of 1 inch lower than the adjacent wheel track. Add directional grooves or scoring to wheel tracks to direct water to the center strip.

Sizing: The pervious center strip must be at least 3 ft wide.

Slope: Driveway center strips are prohibited where the longitudinal slope (along the length of the driveway) exceeds 15%, and the length is limited to 50 ft where the longitudinal slope is 10-15%.

Coverage: The pervious center strip must either be 1) fully vegetated with turf grass, native grass, or groundcovers or 2) covered with at least 4 inches of clean, angular gravel no smaller than ¾ inch. Bare earth is not allowed.

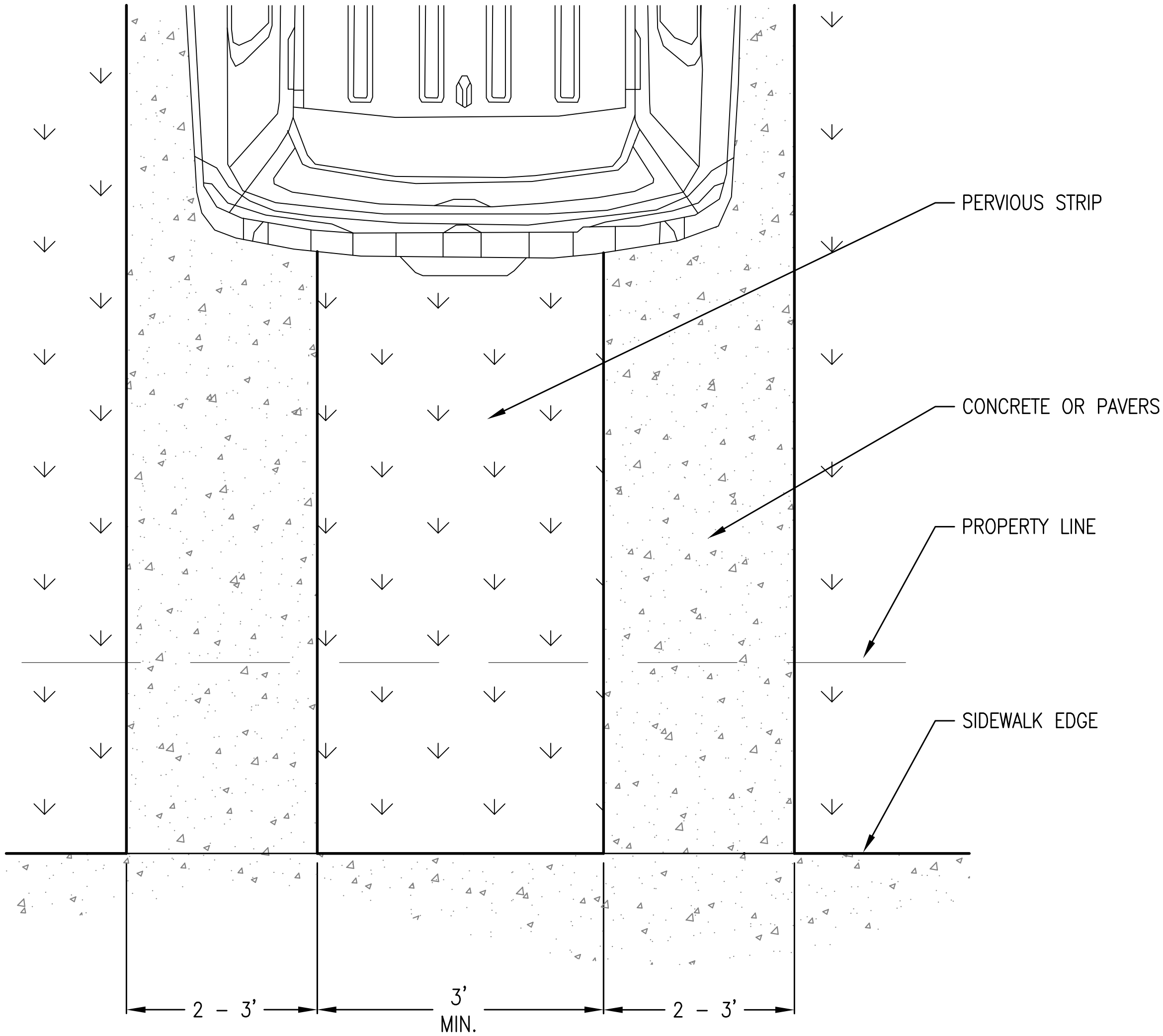
Construction Requirements

Protect the native soil from compaction during construction and amend the soil as described for filter strips if the strip is planted.

Typical Detail

The table below lists the detail drawing that follows.

Detail Sheet	Name	Simplified Approach	Presumptive or Performance Approach
SW-111	Driveway Center Strip	X	



1. Wheel tracks can be concrete, permeable concrete, pavers or concrete grids.

2. The pervious strip must be: 1) turf grass, native grass or groundcovers, or 2) at least 4" of clean, angular gravel no smaller than $\frac{3}{4}$". Bare earth is not allowed.

3. Center strip must be at least 1" lower than adjacent wheel tracks.

4. Add directional grooves or scoring to wheel tracks to direct water to center strip.

5. Driveway center strips are prohibited where the longitudinal slope > 15%, and the length is limited to 50' where the longitudinal slope is 10–15%.

6. Inspections: Call BDS IVR inspection line, (503) 823–7000. Request 487.3 inspections required.

CONSTRUCTION REQUIREMENTS

Protect the center strip from compaction during construction. Do not drive heavy equipment across the area or allow storage of waste or construction materials.

– DRAWING NOT TO SCALE –

Bureau of Environmental Services

STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

DRIVEWAY CENTER STRIP

SW–111

9–2–20

3.2.3.3 Downspout Extensions (Retrofits Only)

Downspout extensions direct roof runoff to existing onsite landscape areas where the runoff can spread and soak into the ground. BES approves this approach only for existing development with suitable circumstances; it is not allowed for new or redevelopment projects.

Design

This approach is allowed only with prior BES approval. Downspout extensions must be designed under the Simplified Approach.

Site Suitability: Downspout extensions are suitable for soils where the tested infiltration rate is at least 2 in/hr. Discharging runoff to landscape areas above buried oil tanks and other structures is prohibited.

Setbacks: See Section 2.2.4 for setback requirements.

Catchment Area and Inflow: A maximum of 500 ft^2 of roof area can drain to an individual downspout extension, and the total roof area managed with downspout extensions cannot exceed 5,000 ft^2 per structure. Extensions must drain directly to areas that can accommodate stormwater flows. They cannot cross walkways or drain onto driveways, patios, or other impervious surfaces.

Sizing: The area of the receiving landscape must be at least 10% of the roof area that drains to it.

Slope and Drainage: The grade of the landscape area must slope gently away from building foundations and neighboring properties, allowing the runoff to spread into the landscape rather than concentrate. The overall slope of the landscape area must not exceed 10%.

Downspout Extension Material: Gutter-grade downspout materials such as aluminum, steel, copper, vinyl, and plastic are acceptable for downspout extensions. Flexible downspout extensions are prohibited.

Securing Downspout Extensions: Downspouts must be secured to the structure, and connections must be securely fastened together with sheet metal screws or similar screws. Rain chains must be securely fastened to the structure and the ground in a vertical alignment that meets setback standards.

Erosion Control: For runoff discharging to a landscape area, install rock or flagstone for erosion control and to disperse flows, unless the landscape area is grass (in that case no erosion control is required). Plastic splash blocks are not allowed.

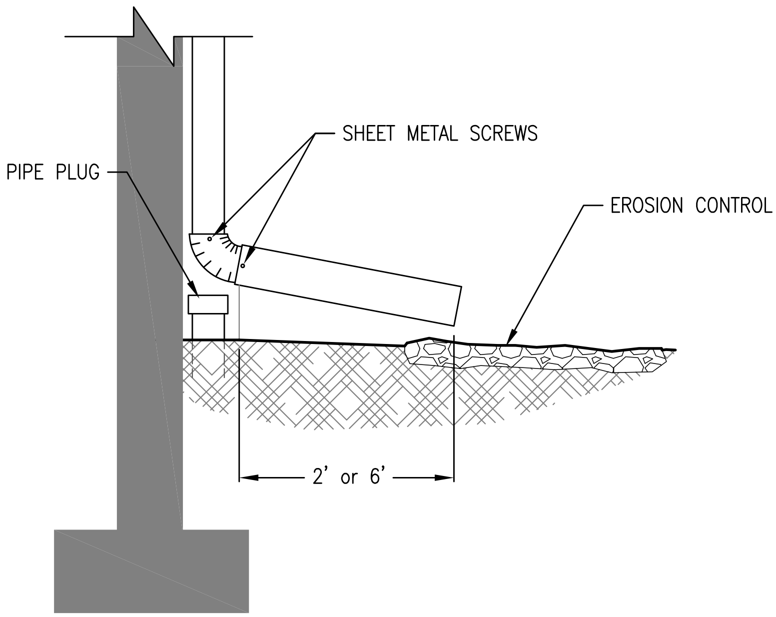
Construction Requirements

Downspouts and gutters may need to be regraded, piped, or redirected to convey water to a safe discharge location so that runoff drains safely away from building foundations and property lines. Downspouts can be fitted in the field to meet the standards based on site conditions. Hinged downspout extensions make it easy to move the extension out of the way during maintenance.

Typical Detail

The table below lists the detail drawing that follows.

Detail Sheet	Name	Simplified Approach	Presumptive or Performance Approach
SW-120	Downspout Extension	X	



1. Applicability: Limited to retrofits of existing areas, only with BES approval.

2. Site Suitability: Suitable for sites with infiltration rates >2" per hour and have an overall slope of 10% or less.

3. Sizing: The footprint of the landscape area where the downspout discharges must be at least 10% of the contributing roof area.

4. Setbacks: The end of the extension must be at least 6 feet from basement walls and at least 2 feet from crawl spaces and concrete slabs, and must be at least 5 feet from the property line (possibly more if the landscape slopes toward the neighbor's property).

5. Do not discharge onto driveways, hardscape or other impervious areas including public sidewalks and streets.

6. Extension materials: Gutter-grade extension materials are required. Flexible hose is prohibited.

7. Entrance Erosion Control: Install river rock, flagstone, or similar materials to dissipate the energy of water discharged by the downspout. No erosion control is required if discharging to lawn. Plastic splash blocks are not allowed.

CONSTRUCTION REQUIREMENTS

Extensions must discharge to areas that can accommodate stormwater flows; they can't cross walkways or drain onto driveways, patios, or other impervious surfaces. Runoff must drain safely away from building foundations and property lines. Downspouts can be field-fit to meet the standards based on site conditions. Hinged downspout extensions or "flipper" extensions are useful for ease of landscape maintenance.

– DRAWING NOT TO SCALE –

3.2.4 Subsurface Infiltration Systems (UICs)

This section provides design and construction requirements for private infiltration facilities classified by the State of Oregon Department of Environmental Quality (DEQ) as underground injection controls (UICs). This section applies to all UICs outside the public right-of-way, including UICs owned and operated by the City that manage runoff from City-owned impervious areas such as parking lots. UICs are typically designed to meet requirements for full onsite disposal of stormwater runoff.

UIC Registration

There are different registration requirements for private UICs and City-owned UICs outside the right-of-way.

Private UICs. Owners or operators of new and existing UICs must register the UIC with DEQ unless the UIC manages roof-only runoff from a single family residential property. DEQ classifies UICs as exempt, authorized by rule, or authorized by permit. Unless DEQ classifies a UIC as exempt, applicants must apply directly to DEQ for a rule authorization or permit. A City Building Permit or Plumbing Permit does not authorize the construction of a UIC. Only DEQ can authorize a private UIC. For contact information, applications, or questions regarding registration, application requirements, or payment, refer to the DEQ UIC website.

City-owned UICs Outside the Right-of-Way. All UICs owned or operated by the City must meet the conditions of the City's Water Pollution Control Facilities Permit for Class V Stormwater Underground Injection Control Systems. BES administers the rule authorization process with DEQ for these UICs, which must be registered with the City's UIC program at BESUIC@portlandoregon.gov.

3.2.4.1 General Design Requirements

This section provides general design requirements that are common to subsurface infiltration systems. Facility-specific design requirements are provided beginning with Section 3.2.4.2.

Pollution Prevention Requirements: UICs can have a direct impact on groundwater. Stormwater runoff therefore must be treated prior to entering a UIC unless the runoff is from roof-only areas or pedestrian-only areas[1]. Table 3-7 presents pretreatment requirements for UICs.

1 See the Oregon DEQ UIC website for exceptions to this statement for roof runoff.

Table 3-7. Pretreatment Requirements for Private UICs

Area	No Pre-treatment Required[1]	Lynch-Style Catch Basin	Sedimentation Maintenance Hole	Stormwater Facility Sized to Treat the Water Quality Storm Event
Pedestrian-only Areas	X			
Roofs	X			
Residential Driveways[2]		X	X	
Sites with <50 Uncovered Parking Spaces or <1,000 Trips per Day[2]		X	X	
Drywells Under Buildings[2]		X	X	
Paved Private Streets with <1,000 Trips per Day			X	
UICs that do not Fit Any of the Above Criteria				X

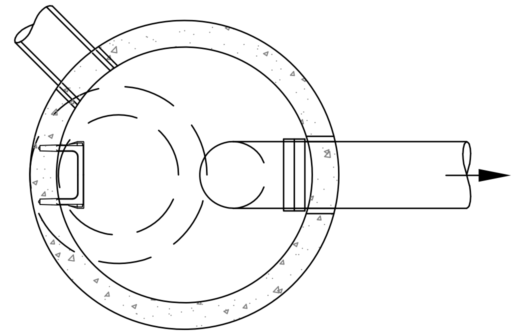
1. Although pre-treatment isn't required, BES recommends it in all cases to increase the life of the facility.
2. Designers have the option of installing either a lynch-style catch basin or sedimentation maintenance hole.

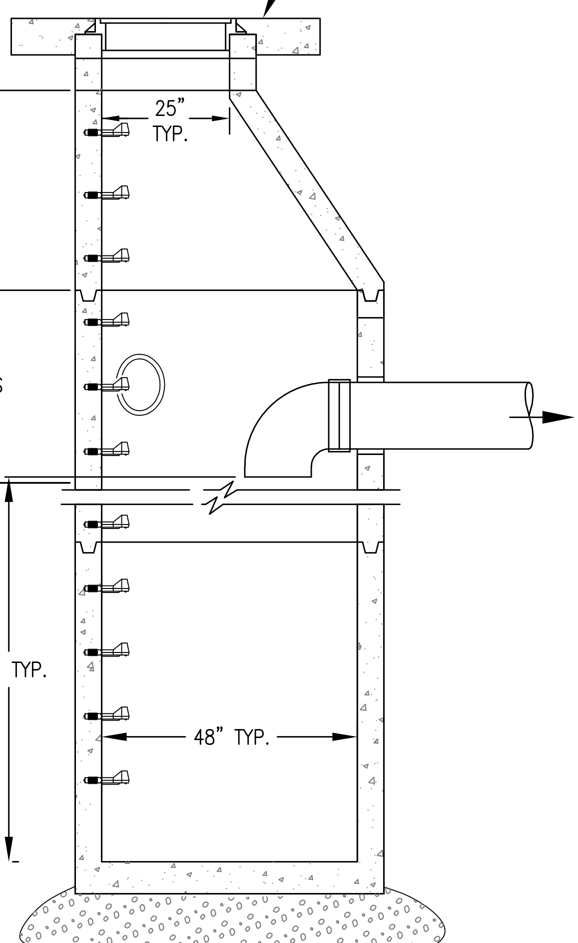
See the City's Source Control Manual for site activities or areas affected by source control requirements. Additional requirements may apply within Wellhead Protection Areas.

Typical Detail

The table below lists the detail drawing that follows.

Detail Sheet	Name	Simplified Approach	Performance Approach
SW-295	Sediment MH		X





- DRAWINGS NOT TO SCALE -

Bureau of Environmental Services

STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

SEDIMENTATION MAINTENANCE HOLE

SW-295

9-8-20

3.2.4.2 Drywells

Drywells are underground structures that capture and hold stormwater runoff, allowing it to infiltrate into the ground. Drywells have a hollow inner ring that is perforated and encased in porous gravel. Residential drywells typically range from 5 ft to 20 ft in depth, although BES allows mini-drywells for smaller catchments.

Design

Standard pre-cast concrete drywells can be designed under the Simplified or Performance Approaches. Drywells that do not meet setback requirements, including drywells under buildings, must be designed under the Performance Approach. Plastic mini-drywells must be designed under the Simplified Approach.

Catchment Area: For drywells designed using the Simplified Approach, the maximum impervious area that can drain to a drywell is 5,000 ft^2. For plastic mini-drywells, runoff from a catchment area of no more than 1,000 ft^2 of impervious area can be managed at a single location; each mini-drywell can manage up to 500 ft^2 with a maximum of two mini-drywells per catchment area.

Site Suitability: A minimum of 5 ft of vertical separation is required between the bottom of the drywell and seasonal high groundwater. For drywells designed under the Simplified Approach, soils must have a tested infiltration rate of at least 2 in/hr. For drywells designed under the Performance Approach, BES requires a minimum design infiltration rate of 2 in/hr unless otherwise approved.

Setbacks:

See Section 2.2.4 for setback requirements. In addition, the following setback requirements apply:

- The top of the perforated drywell sections must be lower than foundations, including foundations for basements. This applies to basements within 10 ft of the drywell for systems designed under the Performance Approach. Consult BDS concerning geotechnical and structural considerations.
- Under the Performance Approach, drywells sized using volume as part of the calculation must be designed so that the maximum water surface elevation during the design storm is at least 1 ft below the lowest finished floor elevation of both onsite and neighboring buildings.
- Setbacks for drywells with greater than 1 ft of gravel between the perforated ring and the soil wall must be measured from the edge of the gravel.

Access: Maintenance access is required for drywells in commercial and industrial settings and for all drywells that do not meet setback requirements including drywells under buildings. A maintenance hole lid is typically required, with adequate space for maintenance vehicles (i.e., the drywell and/or sedimentation maintenance hole must be accessible to a vactor truck). Access for residential installations is optional but recommended; for small residential installations, a surface clean-out port may be most appropriate.

Pretreatment: See Table 3-7 for UIC pretreatment requirements. Where pretreatment is not required, silt traps are strongly recommended to prolong the life of the drywell.

Sizing:

Simplified Approach – For the Simplified Approach, use Table 3-8 to size drywells.

Table 3-8. Simplified Approach Drywells – Sizing Table

	Maximum Catchment Area Managed by a Single Drywell (ft^2)		
Ring Diameter & Type	**24-inch Plastic Mini-DW**	**28-inch Concrete**	**48-inch Concrete**
2 ft Depth	500[1]	NA	NA
5 ft Depth	NA	1000	2500
10 ft Depth	NA	2500	4500
15 ft Depth	NA	3500	5000

1 A maximum of 2 mini-drywells is allowed per catchment area (max catchment = 1,000ft^2)

Performance Approach – For the Performance Approach, size drywells using the following criteria:

- Size drywells to manage the 10-year design storm unless otherwise approved by BES. Drywells under buildings must either be sized for the 100-year design storm or designed with an overland escape route.
- Size drywells using a hydrologic model such as the Santa Barbara Urban Hydrograph method. The design may account for storage in both the drywell and the rock gallery and account for infiltration across the full wetted perimeter.
- The maximum drawdown time, to within 1 ft of the bottom of the drywell (leaving 1 ft of standing water), can be no more than 30 hours.

Dimensions: Concrete drywell rings are either 28 or 48 inches in diameter and come in 5-foot sections. Plastic mini-drywells are 24 inches in diameter and come in 29-inch sections. Drywells are typically encased in 1 foot of gravel on the sides and bottom.

Piping: Oregon Plumbing Specialty Code (OPSC) requirements apply for pipe materials, sizing, and grading.

Construction Requirements

Smearing of the soil surface during excavation can reduce infiltration rates. If smooth excavation tools are used, scratch the sides and bottom of the excavation with a sharp pointed instrument to roughen up the surface. Remove loose material from the bottom of the excavation prior to placement of the drainage aggregate.

Post-Construction Testing

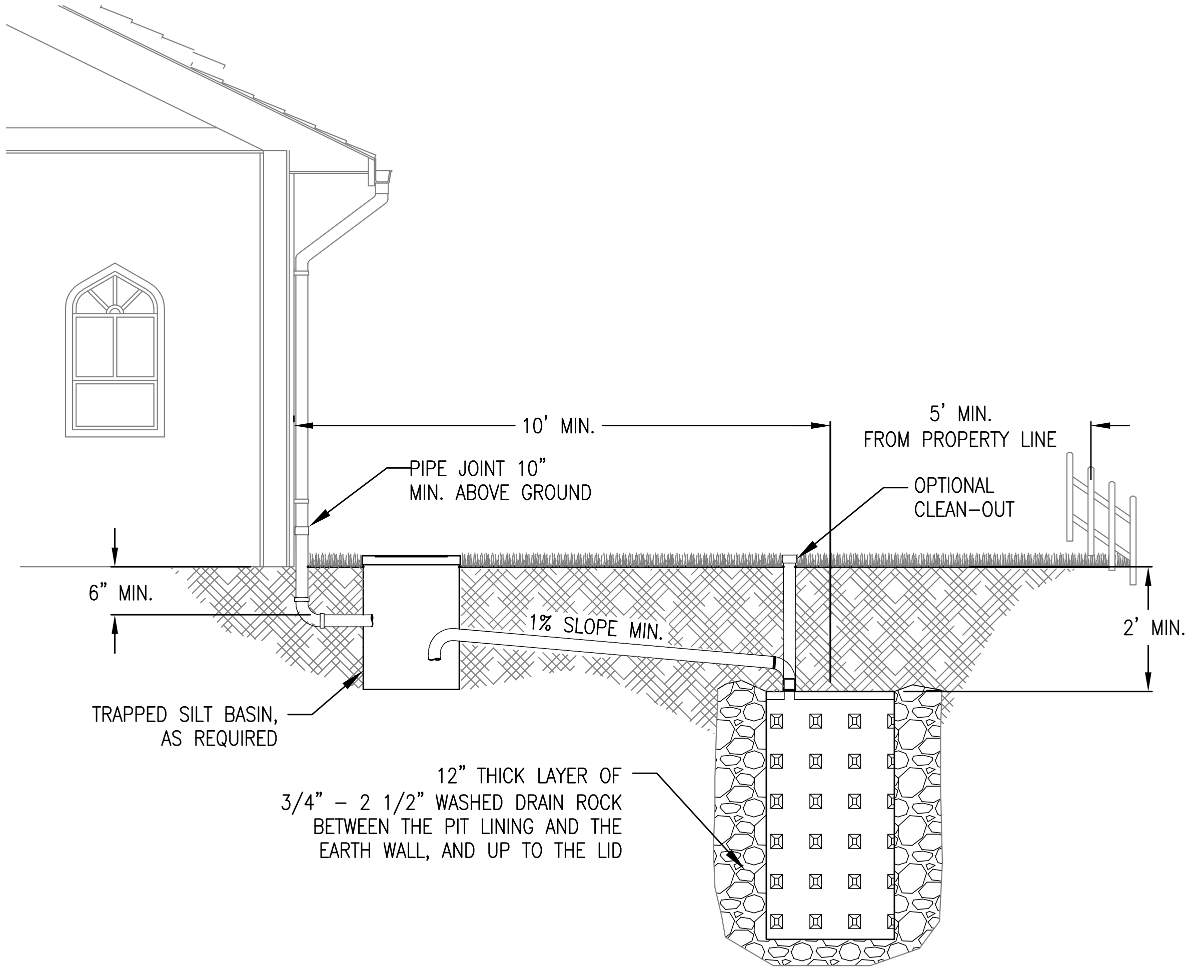
Post-construction testing is required for drywells under buildings. In other circumstances, it is at the discretion of the designer as a potential way to reduce the number of drywells installed or to address specific site conditions. Post-construction testing must meet the following criteria:

- The design engineer, independent tester, or inspector must be present to record test results.
- Maintain the test flow rate for at least 15 minutes, using the design flow rate from the stormwater report or an alternative value from the design engineer.
- Perform one of the following tests to determine the tested rate:
  - A constant head test, monitoring and documenting the inflow rate and recording the depth of water at 5-minute intervals until the depth of water stabilizes for 3 consecutive measurements.
  - A falling head test using the dimensions of the drywell to calculate the volume of water lost during the test and recording the drawdown depth at 5-minute intervals for 30 minutes or until the drywell has drained to within 1 ft of the bottom.
- Apply a safety factor of 2 to the tested infiltration rate.
- Extrapolating a rate for a water depth greater than the tested depth is only allowed if the soil texture is homogenous throughout the depth of the drywell. The extrapolated rate may be no more than 4 times the tested rate.
- Submit results to BES.

Typical Details

The table below lists the detail drawings that follow.

Detail Sheet	Name	Simplified Approach	Performance Approach
SW-180	Drywell	X	
SW-270	Drywell		X



1. Sizing: See adjacent table to size the drywell(s) based on impervious area.

2. Siting Criteria: The base of the drywell must be at least 5' above seasonal high groundwater.

3. Setbacks: Measured from the center, the drywell must be 10' from foundations and 5' from property lines except next to the right-of-way where no setback is required between the edge of the drywell drain rock and the property line. The foundation setback is 8" for plastic mini-drywells.

4. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.

5. Access: In residential settings, an access cleanout is optional but highly recommended.

6. Pre-Treatment: A trapped silt basin such as a sumped catch basin is required except for drywells managing roof runoff and runoff from pedestrian-only areas.

7. The top of the perforated drywell sections must be lower than neighboring foundations.

8. Inspections: Call BDS IVR inspection line, (503) 823-7000. Request 487.3 inspections required.

Drywell Depth	Maximum Catchment Area Managed by One Drywell	
	28" diameter	48" diameter
5'	1000 sf	2500 sf
10'	2500 sf	4500 sf
15'	3500 sf	5000 sf
2x2 plastic mini-drywell (maximum of 2 drywells per catchment)	500 sf	

CONSTRUCTION REQUIREMENTS

Smearing the soil surface during excavation can limit infiltration rates. If smooth excavation tools are used, roughen the sides and bottom of the excavation with a sharp pointed tool. Remove loose material from the bottom of the excavation.

- DRAWING NOT TO SCALE -

Bureau of Environmental Services

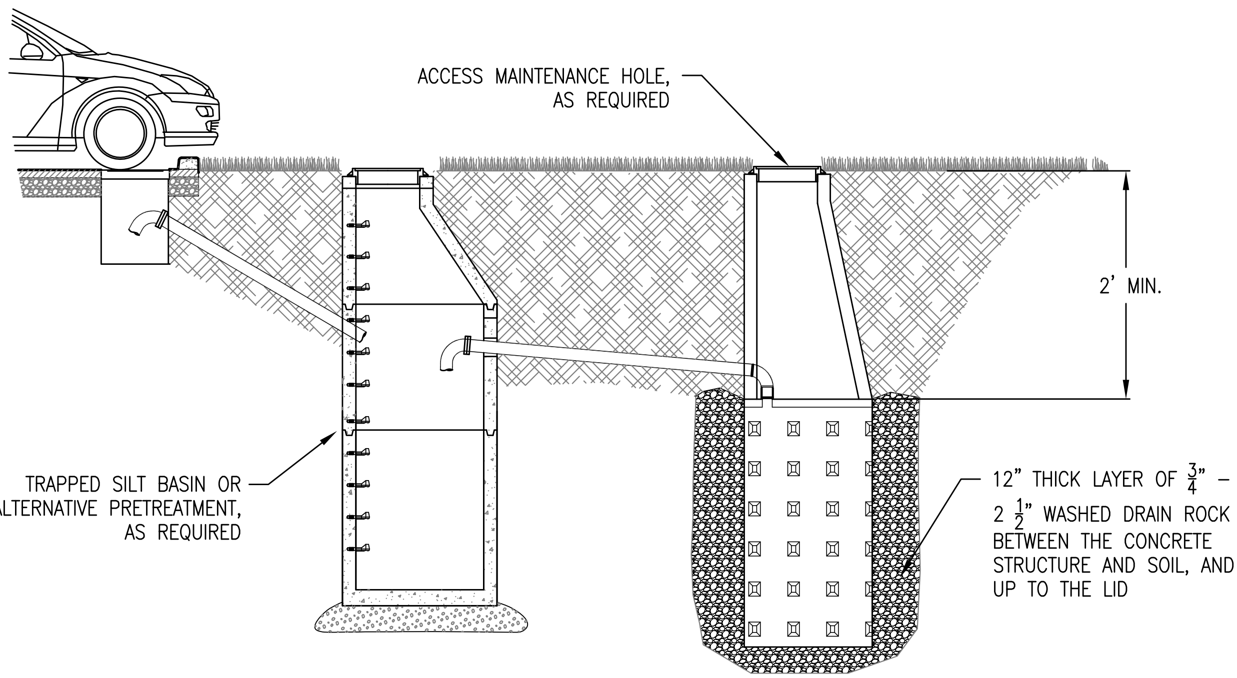
STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

DRYWELL

SW-180

9-2-20

– DRAWING NOT TO SCALE –



1. Detail intended as an example. Detail must match design report.
2. Siting Criteria: The base of the drywell must be at least 5' above seasonal high groundwater, unless otherwise approved. See SWMM Section 2.2 for additional criteria that may restrict infiltration.
3. Sizing: Per stormwater report.
4. Setbacks: Measured from the center, the drywell must be 10' from foundations and 5' from property lines. The exception to the property line setback is next to the right–of–way, where no setback is required between the edge of the drywell drain rock and the property line. Measure all setbacks from the edge of the drain rock if the thickness of the rock layer exceeds 12".
5. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.
6. Access Maintenance Hole: A maintenance hole is required in commercial and industrial settings and for drywells that don't meet setback requirements. Access is highly recommended in residential settings, but not required.
7. Pre–Treatment: A trapped silt basin such as a sumped catch basin is optional only for roof runoff and pedestrian–only paved areas.
8. Inspections: Call BDS IVR inspection line, (503) 823–7000. Request 487.3 inspections required.

CONSTRUCTION REQUIREMENTS

Smearing the soil surface during excavation can limit infiltration rates. If smooth excavation tools are used, roughen the sides and bottom of the excavation with a sharp pointed tool. Remove loose material from the bottom of the excavation.

PERFORMANCE DESIGN APPROACH

Bureau of Environmental Services

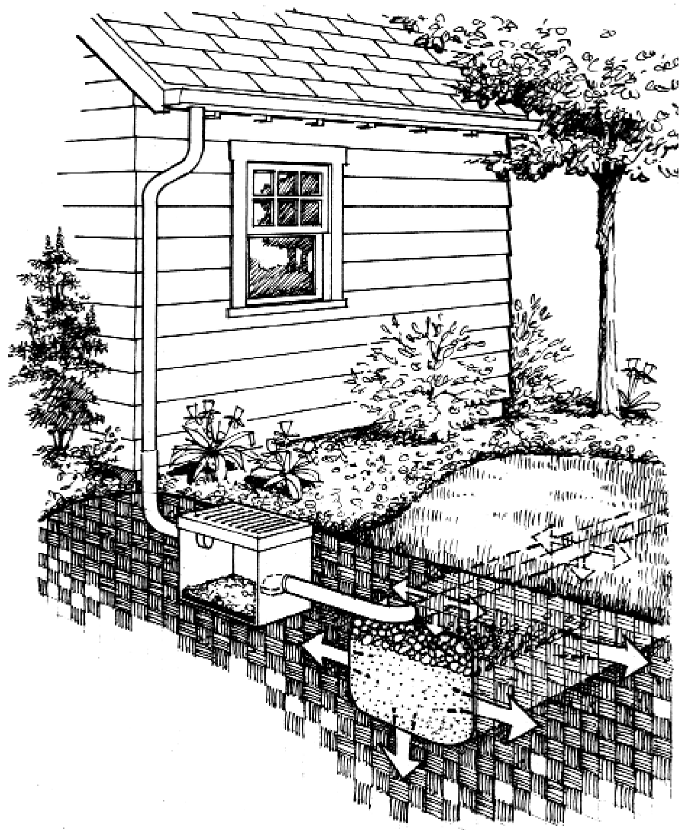
STORMWATER MANAGEMENT TYPICAL DETAILS FOR PRIVATE PROPERTY

DRYWELL

SW–270

9–8–20

3.2.4.3 Soakage Trenches



Soakage trenches are aggregate-filled subsurface trenches that capture and store runoff, allowing the runoff to infiltrate into the ground. Soakage trenches generally are shallower than drywells and they may be used in areas with high groundwater or shallow infiltration barriers such as dense silt and clay layers. Designers can incorporate manufactured chambers to increase the internal volume of the trench.

Design

Soakage trenches can be designed under the Simplified and Performance Approaches. Soakage trenches incorporating manufactured chambers must be designed under the Performance Approach.

Site Suitability: A minimum of 5 ft of vertical separation is required between the bottom of the soakage trench and seasonal high groundwater. Trenches are not allowed under impervious surfaces such as parking lots. For soakage trenches designed under the Simplified Approach, soils must have a tested infiltration rate of at least 2 in/hr. For soakage trenches designed under the Performance Approach, BES requires a minimum design infiltration rate of 2 in/hr unless otherwise approved.

Setbacks:

See Section 2.2.4 for setback requirements. In addition, the following criteria apply:

- The top of the soakage trench must be lower than foundations, including foundations for basements. This applies to basements within 10-ft of the soakage trench for systems designed under the Performance Approach. Consult BDS concerning geotechnical considerations.

- Under the Performance Approach, soakage trenches sized using volume as part of the calculation must be designed such that the maximum water surface elevation for the design storm is at least 1-ft below the lowest finished floor elevation of both onsite and neighboring buildings.

Access: An access port to the perforated pipe is optional but recommended.

Pretreatment: See Table 3-7 for UIC pretreatment requirements. Where pretreatment is not required, silt traps are strongly recommended to prolong the life of the soakage trench.

Sizing:

Simplified Approach – Under the Simplified Approach, the minimum sizing is 25 ft^2 of soakage trench (footprint) per 500 ft^2 of impervious area.

Performance Approach – Under the Performance Approach, the designer may account for infiltration across the full wetted area of the trench. The facility must infiltrate the 10-year storm. The minimum drawdown time for a soakage trench is 30 hours.

If sized using manufactured chambers, see the manufacturer's specifications concerning the dimensions and water holding capacity of the chambers.

Dimensions:

Simplified Approach –

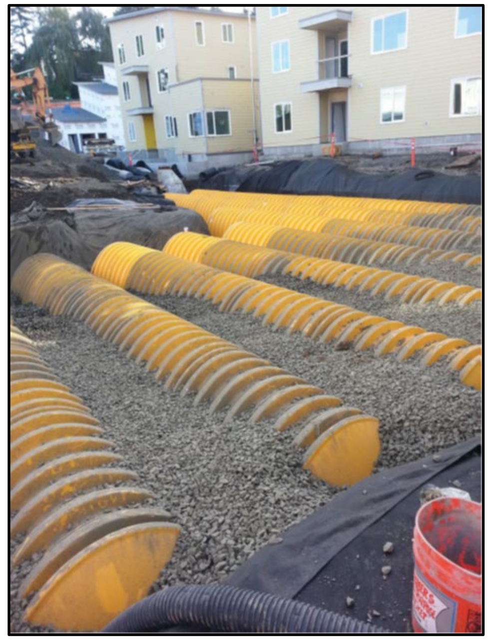
- Install 18 inches of drain rock with a capping soil layer that is 12 inches deep.
- The minimum width of the trench is 2.5 ft under the Simplified Approach.

Performance Approach – The designer has flexibility in determining the dimensions of the soakage trench.

Drainage Layer: Install ¾- to 2½-inch clean aggregate (round or crushed). The pore space of the drain rock should be at least 30%. If sizing using manufactured chambers, include at least six inches of drain rock below the chambers.

Geotextile Fabric: Use appropriate filter fabric between the drainage layer and native soil along the sides and ends of the soakage trench. Cover the perforated pipe with the same fabric to prevent clogging.

Piping: Oregon Plumbing Specialty Code (OPSC) requirements apply for pipe materials, sizing, and grading. Install either PVC D2729 or HDPE leach field pipe within the trench. Install the perforated pipe on top of the aggregate layer.



Manufactured chambers (optional): Manufactured chambers are generally made of high-density polypropylene or polyethylene. They are arched and can be rated for H-10 or H-20 loading, depending on the manufacturer, amount of cover, and type of cover.

Construction Requirements

Clearly mark facility areas before site work begins to avoid soil disturbance during construction. Do not allow vehicular traffic within 10 ft of soakage trench areas, except as needed for construction activities.

The bottom of the soakage trench either must be level or clay check dams must be installed to prevent water from collecting near the downstream end. The perforated pipe must be level.

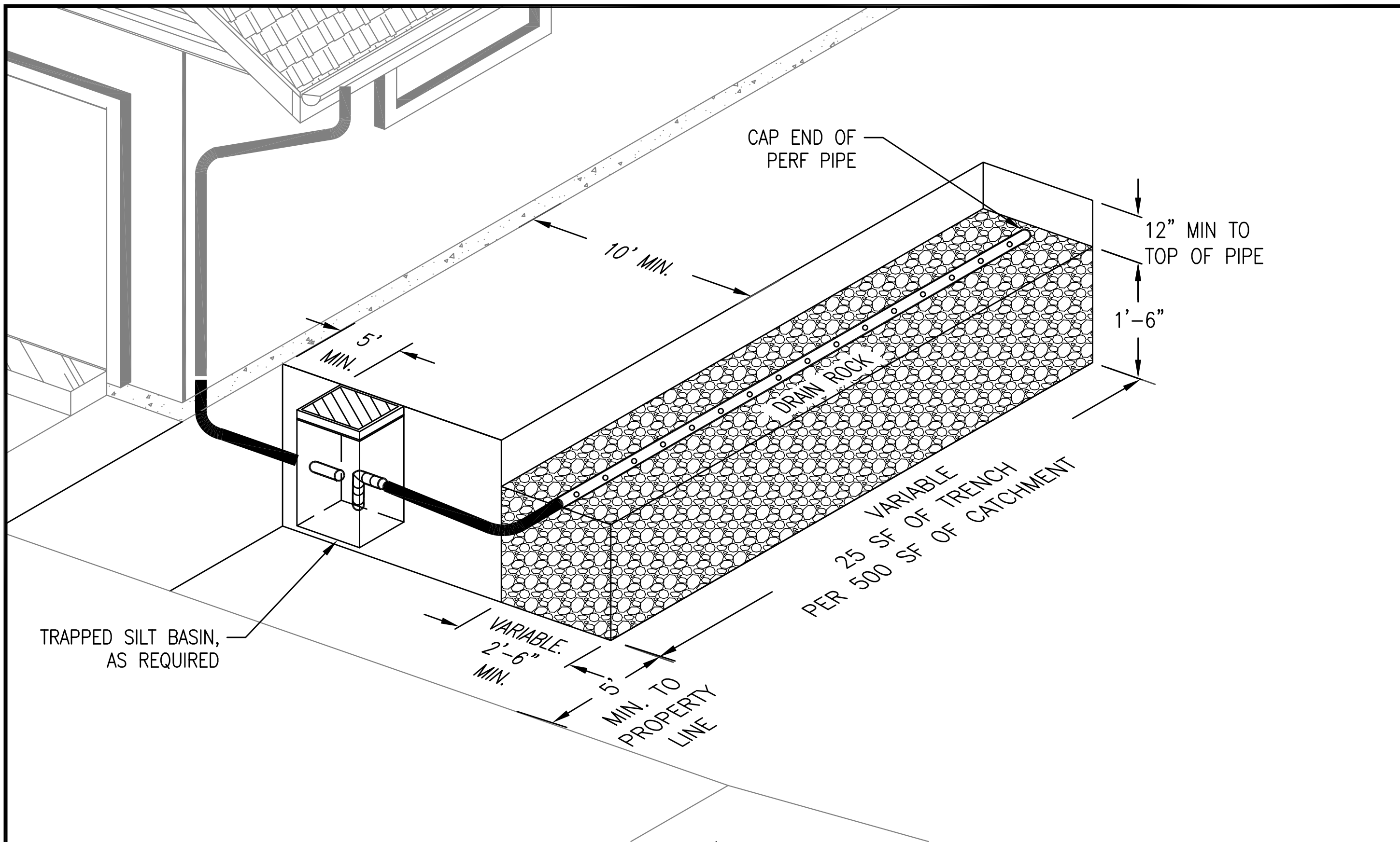
Smearing of the soil surface during excavation can reduce infiltration rates. If smooth excavation tools are used, scratch the sides and bottom of the excavation with a sharp pointed instrument to roughen up the surface. Remove loose material from the bottom of the excavation prior to placement of the drainage aggregate.

Do not plant trees over soakage trenches because of the potential for damage to the perforated pipe by roots.

Typical Details

The table below lists the detail drawings that follow.

Detail Sheet	Name	Simplified Approach	Performance Approach
SW-170	Soakage Trench	X	
SW-260	Soakage Trench		X



1. Siting Criteria: The base of the soakage trench must be at least 5' above seasonal high groundwater.

2. Sizing: 1'–6" tall, 2'–6" wide minimum. 25 square feet of trench per 500 square feet of catchment area.

3. Setbacks: Measured from the edge, the soakage trench must be 10' from foundations and 5' from property lines, except next to the right–of–way.

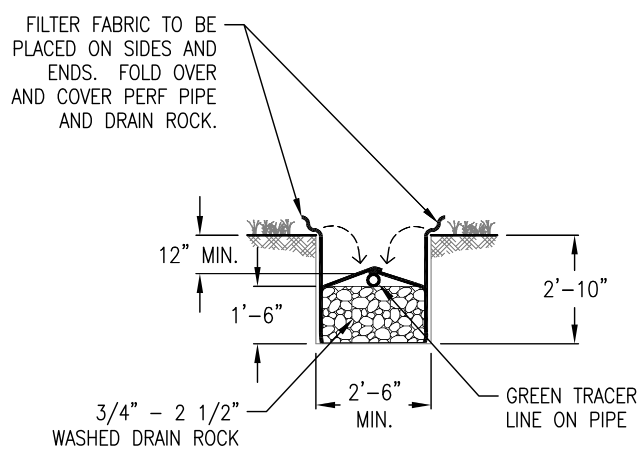
4. Pre–Treatment: A trapped silt basin such as a sumped catch basin is required except for soakage trenches managing roof runoff and runoff from pedestrian–only areas.

5. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.

6. The top of the soakage trench must be lower than foundations, including basements within 10 feet of the soakage trench.

7. Inspections: Call BDS IVR inspection line, (503) 823–7000. Request 487.3 inspections required.

SECTION

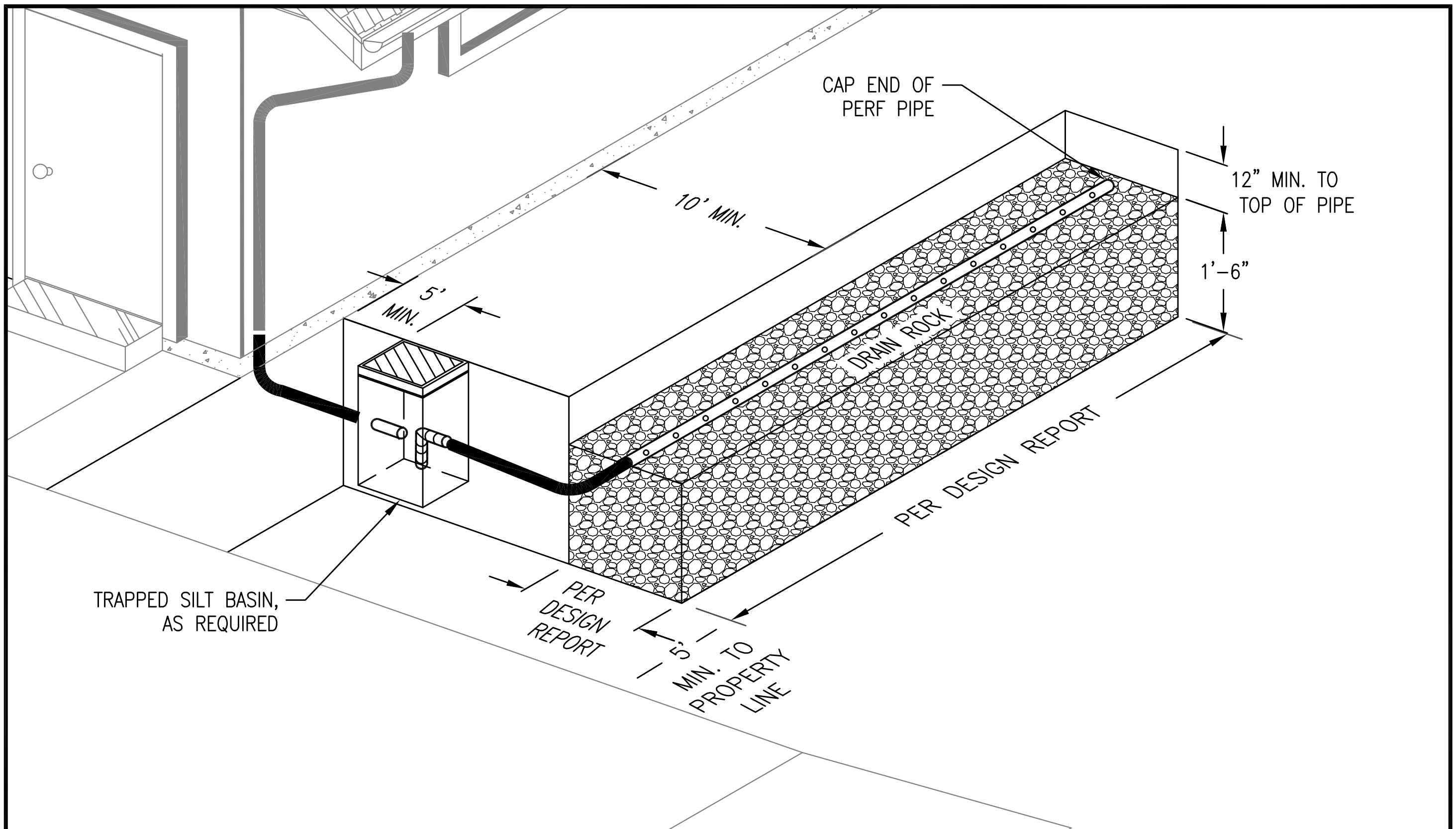


LINE TRENCH SIDES WITH PERMEABLE FILTER FABRIC AS SHOWN, ADD 18" OF DRAIN ROCK. PLACE PERF. PIPE AND COVER ALL.

CONSTRUCTION REQUIREMENTS

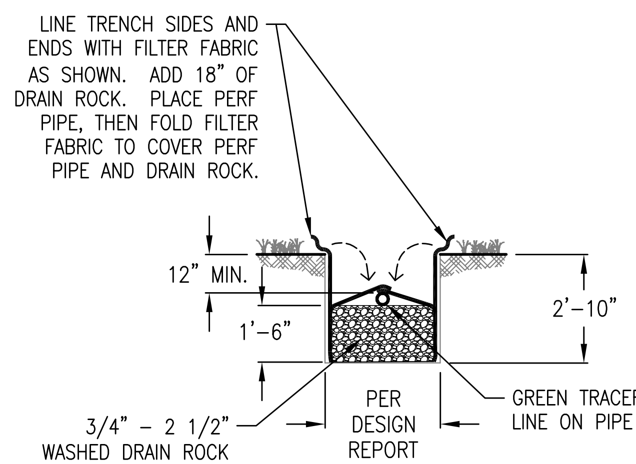
The outline of the facility must be clearly marked before site work begins to avoid soil disturbance. Use of heavy equipment should be minimized within 10 feet of soakage trench areas. The bottom of the soakage trench and the perforated pipe must be level. Clay check dams may be used to prevent water from collecting near the downstream end. Smearing the soil surface during excavation can potentially limit infiltration rates; if smooth excavation tools are used, roughen the sides and bottom of the excavation with a sharp pointed tool. Remove loose material from the bottom of the excavation.

– DRAWINGS NOT TO SCALE –



1. Detail intended as an example. Detail must match design report.
2. Siting Criteria: The base of the soakage trench must be at least 5' above seasonal high groundwater, unless otherwise approved.
3. Sizing: Per design report.
4. Setbacks: Measured from the edge, the soakage trench must be 10' from foundations and 5' from property lines. The exception to the property setback is next to the right–of–way, where no setback is required.
5. Pre–treatment: A trapped silt basin such as a sumped catch basin is optional only for roof runoff and pedestrian–only paved areas.
6. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.
7. Inspections: Call BDS IVR inspection line, (503) 823–7000. Request 487.3 inspections required.

SECTION



CONSTRUCTION REQUIREMENTS

The outline of the facility must be clearly marked before site work begins to avoid soil disturbance. Use of heavy equipment should be minimized within 10 feet of soakage trench areas. The bottom of the soakage trench and the perforated pipe must be level. Smearing the soil surface during excavation can potentially limit infiltration rates; if smooth excavation tools are used, roughen the sides and bottom of the excavation with a sharp pointed tool. Remove loose material from the bottom of the excavation.

– DRAWINGS NOT TO SCALE –

3.2.4.4 Subsurface Sand Filters

Subsurface sand filters capture, store, and treat runoff. They can be sized for flow control in additional to treatment, and unlined sand filters can provide partial or complete onsite infiltration depending on infiltration rates. Lined sand filters can be constructed immediately adjacent to buildings.

Design

Subsurface sand filters must be designed under the Performance Approach.

Site Suitability: A minimum of 5 ft of vertical separation is required between the bottom of an unlined or partially lined subsurface sand filter and seasonal high groundwater. BES requires a minimum design infiltration rate of 2 in/hr unless otherwise approved, per the requirements of the Performance Approach.

Setbacks: See Section 2.2.4 for setback requirements. The additional setbacks for soakage trenches apply to subsurface sand filters (see Section 3.2.4.3).

Access: An access port to the perforated pipe is optional but recommended.

Pretreatment: See Table 3-7 for UIC pretreatment requirements. Where pretreatment is not required, silt traps are strongly recommended to prolong the life of the sand filter.

Sizing: The designer may account for infiltration across the full wetted area of the sand filter. The facility must infiltrate the 10-year storm. The minimum drawdown time for a soakage trench is 30 hours. A design infiltration rate of 1 in/hr is required for the filter sand.

Dimensions:

- Total excavated depth: 58 inches, including 12 inches of cover
- Filter sand depth: 30 inches
- Minimum freeboard: 2 inches above the overflow inlet elevation

Drainage Layer: Where the drain rock provides storage, the specification is 1½-to ¾-inch washed aggregate. Where the drain rock is primarily for detention and conveyance, the specification is ¾-inch washed aggregate. Use ¾-inch washed drain rock in lined facilities. Separate the layer of drain rock from the sand layer with geotextile fabric or a 2- to 3-inch layer of ¾- to ¼-inch washed, crushed rock.

Piping: Oregon Plumbing Specialty Code (OPSC) requirements apply for pipe materials, sizing, and grading. Where a collector manifold with perforated lateral branch lines is used, lateral branch line spacing must not exceed 10 ft. Underdrain laterals must have positive gravity drainage to the collector manifold. The collector manifold must have a minimum 1% grade toward the discharge point. All laterals and collector manifolds must have cleanouts that are accessible from the surface without removing or disturbing the filter media.

Sand Gradation: The sand must be washed sand meeting the particle gradation in Table 3-9. BES will require documentation from a sieve analysis.

Table 3-9. Filter Sand Specification[1]

Sieve Size	Percent Passing
3/8 inch	100
#4	95–100
#8	80–100
#16	50–85
#30	25–60
#50	5-30
#100	0-10
#200	0-3

1 *This specification meets the* ***ASTM C33*** *specification for concrete sand.*

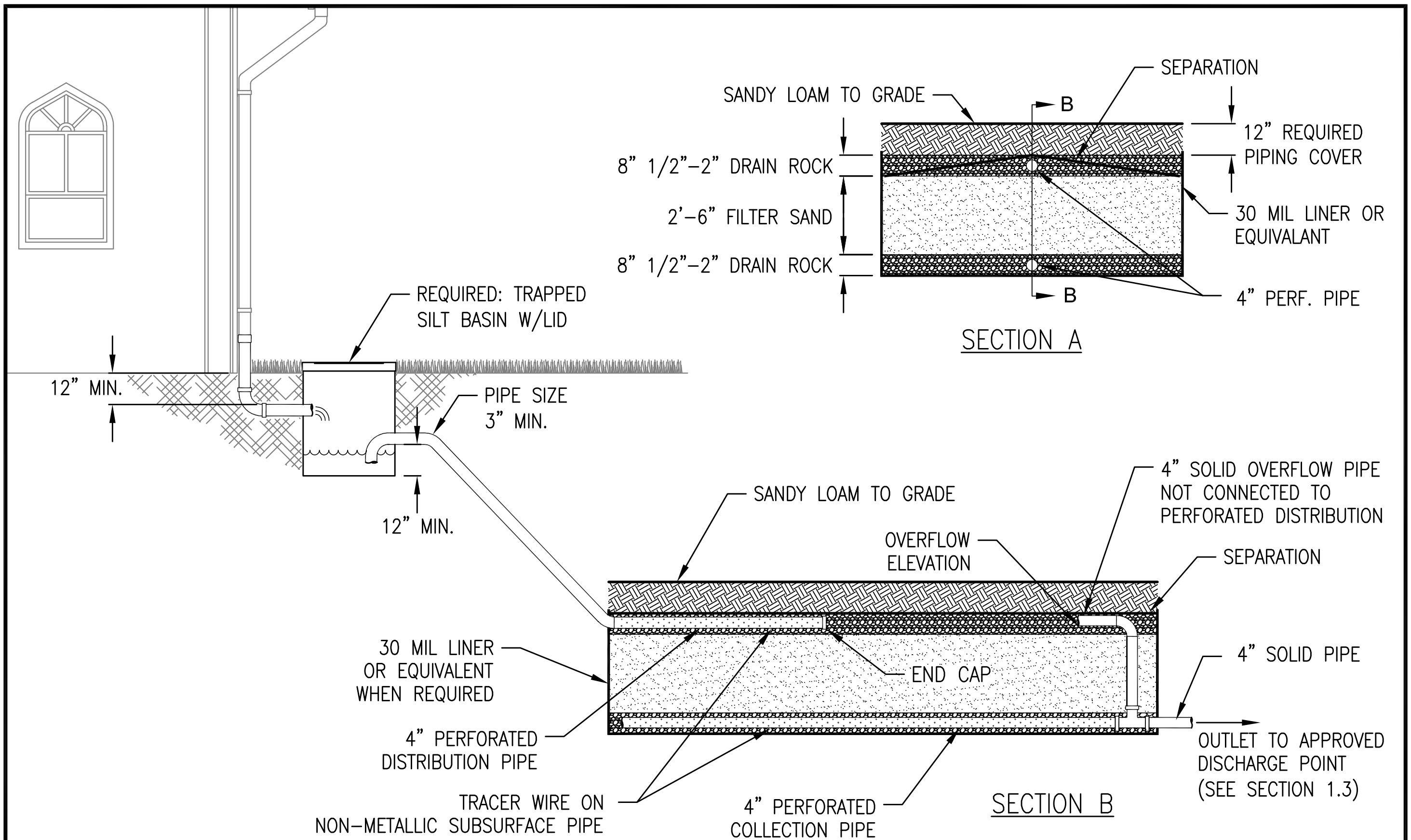
Construction Requirements

The construction requirements for soakage trenches apply (see Section 3.2.4.3)

Typical Details

The table below lists the detail drawing that follows.

Detail Sheet	Name	Simplified Approach	Performance Approach
SW-280	Subsurface Sand Filter		X



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to and during construction.

2. Setbacks: Setbacks aren't required for lined facilities. Setbacks for infiltration facilities, measured from the facility edge, are 10' from foundations and 5' from property lines except next to the right-of-way.

3. Trapped silt basin required prior to inlet to subsurface sand filter.

4. Overflow: Perforated collection pipe within top gravel layer.

5. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.

6. Drain Rock and Filter Sand:
   a. 8" of 3/4" washed drain rock as base.
   b. 30" of washed filter sand per SWMM Section 3.2.4.4.
   c. 8" top layer of 3/4" washed drain rock over sand.
   Separation between drain rock and sand: Use filter fabric or a gravel lens (3/4 – 1/4 inch washed, crushed rock 2 to 3 inches deep) or approved equivalent.

7. Waterproof Liner: Must be 30 mil EPDM, HDPE or equivalent for facilities when lining is required.

8. Inspections: Call BDS IVR Inspection Line, (503) 823-7000. Request 487.3 inspections required.

CONSTRUCTION REQUIREMENTS

The location of the infiltration sand filter must not be compacted prior to, during, and after the construction of the facility.

– DRAWINGS NOT TO SCALE –

3.2.5 Other Stormwater Facilities

This section provides design and construction requirements for private stormwater facilities not described in the preceding sections.

3.2.5.1 Manufactured Stormwater Treatment Technologies (MSTTs)

Manufactured Stormwater Treatment Technologies (MSTTs) are manufactured devices designed to treat stormwater. BES has approved a number of MSTTs for use in the City of Portland based on their compliance with BES' pollution reduction requirements for discharging to stormwater-only systems. The list of approved MSTTs is posted on the BES website. The website includes links to the conditions of use for each device. The conditions include the unit sizings required to meet the City's pollution reduction requirements.

BES will approve the use of an MSTT only after the designer has demonstrated a vegetated surface facility is infeasible.

Design

MSTTs must be designed to treat the water quality storm event using the Performance Approach. Projects proposing the use of MSTTs must use devices on the BES list of approved devices and also meet BES' specified conditions of use, including sizing requirements. See Section 2.5 for circumstances in which designers may seek BES approval for an MSTT that is not on the BES list of approved MSTTs. The design must provide reasonable access for maintenance activities.

Design MSTTs in accordance with the manufacturer's specifications. The design must be completed with the input of the manufacturer.

Submittal Requirements

See Section 3.4 for general submittal requirements for the Performance Approach and facility-specific submittal requirements that apply for MSTTs.

Construction Requirements

Manufacturers may require specific installers and installation techniques. Install MSTTs per the manufacturer's specifications.

3.2.5.2 Rainwater Harvesting

Rainwater harvesting systems collect and store stormwater runoff for non-potable uses within a house or building or for landscape irrigation. Runoff can be collected for use in toilets and at hose bibs. Rainwater harvesting can help reduce the volume of stormwater a site discharges to the separate or combined sewer systems when onsite infiltration is not feasible. A percentage of the annual runoff volume can be reused, depending on the size of the water storage facility and the rate of use. Where a site's full stormwater management obligation cannot be met, the systems can manage a portion of the flow and lessen the scope of the requirement for stormwater management.

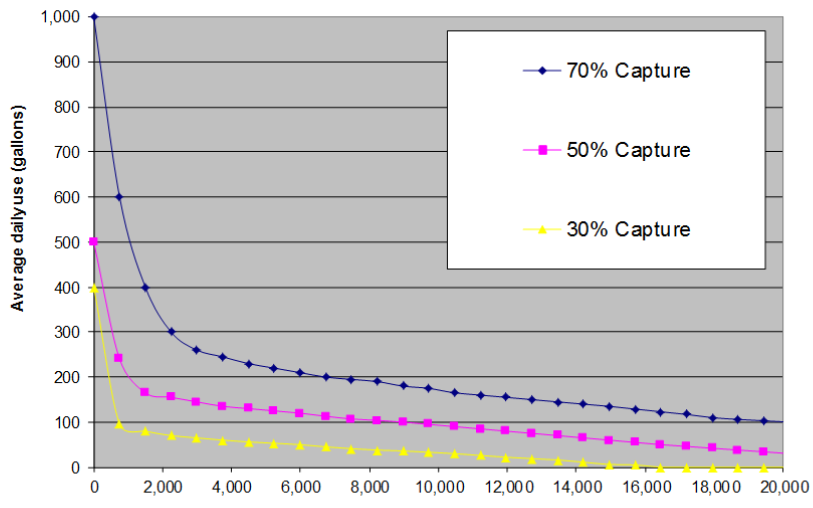
Design

Rainwater harvesting systems must be designed under the Performance Approach.

Sizing: The designer must demonstrate how the design meets the requirements of Chapter 1 for any offsite discharge.

The simple analysis provided below is as an example of one of the types of sizing calculations that may be useful for sizing a rainwater harvesting system. Figure 3-2, below, presents the results of an analysis of a 5,000 ft^2 project site with 100% impervious surface. The analysis used 8.5 months of 5-minute rainfall intensity data from Portland's Fernwood rain gage. The figure shows the relationship between water storage volume and average daily water use for average annual runoff capture goals of 30%, 50%, and 70%.

Figure 3-2. Average Annual Runoff Capture Rates for 5,000 ft^2 of IA



In this example, if the stormwater management goal is a 50% reduction in the annual release volume, the pink (middle) line shows an average daily use of approximately 160 gallons per day would be needed if a 2,000-gallon tank was used. A larger tank would need a smaller average daily use rate to achieve the same stormwater management goal of 50% reduction in the annual volume.

Cisterns: For toilets, a separate cistern is needed for each residence in a multi-unit dwelling. For landscape irrigation, a shared cistern can be used.

Plumbing and Backflow Prevention. All systems must have plumbing approval from BDS. The Portland Water Bureau requires containment backflow protection in the form of a reduced pressure (RP) backflow assembly. Locate backflow assemblies at the property line, immediately adjacent to the location of the water service connection.

Meters: Sewer rates are based on domestic water usage. If a rainwater harvesting system is installed, additional meters may be required to accurately bill for the discharge of sanitary sewage.

Signs: All toilets and hose bibs must have permanent signs notifying users of non-potable water.

Submittal Requirements

See Section 3.4 for general submittal requirements and facility-specific submittal requirements that apply for rainwater harvesting.

3.2.5.3 Structured Detention Facilities

Structured detention facilities store stormwater as part of a flow control system. Examples of structured detention facilities include tanks, vaults, and oversized pipes. Tanks and vaults can be used in conjunction with other stormwater facilities to provide initial or supplemental storage. They do not provide water quality treatment; additional facilities are required to meet pollution reduction requirements.

Design

Structured detention facilities must be designed under the Performance Approach.

Site Suitability: Place tanks and vaults on stable, consolidated native soil with suitable bedding. Do not install tanks and vaults in fill slopes unless a geotechnical analysis confirms the suitability of the installation.

Pretreatment: Structured detention facilities either must include an upstream sedimentation system (e.g., a sedimentation maintenance hole or a sediment containment pond), or they must be oversized to allow for temporary accumulation of sediment.

Access: All areas of a tank or vault must be within 50 ft of a minimum 36-inch-diameter access entry cover. Access openings must have round, solid, locking lids. Enclose any weir and orifice structures in a catch basin, maintenance hole, or vault that is accessible for maintenance.

Sizing: Where the tank or vault is designed to provide sediment containment, provide a minimum of ½ ft of dead storage, and lay the tank or vault flat. Design the flow control structure to safely convey the 100-year storm event as overflow without causing flooding of the contributing drainage area.

Materials and Structural Stability: The system must withstand periodic inundation, potentially corrosive chemical or electrochemical soil conditions, and heavy ground and surface loadings. All tanks, vaults, and pipes must meet applicable structural requirements for overburden support and traffic loadings. Design tanks and vaults under parking areas to accommodate H-20 live loads. Design end caps for structural stability at maximum hydrostatic loading. Construct detention vaults of structural reinforced concrete (3,000 psi, ASTM 405). All tanks and vaults must be lined, and all construction joints must have water stops. Ballasting may be required in soils where groundwater might induce buoyancy. Use concrete or earth backfill, providing concrete anchors or other counteractive measures.

Oregon Plumbing Specialty Code (OPSC) requirements apply for pipe materials, sizing, and grading.

Orifices:

Orifices are typically required to meet flow control requirements. See Chapter 1 for design standards and general sizing requirements that apply to projects using orifices. Equations for orifice control calculations can be found in Chapter 8 of the BES Sewer and Drainage Facilities Design Manual.

Orifices may be constructed on a traditional "tee" riser section or as part of a baffle system. Orifices must be easily accessible for maintenance in case the orifice clogs. The designer is responsible for selecting a suitable orifice configuration to meet engineering requirements and ensure maintenance is feasible.

Minimum Diameter and Clogging Protection – The minimum diameter for orifices is based on the potential for clogging. Filtered flow (e.g., flow that has been filtered by flowing through the blended soil of a bioretention facility, a sand filter, or an MSTT device) is less likely to clog orifices and therefore orifices taking only filtered flow can be smaller. Unfiltered flow (e.g., flow from overflow pipes, ponds, or underdrains of hybrid facilities) is more likely to contain material that can clog orifices and therefore orifices taking any unfiltered flow must be larger. The following requirements apply to orifices:

- Minimum size for orifices taking only filtered flow: 3/8 inch in diameter. Additional protection is not required.
- Minimum size for orifices taking any unfiltered flow: 1 inch in diameter, with protection. Protect the orifice by surrounding it with stainless steel screening (i.e., hardware cloth) with a mesh of ¾ inch or less.

Materials – Use a strong, thin material such as stainless steel, HDPE, or PVC for the orifice plate if the orifice is less than 3 inches in diameter. The thickness of the orifice plate must be less than the diameter of the orifice. The plate must be secured to the structure.

Orifices may not meet the minimum size requirements when designed to meet performance requirements for small storms, particularly in areas with municipal separate storm sewer systems (Hierarchy Level 2). In those cases, the designer should rely on partial infiltration or other retention systems to the maximum extent practicable to meet flow control requirements.

Multiple orifices may be necessary to meet the 2- through 25-year design storm performance requirements for a detention system. Large projects may result in high flow rates requiring large orifices that are impractical. In such cases, locate multiple orifices at the same elevation to reduce the size of the individual orifices.

Submittal Requirements

See Section 3.4 for general submittal requirements and facility-specific submittal requirements that apply for structured detention facilities.

3.2.5.4 Surface Sand Filters

Surface sand filters are walled facilities that capture, store, and filter stormwater runoff. They can be designed for total or partial infiltration depending on soil infiltration rates. They can be lined if conditions do not allow for infiltration.

Design

BES approval is required for the use of surface sand filters. BES typically only approves surface sand filters where vegetated planters are infeasible due to shady conditions or other constraints. Surface sand filters can be designed under the Simplified Approach or the Performance Approach.

Setbacks: See Section 2.2.4 for setback requirements.

Access: See access requirements in Section 3.2.2.1.

Pollution Prevention: See pollution prevention requirements in Section 3.2.2.1.

Sizing:

Simplified Approach – Surface sand filters designed under the Simplified Approach must have a sizing ratio of 6% relative to the impervious area draining to them.

Performance Approach – Surface sand filters designed under the Performance Approach must be sized to meet applicable water quality, flow control, and disposal requirements. A design infiltration rate of 1 in/hr is required for the filter sand.

Dimensions and Slopes:

All surface sand filters –

- Minimum width: 2 ft, measured from the insides of the walls
- Minimum freeboard: 2 inches
- Minimum depth of the filter sand: 24 inches
- Maximum slope of the sand surface: 0.5% in any direction

Simplified Approach –

- Ponding depth: 12 inches

Performance Approach –

- Maximum ponding depth: 18 inches
- Sloped sand filters aren't allowed
- Design infiltration rate of the sand media: 6 in/hr.

Drainage and Overflow:

Simplified Approach – Surface sand filters designed under the Simplified Approach must have an underdrain with an overflow pipe unless otherwise approved.

Performance Approach – The surface sand filter must have an underdrain system and/or an overflow pipe unless the facility infiltrates the 10-year event.

Forebays: BES recommends adding a forebay to the design to protect the sand filter from inputs of sediment, debris, and leaves. Sand filters are more prone to clogging with sediment and organics than vegetated systems as they lack the plant root systems that help maintain infiltration rates in vegetated systems.

Components/Materials: Section 3.2.2.1 provides requirements for the following components that surface sand filters share with bioretention facilities: walls, liners, and waterproofing; piping; drain aggregate; pipe overflow configurations; flow control orifices; check dams; flow dissipators; and entrance erosion control.

Sand Specification: The filter sand must be clean, washed sand that meets the particle gradation specification in Table 3-9.

Construction Requirements

See standard construction requirements for bioretention facilities in Section 3.2.2.2.

Submittal Requirements

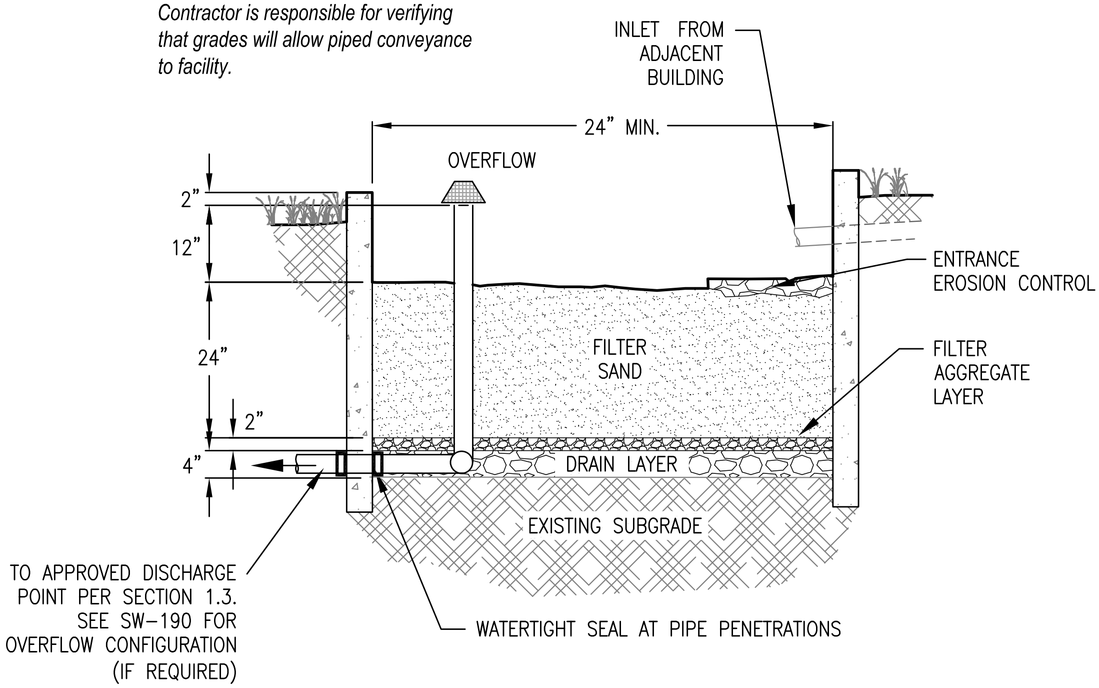
See Section 3.4 for general submittal requirements and facility-specific submittal requirements that apply for surface sand filters.

Typical Details

The table below lists the detail drawings that follow.

Detail Sheet	Name	Simplified Approach	Performance Approach
SW-142	Unlined Surface Sand Filter	X	
SW-143	Lined Surface Sand filter	X	

Contractor is responsible for verifying that grades will allow piped conveyance to facility.



1. Setbacks: 10' from building foundations; 5' along property lines except next to right-of-way. Walls can't exceed 30" height above grade if within 5' of property line including right-of-way.

2. Facility Slope (sand surface): Maximum of 0.5% in all directions.

3. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.

4. Drain Layer: 4" of $\frac{3}{4}$"–1 $\frac{1}{2}$" washed drain rock. Filter aggregate layer: 2–3" of $\frac{1}{4}$"–No.10 washed angular aggregate.

5. Overflow: Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.

6. Filter Sand: Install 24" of filter sand. See sand spec. in SWMM section 3.2.5.4.

7. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.

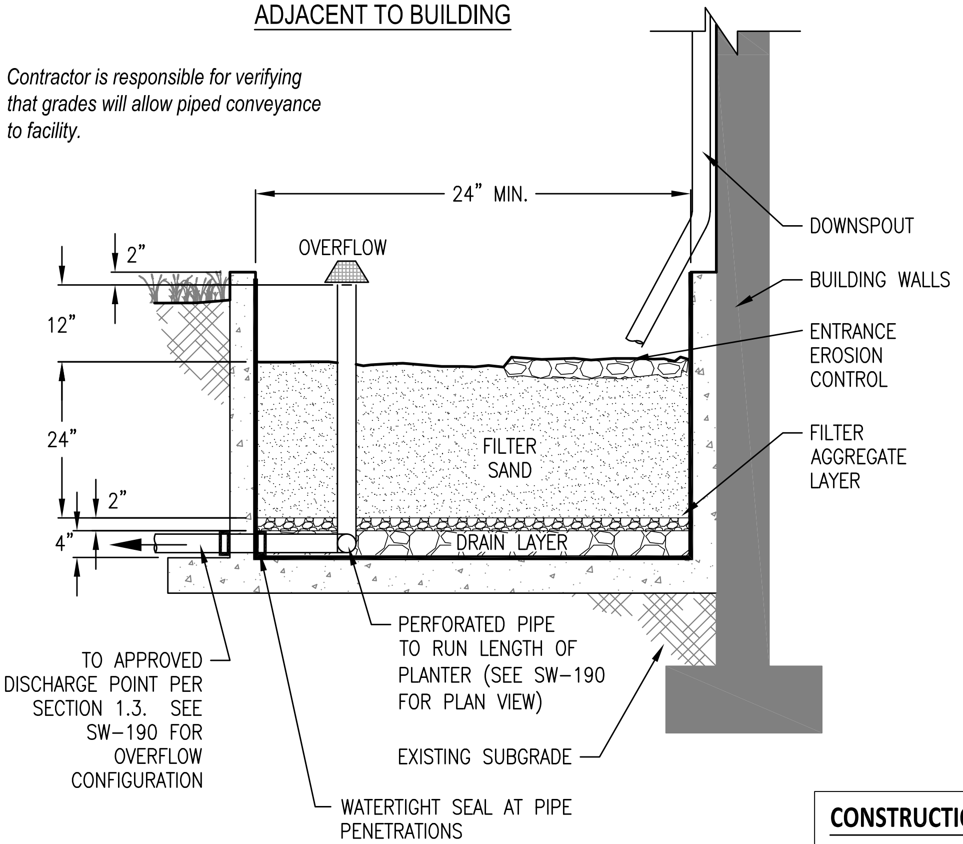
8. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, request 487. 3 inspections required.

CONSTRUCTION REQUIREMENTS

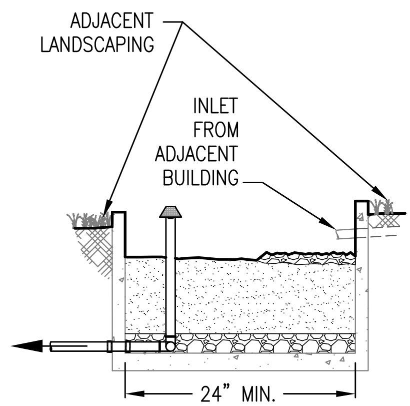
Mark the location of future facilities, and fence or cover facility locations after excavation. Do not allow vehicular traffic, foot traffic, material storage, or heavy equipment within 10 feet of the infiltration area except as needed to excavate, grade, and construct the facility. Do not allow entry of runoff or sediment during construction.

– DRAWINGS NOT TO SCALE –

ADJACENT TO BUILDING



FREESTANDING



CONSTRUCTION REQUIREMENTS

Do not allow temporary storage of construction waste or materials in the facilities. Do not allow entry of runoff or sediment during construction.

1. Setbacks: No setback is required for lined sand filters. Wall height must be less than 30" above finished grade if within 5' of property line.
2. Facility Slope (sand surface): Maximum of 0.5% in all directions.
3. Overflow: Overflow elevation must allow for 2" of freeboard, minimum. Protect from debris and sediment with strainer or grate.
4. Piping: Conform with Oregon Plumbing Specialty Code (OPSC) requirements.
5. Drain Layer: 4" of $\frac{3}{4}$"–1 $\frac{1}{2}$" washed drain rock. Filter aggregate layer: 2–3" of $\frac{1}{4}$"–No.10 washed angular aggregate.
6. Filter Sand: Install 24" of filter sand. See filter sand spec. in SWMM Section 3.2.5.4.
7. Planter Structure: A single-pour monolithic concrete shell, without cold joints, is required to avoid the requirement for a liner.
8. Waterproofing: No additional waterproofing is needed if structure is monolithically poured.
9. Entrance Erosion Control: Install river rock, flagstone, or similar to dissipate the energy of incoming water at entrances and ends of downspout extensions.
10. Inspections: Call BDS IVR Inspection Line, (503) 823-7000. Request 487.3 inspections required.

– DRAWINGS NOT TO SCALE –

3.2.5.5 Grassy Swales

Grassy swales are grass channels designed primarily for conveying and treating stormwater runoff. Water quality treatment is provided as water moves horizontally through the swale and is filtered through the grass. Grassy swales can be designed to manage flow rates and volume if infiltration rates are adequate. They can be lined if infiltration is prohibited.

Design

Grassy swales must be designed under the Performance Approach.

Site Suitability: Grassy swales are appropriate for all soil types.

Setbacks: See Section 2.2.4 for setback requirements.

Access: See access requirements in Section 3.2.2.1.

Pollution Prevention: See pollution prevention requirements in Section 3.2.2.1.

Sizing: The swale must be designed to treat runoff from the pollution reduction design storm intensity, using the following criteria:

- Maximum design velocity: 0.9 ft/s

- Minimum hydraulic residence time: 9 minutes (i.e., time for the design flow to pass through the swale)
- Manning n value: 0.25
- Maximum ponding depth: 4 inches unless otherwise approved (This is to maximize contact with the grass.)

It is recommended to allow high flows exceeding the pollution reduction design storm to bypass the grassy swale.

Swales without high-flow diversion devices must be sized to safely convey the 25-year storm event (peak 25-year, 5-minute intensity = 3.32 inches per hour), analyzed using the Rational Method. They must also meet the following criteria:

- Have a minimum of 4 inches of freeboard above the water surface.
- Maintain a maximum velocity through the facility of 3 ft/s.

The figures below provide minimum required dimensions (swale length and bottom width) given peak flow rates. The values are derived from the City's [Sewer and Drainage Facilities Design Manual].

Figure 3-3. Swale Length at 1.5% Longitudinal Slope

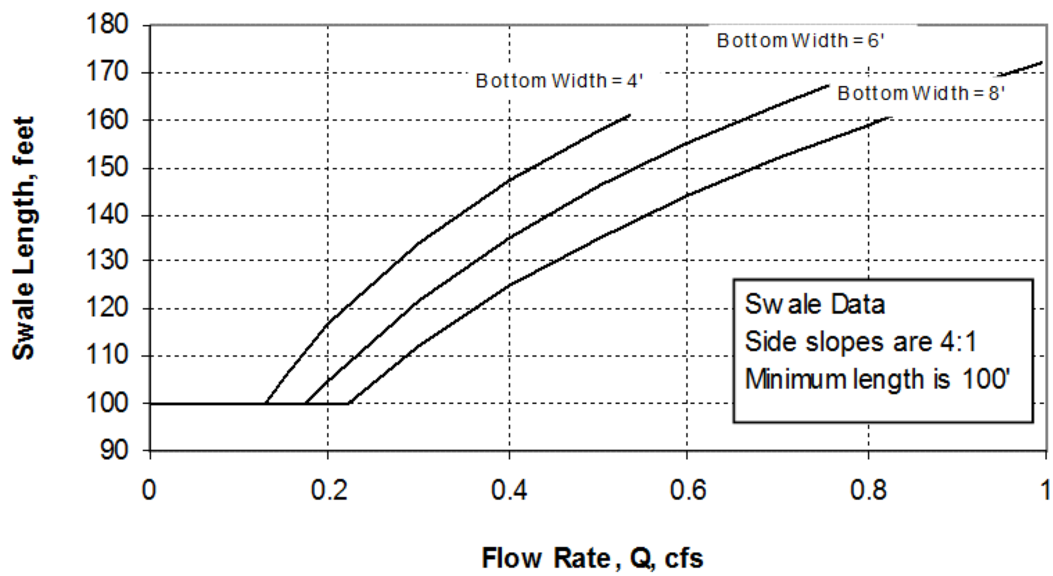


Figure 3-4. Swale Length at 3.0% Longitudinal Slope

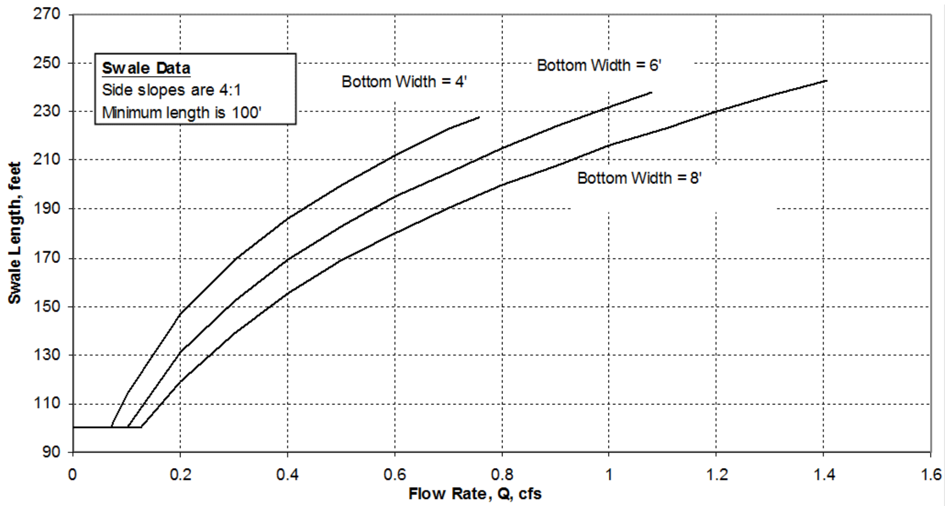
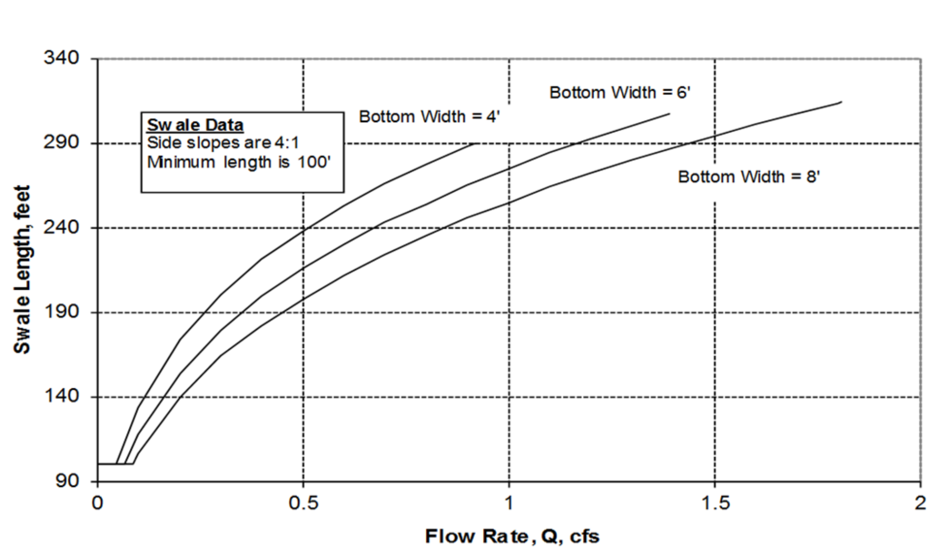


Figure 3-5. Swale Length at 5.0% Longitudinal Slope



Dimensions and Slopes: Minimize the depth of the swale and the steepness of the side slopes to avoid safety risks and prevent erosion within the facility. The bottom of the grassy swale must be smooth with a uniform longitudinal slope to minimize flow channelization. Grassy swales must also meet the following criteria:

All grassy swales:

- Minimum length: 100 ft
- Maximum side slopes: 4 horizontal to 1 vertical (4:1)

Grassy swales on private property:

- Minimum top width: 10 ft
- Minimum bottom width: 2 ft (must be flat)

Grassy swales on public property:

- Minimum top width: 12 ft
- Minimum bottom width: 4 ft (must be flat)

Flow Spreader: Install a flow-spreading device at the inlet to distribute flows evenly across the bottom of the swale. In swales with a bottom width greater than 6 ft, install a flow spreader at least every 50 ft.

Soil: Amend the native soils per the requirements for rain gardens if needed to support plant growth (see Section 3.2.2.2).

Vegetation: Plant the entire surface area of the grassy swale with native grass or swale seed mix to provide 100% coverage of both the swale bottom and the side slopes. For BES-maintained facilities, select native wildflowers and grasses that require minimal mowing (i.e., no more than once or twice annually). BES does not allow lawn-type areas in BES-maintained facilities and exceptions require BES approval. Grassy swales in environmental zones must meet requirements established by PCC Title 33 for grass species in Environmental Zones.

BES may allow trees and shrubs in the flow path if the swale exceeds the length and widths specified. See Section 3.5 for information about trees.

Construction Requirements

See standard construction requirements for bioretention facilities in Section 3.2.2.2.

Seed native grass mixes in the swale flow path. Apply seed at the rates specified by the supplier. Plants must be established by the time the facility is completed and at least 3 months after seeding. Establish grasses as soon as possible after the swale is completed and before water is allowed to enter the facility. Do not allow entry of concentrated stormwater flows until the vegetation is fully established.

Unless vegetation is established prior to completion of construction, install biodegradable erosion control matting that is appropriate for low-velocity flows (approximately 1 ft/s) in the flow path before allowing water into the facility.

3.2.5.6 Ponds

Ponds are designed to capture, store, treat, and release stormwater runoff. The City encourages pond designs that provide multiple benefits (e.g., use in parks, open space, or recreational facilities). Three types of ponds are described in this section: wet ponds, extended wet ponds, and dry detention ponds.

- **Wet Ponds** have 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; gravitational settling and biological processes remove pollutants. Wet ponds only meet water quality requirements.
- **Extended Wet Ponds** have a permanent pool but have additional storage above the pool that fills during storm events and releases water over several hours. The permanent pool is sized to provide pollution reduction, and the additional storage is sized to meet flow control requirements. Pollutants are removed through gravitational settling and biological processes.
- **Dry Detention Ponds** fill during storm events and slowly release water over several hours.

Design

Ponds must be designed under the Performance Approach.

Location and Ownership: Ponds maintained by the City must be located in a separate tract with public sewer easements dedicated to the City. Ponds serving more than one tax lot or designed to function as multi-use/recreational facilities must be in a separate tract, defined easement, or designated open space. In-stream ponds are prohibited.

Site Suitability: Ponds are appropriate for sites with slow-draining soils (i.e., < 2 in/hr) or where a liner is required. Designers should consider the use of an infiltration basin where soils drain well (i.e., ≥ 2 in/hr).

Setbacks:

Ponds must meet the following setback requirements unless otherwise approved by BES. All distances are minimum distances measured from the edge of the maximum water surface elevation, unless stated otherwise.

- 20 ft to property lines and structures unless an easement with the adjacent property owner is provided.
- 100 ft to a septic tank, distribution box, or septic tank drain field.

- 200 ft to the top of slopes greater than 15% unless BES approves a geotechnical report submitted by the applicant that demonstrates the design protects structures and slope stability and does not pose additional risks.
- 500 ft or the 2-year time of travel, whichever is greater, to a well that supplies drinking water.
- 5 ft or one-half of the berm height, whichever is greater, from the toe of the pond berm embankment to the nearest property line.

Catchment Area and Inflow: Design wet ponds and extended wet detention ponds for large drainage areas (i.e., 5 to 150 acres) to help avoid long periods of stagnant water.

Access: See access requirements in Section 3.2.2.1. Additionally, public ponds must include an access route that is at least 12-ft-wide (unless the City approves a narrower width) with a slope of no more than 10%. An access route as narrow as 8-ft-wide is allowed with City approval. Where maintenance access is provided along the top of the berm, the minimum width of the top of the berm must be 15 ft. Enclose any weir and orifice structures in a catch basin, maintenance hole, or vault and make them accessible for maintenance.

Pollution Prevention: See pollution prevention requirements in Section 3.2.2.1.

Sizing:

Wet ponds must be sized for water quality. Extended wet detention ponds must be sized for both water quality and flow control. Detention ponds must be sized for flow control. The sizing requirements for water quality and flow control are described below.

Sizing for Water Quality – Wet ponds and extended wet pends must be sized for water quality. To size for water quality, the permanent pool (i.e., dead storage) volume must be equivalent to the runoff volume generated by the water quality design storm of 1.61 inches over 24 hours (using the City’s modified NRCS Type 1A rainfall distribution).

Sizing for Flow Control – Detention ponds and extended wet detention ponds must be sized to meet applicable flow control requirements. The flow control volume is in addition to any dead storage volume (e.g., it does not count the permanent pool for water quality or the dead storage for sediment). The additional storage must be designed using acceptable hydrologic modeling techniques for flow control (see Section 2.5.2).

Dimensions and Slopes:
The depth of the facility and the steepness of the side slopes should be minimized to reduce safety risks.

- For wet ponds and extended wet ponds, the minimum length-to-width ratio is 3:1, measured at the maximum water surface elevation, to prevent "short-circuiting" (i.e., to prevent water passing through the facility too quickly to be properly treated), unless otherwise approved. Subject to City approval, if area constraints make this ratio unworkable, the applicant may use baffling, islands, or peninsulas to increase the flow path and prevent short-circuiting.
- Slopes within the pond and pond embankments on both the upstream and downstream face must not exceed 3 horizontal to 1 vertical (3:1).
- The maximum depth of the pond, excluding freeboard, must not exceed 4 ft. The 0- to 2-foot depth must be evenly distributed around the perimeter to allow for safe egress from the pond.
- The pond must have at least 1 ft of freeboard above the emergency overflow structure or spillway elevation.
- Pond berm embankments 6 ft or more in height (including freeboard) must have a minimum top width of 6 ft, or as recommended by a geotechnical engineer.
- Maximize the distance between all inlets and the outlet to facilitate sedimentation.

Cells and Islands/Peninsulas:

Cells – All ponds must be divided into at least two cells. Design the first cell (the forebay) to contain approximately 10% of the design surface area. For detention ponds, the first cell must provide at least 0.5 ft of dead storage for sediment (not to be included in flow control sizing).

islands/peninsulas – Islands or peninsulas may be installed for aesthetic reasons and to increase the flow path and prevent short-circuiting.

Outlet/Overflow: All ponds must have an emergency overflow spillway or structure designed to safely convey the 100-year design storm to the overflow spillway or structure crest with 1 ft of freeboard.

Design and site the overflow to protect the structural integrity of the berm while conveying the 100-year flow around the berm structure for discharge into the downstream conveyance system. Set the subgrade of the spillway at or above the 100-year overflow elevation of the control structure. The emergency overflow spillway weir section must be designed to safely convey the post-development runoff from the 100-year storm event, using the following formula:

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

Where:

L = Length of the bottom of the weir (ft);

Q_{100} = 100-year post-development flow rate (ft^3/s); and

H = Height of emergency overflow water surface (ft).

The spillway must direct overflows safely toward the downstream conveyance system. Place it in existing soil wherever feasible. Armor the spillway with riprap or other flow-resistant material to protect the embankment and minimize erosion. Extend riprap to the toe of each face of the berm embankment.

If a riser-pipe outlet is used, protect the outlet with a trash rack and anti-vortex plate. If an orifice plate is used, protect the orifice plate with a trash rack with at least 10 ft^2 of open surface area. In both cases, the rack must be hinged or easily removable to allow cleaning. Secure the rack to prevent it from being removed or opened between maintenance visits.

Components/Materials: Section 3.2.2.1 provides requirements for the following components and materials that are common to ponds: walls, liners, and waterproofing; piping; orifices; entrance erosion control; and vegetation. In addition to the requirements for the components/materials listed above, the following apply to some or all ponds.

Flow Control Structure: The control structure must be designed to pass the 100-year storm event as overflow, without flooding the contributing drainage area.

Wet Ponds and Extended Wet Ponds – For wet ponds and extended wet ponds, the control structure must be located above the elevation of the permanent pool.

Extended Wet Ponds and Dry Detention ponds – The flow control structure includes orifices (see below) and is required to restrict flows exiting the pond to the rates required in Section 1.3.

Flow Control Orifices (for Extended Wet Detention and Dry Detention Ponds): Section 3.2.2.1 provides general requirements for orifices. Additionally, for ponds, multiple orifices may be necessary to meet the 2- through 25-year design storm performance requirements. Large projects may result in high flow rates requiring large orifices that are impractical. In those cases, locate several orifices at the same elevation to reduce the size of individual orifices.

Anti-Seepage Collars: Place anti-seepage collars on outflow pipes penetrating berm embankments.

Growing Medium: Because grading generally requires removing topsoil, the resulting surface soil generally requires amendment. Amend the native soils per the requirements for rain gardens. Alternatively, return topsoil to prepare for planting.

Vegetation: The facility area is equivalent to the area of the pond, including bottom and side slopes, plus the 10-ft buffer around the pond. For ponds with a permanent pool, the emergent plant zone must cover at least 25% of the water surface area. The pond vegetation for side slopes and buffers applies to the remainder of the facility area (including the buffer) that is above the elevation of the permanent pool. Minimum plant material quantities are shown in the following tables.

For plant selection, see plant lists in Section 3.5. For BES-maintained facilities, select wildflowers, native grasses, and groundcovers to minimize mowing (i.e., no more than twice annually). BES does not allow turf and lawn in its facilities. Exceptions require BES approval.

Table 3-10. Wet and Extended Wet Pond Vegetation - Emergent Plants

Number of Plants	Vegetation Type	Per Ft^2	Size	Spacing Density (ft on center)
115	Wetland plants	100	6-inch plugs	1
OR				
100	Wetland plants	100	6-inch plugs	1
4	Small shrubs	100	#1 container	3
OR				
100% seed coverage				

Table 3-11. Dry Detention Pond Vegetation - Inundated Area

Total Number of Plants per 100 ft²	Number of Plants per 100 ft² by Type	Vegetation Type	Size	Spacing density (ft on center)
80	80	Herbaceous plants	#1 container	1.25
OR				
76	72	Herbaceous plants	#1 container	1.25
	4	Small shrubs	#1 container	1
OR				
100% seed coverage				

Table 3-12. Pond Vegetation - Side Slopes and Buffers

Number of Plants	Vegetation Type	Per ft²	Size	Spacing Density (ft on center)
1	Tree	300	Evergreen: Min 6-ft height	
			OR	
			Deciduous: 1 ½ inch caliper at 6 inches above base	
AND				
4	Large shrubs	100	#3 container	4

The planting design must minimize solar exposure in open water areas. Locate trees or other appropriate vegetation around the east, south, and west sides of the facility to maximize shading. Reducing solar exposure reduces heat gain prior to discharging to a receiving water and helps reduce algae blooms and the potential for development of anaerobic conditions.

Fencing: A fence or an equivalent alternative is required for all City-maintained ponds with a permanent or temporary pool greater than 18 inches deep, interior side slopes steeper than 3 horizontal to 1 vertical, or walls/bulkheads greater than 24 inches high. Fencing for privately-owned facilities is at the discretion of the owner.

For both private and City-maintained facilities, [Portland City Code (PCC) Title 33 (Planning and Zoning)] may prohibit fencing in some locations. The designer is responsible for determining which sections of PCC Title 33 apply. If PCC Title 33 prohibits fencing, the designer may have to modify the facility or site design such that the pond does not require a fence or provide an alternate way to secure the site.

For both private and City-maintained facilities, [Portland City Code (PCC) Title 33 (Planning and Zoning)] may require screening in some locations. The design must address screening requirements for fencing.

Fences must be at least 6 ft high for both private and City-maintained facilities where fencing is used, although the 6-ft height may not be required in situations where fences are not needed to prevent climbing (e.g., on steep slopes). For City-maintained facilities, provide a minimum of one locking access gate for vehicles. The vehicle gate must be 12 ft wide, with two 6-ft-wide swinging sections. Provide at least one pedestrian gate with a minimum width of 4 ft.

Fencing materials should complement the site design.

Retaining Walls (optional): BES pre-approval is required for the design of retaining walls. Retaining walls must not exceed one-third of the circumference of the pond.

Baffles (optional): Baffles may be installed to increase the flow path and prevent short-circuiting if area constraints make the standard ratio unworkable. City approval is required.

Construction Requirements

See standard construction requirements for bioretention facilities in Section 3.2.2.2.

The designer of a berm embankment must be an Oregon-licensed civil engineer. As described below, construct pond berm embankments on native consolidated soil, or compacted and stable fill soil, that is free of loose surface soil materials, roots, and other organic debris:

- Excavate a trench that is at least 50% of the berm embankment cross-section height and width, measured through the center of the berm, which keys the berm into the native soil and prevents it from sliding.
- Place compacted soil (95% maximum dry density, using the Modified Proctor Method per ASTM D1557) in 6- to 8-inch lifts for hand-held equipment, or 10- to 12-inch lifts for heavy equipment.
- Place topsoil over the consolidated soil to support plantings.
- Seed the exposed side slopes with an appropriate seed mix.

- Protect establishing vegetation with appropriate surface-protection Best Management Practices (BMPs) and reseed as necessary. (See the City's Erosion and Sediment Control Manual.)

If a chain link fence is proposed for a City-maintained facility, it must comply with the City of Portland Standard Construction Specifications.

Submittal Requirements

See Section 3.4 for general submittal requirements and facility-specific submittal requirements that apply for ponds.

3.3 Operations and Maintenance Requirements & Submittals

Stormwater systems must be maintained so they function as intended and limit offsite environmental and drainage impacts. Stormwater facilities, including associated paths, gates, and covers, must be maintained to provide safe and efficient access for maintenance. Check stormwater systems regularly to assess maintenance needs. Routine inspection and maintenance can help keep overall maintenance costs at a minimum by detecting problems early.

This section addresses operations and maintenance (O&M) of private stormwater facilities. For operations and maintenance of drainageways, drainage reserves, culverts, and outfalls, see Section 5.10.

O&M Responsibility and Enforcement

The property owner or a designated responsible party is responsible for O&M. Responsibilities and requirements for O&M are identified and enforced through the O&M Form and O&M Plan that are submitted to BES. 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 Portland City Code 17.38.045: Enforcement. This requirement is binding on all current and future owners of the property. The current responsible party is required to update the name of the responsible party as needed whenever the facility is inspected under BES's Maintenance Inspection Program. Failure to comply with the O&M Plan can trigger an enforcement action, including penalties.

For MSTTs, even if the manufacturer includes a maintenance plan or warranty with the device at the time of purchase, the ultimate responsibility for O&M is with the property owner. It is the property owner's responsibility to document completion of maintenance per any maintenance agreement or while under warranty.

O&M Submittal Requirements

Applications for projects with one or more stormwater facilities must include the following O&M submittals for each type of facility:

- An O&M Plan and
- Unless exempt, an O&M Form. Most residential drywells and soakage trenches designed under the Simplified Approach are exempt from the requirement to submit an O&M Form. BES also doesn't require an O&M Form for driveway center strips.

3.3.1 O&M Forms

The O&M Form documents the owner of the site and property, the parties responsible for O&M activities, and information about the stormwater facility and provides space for a simple site plan. Complete the O&M Form in full as described below. BES may require additional or updated site plan information during permit review, depending on individual site conditions.

The Site Legal Description must include all the tax lots (i.e., parcels) with stormwater runoff managed by the onsite stormwater management system. The information must be accurate and correctly filled out on the O&M Form prior to submittal to the county for recording. To find a property's legal description, visit Portland Maps and enter the property's exact address. To locate the Site Legal Description on the site, select the "Assessor Detail" link from the menu, and scroll down to locate the boxes labeled "Tax Roll" and "Instrument Number." If the Tax Roll description has "TL" in it, include the Instrument Number where indicated on Form 2. This information is intended as guidance and it may not be adequate for filing by the county.

The O&M Form includes a small space for a sketched site plan. If the space is insufficient to include all the information below, attach a separate site plan. The site plan must include the following information:

- Property boundaries and a north arrow.
- The locations of all the stormwater facilities and conveyance features in relation to labeled streets, buildings, or other permanent features.
- The locations of utilities, including existing-to-remain and proposed water, sanitary, and storm sewers.
- Facility dimensions and setback distances from property lines and structures.
- All stormwater piping associated with the facility, including pipe sizes, materials, slopes, and invert elevations.
- Flow arrows illustrating the direction of flow and the order in which stormwater passes through the system if there is a sequence of facilities.
- A cross-section of each facility with general dimensions and subsurface elements such as liners, layers of soil and aggregate, and pipes.
- Offsite discharge locations, including the ownership, and type of the system to which the discharge drains.

There are two versions of the form: a standard form and a form for private streets and private shared facilities.

CITY OF PORTLAND
Stormwater Management Manual

OPERATIONS & MAINTENANCE FORM

STANDARD FORM FOR PRIVATE STORMWATER 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 and associated administrative rules.

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 and Presumptive Approach,** please attach the Standard O&M Plan for each facility type from the *Stormwater Management Manual*, Section 3.3.

For the **Performance Approach,** please attach an approved, site specific O&M Plan per the *Stormwater Management Manual,* Section 3.3.

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 signed by the owner and recorded with this O&M Form. The owner further acknowledges that this form and associated documents have 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 to BES and record, with the appropriate County, complete and accurate O&Ms enforceable under City Code 17.38. Property owners must consult with the City prior to making changes to the O&M Plan to determine if a new permit or O&M submittal is required. Substantial changes to the O&M require City approval prior to recording with the County. Examples include changes to the facility type, discharge point, or total drainage area. 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:

OPERATIONS & MAINTENANCE FORM

STANDARD FORM FOR PRIVATE STORMWATER 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 described in SWMM Section 3.3, O&M Requirements and Submittals.

STEP 1 – COMPLETE THE FOLLOWING TABLE

Stormwater Facility Type (Chapter 3)	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 and shown on the following (or attached) site plan is a required condition of the City's 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 the current owners and the 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

CITY OF PORTLAND
Stormwater Management Manual

OPERATIONS & MAINTENANCE FORM

PRIVATE STREET/PRIVATE SHARED STORMWATER 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#s (6 Digits) ______ ______ ______

R#s (6 Digits) ______ ______ ______

Site Address ______

City/State/Zip ______

Preparation Date: ______

OWNER INFORMATION (ALL LEGAL OWNERS)

Attach additional pages for additional 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: *(Include all subdivided taxlot information and subdivision name)*

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/Parties

Contact Name ______

Contact Organization ______

Phone *(area code required)* ______

Email: ______

Maintenance Practices and Schedule

These operation and maintenance practices for shared facilities 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 and Presumptive Approach,** please attach the Standard O&M Plan for each facility type from the *Stormwater Management Manual*, Chapter 3, Section 3.3.

For the **Performance Approach,** please attach an approved, site specific O&M Plan per the *Stormwater Management Manual,* Chapter 3, Section 3.3.

OPERATIONS & MAINTENANCE FORM

PRIVATE STREET/PRIVATE SHARED STORMWATER 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 described in SWMM Section 3.3, O&M Requirements and Submittals. Site plan must be inclusive of all subdivided taxlots serviced by the shared stormwater management facilities.

STEP 1 – COMPLETE THE FOLLOWING TABLE

Stormwater Facility Type (Chapter 3)	Stormwater Facility Size (sf)	Drainage Source: Private Street, Parking Area, or Roof?	Impervious Area Treated (sf)	Facility Location Tract or Easement?	Discharge Point
Totals					

Maintaining the stormwater management facility or facilities listed above and shown on the following (or attached) site plan and recorded plat is a required condition of the City's approval for the identified property. Property owners are required to operate and maintain shared 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 properties. 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 the current owners and the written approval of the Bureau of Environmental Services.

STEP 2 – REQUIRED SITE PLAN AND RECORDED PLAT

(insert or draw here, or attach separate sheet)

☐ I Have Attached a Site Plan

SIGNATURE AND ACKNOWLEDGEMENT

By signing below, the owners accept and agree to the terms and conditions contained in this O&M Form and in any document signed by the owners and recorded with this O&M Form. The owners further acknowledge that this form and associated documents have 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 owners to restore the stormwater facilities to a functional state as approved under original requirements.

The owners also accept that the City requires property owners to submit to BES and record, with the appropriate County, complete and accurate O&Ms enforceable under City Code 17.38. Property owners must consult with the City prior to making changes to the O&M Plan to determine if a new permit or O&M submittal is required. Substantial changes to the O&M require City approval prior to recording with the County. Examples include changes to the facility type, discharge point, or total drainage area. 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 or HOA 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:

OPERATIONS & MAINTENANCE FORM

PRIVATE STREET/PRIVATE SHARED STORMWATER FACILITIES

OWNERS' SIGNATURE PAGE

PROJECT NAME___________________________ **SITE ADDRESS** ___________________________

PERMIT # ___________________________ **CITY/STATE/ZIP** ___________________________

SITE R#s (6 Digits) __________ __________

__________ __________

__________ __________

Signature – Owner 1	Signature – Owner 2
Printed Name	Printed Name
Mailing Address	Mailing Address
Date	Date
Signature – Owner 3	Signature – Owner 4
Printed Name	Printed Name
Mailing Address	Mailing Address
Date	Date
Signature – Owner 5	Signature – Owner 6
Printed Name	Printed Name
Mailing Address	Mailing Address
Date	Date

3.3.2 O&M Plans

There are two types of O&M Plans: a Standard O&M Plan and a Site-Specific O&M Plan. For stormwater facilities designed under the Simplified and Presumptive Approaches, a Standard O&M Plan is required. For facilities designed under the Performance Approach, a site-specific O&M plan is required.

For conveyance features (e.g., drainage reserves, culverts, and outfalls), see Chapter 5 for standard O&M plans.

The O&M Plan lays out O&M requirements. The key goals for any O&M Plan are as follows:

- Relay information between the designer or engineer and those providing maintenance.
- Identify the elements of the stormwater system, including all the stormwater facilities, areas contributing runoff to the stormwater facilities, discharge locations, and stormwater conveyance features (e.g., drainage reserves, culverts, and outfalls).
- Provide guidance to prevent system deterioration and failure.
- Define the visual indicators of diminished performance and maintenance needs for each stormwater management facility and conveyance feature.
- Provide a schedule for inspection and maintenance.
- Designate property owners or other parties responsible for O&M activities.
- Require inspection and maintenance logs to be filled out by maintenance personnel and kept by the responsible parties.

The inspection and maintenance log documents O&M activities that have been completed. The log must include all inspection dates, components inspected, and maintenance or repairs completed. It must also document deficiencies and corrective actions taken to keep structural and vegetative components in good working order. An example of a log is included on the back of each standard O&M Plan (see Section 3.3.2.1). The City may accept work orders, invoices, or receipts in lieu of a log when evaluating the adequacy of the maintenance program.

The property owner or responsible party must keep a copy of the appropriate O&M Plan and O&M Form. The property owner is responsible for ensuring that maintenance occurs, and that maintenance records are kept even if someone other than the property owner is performing the maintenance. For example, a facility manager or maintenance company may be the responsible party.

O&M practices must be consistent with the version of the Stormwater Management Manual that was in effect when the original O&M Form was filed, or with the most current O&M guidance for the facility.

The O&M Plan and a set of the design drawings should be present during inspections for at least the first 2 years so it is clear how the site should function.

3.3.2.1 Standard O&M Plans

When the Simplified or Presumptive Approach is used, submit a standard O&M Plan for each facility type in the permitted development (see standard O&M plans below). Include a description of each type of facility servicing the site, the impervious surface draining to the facilities, all stormwater conveyance pipes, and discharge locations for each facility.

STANDARD O&M PLAN FOR THE SIMPLIFIED APPROACH

Ecoroofs

Structural components, including the waterproof membrane, must be operated and maintained in accordance with the manufacturer's specifications and design documents.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Clogged drains	Remove sediment and debris where they are posing problems.
	Damaged membrane	Repair or replace as needed.
Vegetation must cover at least 90% of the planted portion of the facility at maturity.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Dead or stressed vegetation	Replant per original plan, or substitute from plant list in SWMM section 3.5. Assess and address the cause.
	Dry grass or other plants	Trim dry grasses and remove clippings. If plantings are overwhelmed by undesired grasses and other plants, replant with more suitable plants or mow annually by July 4th, and preferably twice annually.
	Weeds	Manually remove weeds before they go to seed.
Growing medium must sustain healthy plant cover and drain per the design.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Exposed soil	Cover with plants and mulch as needed.
	Eroded soils and gullies	Fill, hand tamp, or lightly compact and plant to disperse flow.
	Crusting, dry, or shrinking medium	Rake or amend to restore infiltration or flow.
	Ponding or excessive moisture	Amend soils and clear drains. Check irrigation system for leaks.

Annual Maintenance Schedule

Summer	Make necessary repairs. Improve growing medium as needed. Irrigate as needed.
Fall	Replant exposed soil, replace dead plants. Provide erosion control for bare soil.
Winter	Monitor infiltration/flow-through rates.
Spring	Replant areas of exposed soil and replace dead plants
All seasons	Weed as necessary. Clean drains as necessary.

Maintenance Records: Facility operators are required to keep an inspection and maintenance log. Record date, description, and contractor (if applicable) for all ecoroof maintenance. Keep work orders and invoices on file and make available upon request of the City inspector.

Fertilizers: Their use is strongly discouraged because of potential negative impacts to downstream systems. Sedums don't require fertilizer for vigorous growth. Never apply fertilizer before testing the fertility of the growing medium to determine whether fertilizer is needed and appropriate application rates. Use only organic, slow-release fertilizers. See SWMM Section 3.2.1 for more information.

Pesticides/Herbicides: Their use is prohibited.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or the facilities discharge point. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into roof drains.

Irrigation: During the establishment period (up to 3 years), irrigation must not exceed ½ inch of water per 4 inches of growing medium per week, regardless of water source. Post-establishment irrigation must not exceed ¼ inch of water per 4 inches of media every 10 days (May through October), regardless of water source. Consider installing an irrigation flow meter for ecoroofs greater than 5,000 square feet. Annually winterize and test the irrigation system for leaks. Make sure irrigation piping is covered by at least 2" of soil at all times.

Flow Control: Ecoroofs must drain within 48 hours after the end of a rain event. Record time/date, weather, and site conditions if unplanned ponding occurs.

Vectors (Mosquitoes and Rats): Ecoroofs must 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.

Operations and Maintenance Log

Date	Work Performed By	Type of Work Performed			Notes	Initials
		Plant Replacement type, location	Structural Repairs – type, location	Other		

STANDARD O&M PLAN FOR THE SIMPLIFIED APPROACH

Permeable Pavement

Structural components, including surface materials, must evenly infiltrate stormwater.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Clogged surface; ponding	Vacuum or dry sweep at least once a year.
	Unraveling or settled pavement	Repair as per manufacturer specification. Do not apply sealants to pervious pavement.
Vegetation must be minimized to reduce impacts to pervious pavement.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Leaf debris	Sweep leaf litter and sediment to prevent surface clogging and ponding.
	Vegetation encroachment	Prevent large root systems from damaging subsurface structural components.
	Weeds, Moss	Manually remove, mow, or torch.
Filter medium must be maintained to preserve infiltration capacity.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Aggregate loss	Replace paver pore space with aggregate per original design.

Annual Maintenance Schedule

Summer	Make structural repairs.
Fall	Vacuum sweep.
Winter	Monitor infiltration rates.
Spring	Vacuum, power wash, dry sweep (at least once per year).
All seasons	Weed as necessary.

Maintenance Records: All facility operators are required to keep an 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 per design standards, maintaining access to the entirety of the facility for inspection & maintenance.

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

Pesticides/Herbicides: Their use is prohibited.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or the facility discharge points. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility.

Vectors (Mosquitoes and Rats): Stormwater facilities must 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.

Operations and Maintenance Log

Date	Work Performed By	Type of Work Performed	Notes	Initials

STANDARD O&M PLAN FOR THE SIMPLIFIED APPROACH

Rain Gardens

Structural components must be operated and maintained in accordance with the design specifications.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Clogged gutters, drains, downspouts, or inlets	Remove sediment, debris, and blockages from downspouts, gutters, pipes, and inlets to maintain at least 50% conveyance at all times. Clean at least twice a year depending on the presence of overhanging trees. Clear any build-up of soil, bark dust, and/or vegetative growth from around downspout extension and/or splash blocks. Verify there is sufficient slope so that water flows away from the foundation.
	Damaged or missing pipes, gutters, and downspouts	Repair or replace broken gutters and downspouts as needed. Identify possible leaks and verity 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.
Vegetation must cover at least 90% of the facility at maturity.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Dead or stressed vegetation	Remove dead material; replant per original planting plan, or substitute from the plant list in Section 3.5.
	Dry grass or other plants	Irrigate and mulch as needed. Maintain grass height at 6”-9”.
	Weeds	Manually remove weeds
Growing medium must sustain healthy plant cover and drain within 48 hours.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Gullies, erosion, exposed soils, sediment accumulation	Fill in and lightly compact areas of erosion with City-approved soil mix (see SWMM section 3.2.2.1) and replant according to planting plan or substitute from the plant list in SWMM section 3.8. Any erosion deeper than 2 inches must be addressed. Sediment more than 4 inches deep must be removed.
	Scouring at the inlet(s)	Ensure splash blocks or inlet gravel/rock are placed correctly to prevent erosion.
	Ponding	Till, amend, or rake soil as needed to ensure ponding water drains within 48 hours.

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.
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 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.

Fertilizers: Their use is strongly discouraged because of the potential for negative environmental impacts. Never apply fertilizer before testing the fertility of the growing medium to determine whether fertilizer is needed and appropriate application rates. Use only organic, slow-release fertilizers. See SWMM Section 3.2.2.1 for more information.

Pesticides/Herbicides: Their use is prohibited.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or facility discharge points. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility.

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

Vectors (Mosquitoes and Rats): Stormwater facilities must 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.

Access: Maintain ingress/egress per design standards, maintaining access to the entirety of the facility for inspection & maintenance.

Operations and Maintenance Log

Date	Work Performed By	Type of Work Performed					Notes	Initials
		Clean inlets and Outlets	Sediment and Trash Removal	Plant Replacement type, location	Structural Repairs – type, location	Other		

STANDARD O&M PLAN FOR THE SIMPLIFIED AND PRESUMPTIVE APPROACHES

Basins

Structural components must be operated and maintained in accordance with the design specifications.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Clogged inlets or outlets	Remove sediment, debris, and blockages from catch basins, trench drains, curb inlets, and pipes to maintain at least 50% conveyance at all times
	Broken inlets or outlets, including grates	Repair or replace broken downspouts, curb cuts, standpipes, and screens as needed.
	Cracked or exposed drain pipes	Repair or seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage.
	Check dams missing/broken	Maintain or replace rock check dams as per design specifications.
	Perforated liner	Replace or repair liner as needed.
Vegetation must cover at least 90% of the facility at maturity.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Dead or stressed vegetation	Replant per original planting plan, or substitute from the plant list in SWMM section 3.5. Irrigate and mulch as needed; prune tall, dry grasses and remove clippings.
	Tall grass and vegetation	Maintain grass height at 6”-9”. Trim to allow sight lines and foot traffic, also to ensure inlets and outlets freely convey stormwater into and/or out of facility.
	Weeds	Manually remove weeds.
Growing medium must sustain healthy plant cover and drain within 48 hours.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Gullies, erosion, exposed soil, sediment accumulation	Fill in and lightly compact areas of erosion with City-approved soil mix (see SWMM section 3.2.2.1). and replant according to planting plan or substitute from the plant list in SWMM section 3.8. Erosion more than 2 inches deep must be addressed. Sediment more than 4 inches deep must be removed.
	Scouring at the inlet(s)	Ensure splash blocks or inlet gravel/rock are placed correctly to prevent erosion.
	Slope slippage	Stabilize 3:1 slopes/banks with plantings from the original planting plan or from the plant list in SWMM section 3.5.
	Ponding	Rake, till, or amend soil surface with City-approved soil mix to restore infiltration rate. Remove sediment at entrance.

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.
Spring	Remove sediment and plant debris. Replant exposed soil and replace dead plants.
All seasons	Weed as necessary.

Maintenance Records: All facility operators must keep an inspection log. Record date, description, and contractor for all repairs, landscape maintenance, and facility activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Fertilizers: Their use is strongly discouraged because of the potential for negative environmental impacts. Never apply fertilizer before testing the fertility of the growing medium to determine whether fertilizer is needed and appropriate application rates. Use only organic, slow-release fertilizers. See SWMM Section 3.2.2.1 for more information.

Pesticides/Herbicides: Their use is prohibited.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or facility discharge points. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility.

Vectors (Mosquitoes and Rats): Facilities must not harbor mosquito larvae or rodents. Record the time/date, weather, and site conditions when vector activity is observed. Record when vector abatement started and ended.

Infiltration/Flow Control: Facilities must drain within 48 hours. Record time/date, weather, and conditions when ponding occurs

Access: Maintain ingress/egress per design standards, maintaining access to the entirety of the facility for inspection & maintenance

Operations and Maintenance Log

Date	Work Performed By	Type of Work Performed					Notes	Initials
		Clean inlets and Outlets	Sediment and Trash Removal	Plant Replacement type, location	Structural Repairs – type, location	Other		

STANDARD O&M PLAN FOR THE SIMPLIFIED AND PRESUMPTIVE APPROACHES

Planters

Structural components must be operated and maintained in accordance with the design specifications.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Clogged inlets or outlets	Remove sediment and debris from catch basins, trench drains, curb inlets, and pipes; maintain at least 50% conveyance at all times.
	Broken inlets or outlets	Repair/replace broken downspouts, curb cuts, standpipes, and screens.
	Damaged liners and walls	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.
	Cracked or exposed drain pipes	Repair or seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage
Vegetation must cover at least 90% of the facility at maturity.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Dead or stressed vegetation	Replant per original planting plan, or substitute from the plant list in Section 3.8. Irrigate and mulch as needed; prune tall, dry grasses and remove clippings.
	Tall grass and vegetation	Maintain grass height at 6"-9". Trim to allow sight lines and foot traffic, also to ensure inlets and outlets freely convey stormwater into and/or out of facility.
	Weeds	Manually remove weeds.
Growing medium must sustain healthy plant cover and drain within 48 hours.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Gullies, erosion, exposed soils, sediment accumulations	Fill in and lightly compact areas of erosion with City-approved soil mix (SWMM section 3.2.2.1) and replant according to planting plan or substitute from the plant list in SWMM section 3.8. Sediment more than 4 inches deep must be removed.
	Scouring at the inlet(s)	Ensure splash blocks or inlet gravel/rock are placed correctly to prevent erosion.
	Ponding	Rake, till, or amend soil surface with City-approved soil mix to restore infiltration rate. Remove and replace sediment at entrances.

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.
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 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.

Fertilizers: Their use is strongly discouraged because of the potential for negative environmental impacts. Never apply fertilizer before testing the fertility of the growing medium to determine whether fertilizer is needed and appropriate application rates. Use only organic, slow-release fertilizers. See SWMM Section 3.2.2.1 for more information.

Pesticides/Herbicides: Their use is prohibited.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or facility discharge points. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility.

Infiltration/Flow Control: Facilities must drain within 48 hours. Document time/date and weather if extended ponding occurs.

Vectors (Mosquitoes and Rats): Stormwater facilities must not harbor mosquito larvae or rodents that pose a threat to public health or that undermine facility structures. Record the time/date, weather, and site conditions when vector activity observed. Record when vector abatement started and ended.

Access: Maintain ingress/egress per design standards, maintaining access to the entirety of the facility for inspection & maintenance.

Operations and Maintenance Log

Date	Work Performed By	Type of Work Performed					Notes	Initials
		Clean inlets and Outlets	Sediment and Trash Removal	Plant Replacement type, location	Structural Repairs – type, location	Other		

STANDARD O&M PLAN FOR THE SIMPLIFIED APPROACH

Filter Strips

Runoff from impervious surface must enter filter strip as sheet flow		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Runoff isn't entering as sheet flow	Remove debris dams or other impediments to sheet flow
Vegetation must cover at least 90% of the facility at maturity.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Dead or stressed vegetation	Replant per planting plan, or substitute from BES plant list (see Section 3.5).
	Dry grass or other plants	Irrigate and mulch as needed; trim tall grasses and remove clippings. Maintain grass height at 6"-9".
	Tall grass and vegetation	Prune to allow sight lines.
	Weeds	Manually remove weeds.
Growing medium must sustain healthy plant cover.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Gullies, erosion, or exposed soils	Fill in and lightly compact areas of erosion and replant according to planting plan or substitute from BES plant list (see SWMM Section 3.8). Erosion deeper than 2 inches must be addressed.
	Slope slippage	Stabilize slopes with plantings from the plant list in SWMM Section 3.8.

Annual Maintenance Schedule

Summer	Remove any build-up of weeds or organic debris.
Fall	Replant exposed soil and replace dead plants. Remove sediment and plant debris.
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 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.

Fertilizers: Their use is strongly discouraged because of the potential for negative environmental impacts. Never apply fertilizer before testing the fertility of the growing medium to determine whether fertilizer is needed and appropriate application rates. Use only organic, slow-release fertilizers. See SWMM Section 3.2.2.1 for more information.

Pesticides/Herbicides: Their use is prohibited.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or facility discharge points. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility.

Vectors (Mosquitoes and Rats): Stormwater facilities must 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.

Access: Maintain ingress/egress per design standards, maintaining access to the entirety of the facility for inspection & maintenance.

Operations and Maintenance Log

Date	Work Performed By	Type of Work Performed				Notes	Initials
		Sediment and Trash Removal	Plant Replacement type, location	Structural Repairs – type, location	Other		

STANDARD O&M PLAN FOR THE SIMPLIFIED APPROACH

Drywells and Soakage Trenches

Structural components must be operated and maintained in accordance with the design specifications.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Clogged inlets, maintenance holes, catch basins, or silt traps	Clean gutters, rain drains, catch basins, or silt traps at least twice a year. Remove sediment, debris, and blockages from catch basins, trench drains, curb inlets, and pipes to maintain at least 50% conveyance at all times.
	Cracked drain-pipes, catch basins or maintenance holes	Repair or seal cracks. Replace when repair is insufficient.
	Vegetation encroachment	Prevent large root systems from trees and bushes from damaging subsurface structural components.
	Ponding water	Remove sediment and debris from all accessible components. Repeated ponding in the system may indicate end of facility life. Consult with City prior to decommissioning or replacement activities.

Annual Maintenance Schedule

Summer	Make structural repairs. Clear drains, inlets and catch basins.
Fall	Clean gutters and rain drains; remove sediment and plant debris.
Winter	Monitor infiltration rates.
Spring	Clean gutters and rain drains

Maintenance Records: All facility operators are required to keep an 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 per design standards, maintaining access to the entirety of the facility for inspection & maintenance.

Infiltration/Flow Control: Facilities must drain within 48 hours of the end of a rain event. Record time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or the facilities discharge point. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility.

Vectors (Mosquitoes and Rats): Stormwater facilities must 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.

Operations and Maintenance Log

Date	Work Performed By	Type of Work	Notes	Initials

STANDARD O&M PLAN FOR THE SIMPLIFIED APPROACH

Surface Sand Filters

Structural components must be operated and maintained in accordance with the design specifications.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Clogged inlets or outlets	Remove sediment and debris from catch basins, trench drains, curb inlets, and pipes; maintain at least 50% conveyance at all times.
	Broken inlets or outlets	Repair/replace broken downspouts, curb cuts, standpipes, and screens.
	Damaged liners and walls	Extend and secure any liners to the walls above the high-water mark. The facility must be water tight to protect abutting foundations from moisture damage.
	Cracked or exposed drain pipes	Repair or seal cracks. Replace when repair is insufficient. Cover with 6 inches of growing medium to prevent freeze/thaw and UV damage
Sand Filter must drain within 48 hours.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Gullies, erosion, sediment accumulations	Fill in and lightly compact areas of erosion with City-approved sand mix (see SWMM section 3.3.4.1). Sediment more than 4 inches deep must be removed.
	Scouring at the inlet(s)	Ensure splash blocks or inlet gravel/rock are placed correctly to prevent erosion.
	Ponding	Rake, till, or replace sand with City-approved sand to restore infiltration rates. Remove and replace sediment at entrances. Remove organic debris including leaves on a regular basis.

Annual Maintenance Schedule

Summer	Make structural repairs; clean gutters and downspouts; remove weeds and organic debris.
Fall	Remove sediment
Winter	Clear gutters and downspouts.
Spring	Remove sediment
All seasons	Weed as necessary.

Maintenance Records: All facility operators are required to keep an 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.

Fertilizers/Pesticides/Herbicides: Their use is prohibited.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or facility discharge points. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility.

Access: Maintain ingress/egress per design standards, maintaining access to the entirety of the facility for inspection & maintenance.

Pollution Prevention: All sites must implement Best Management Practices to prevent the introduction of pollutants to stormwater and/or the facilities discharge point. In the event of a spill, call 503-823-7180 to report it immediately and document the circumstances and the corrective action taken; include the date/time, weather and site conditions. Never wash spills into a stormwater facility. Infiltration/Flow Control: All facilities must drain within 48 hours. Record time/date, weather, and conditions when ponding occurs.

Vectors (Mosquitoes and Rats): Stormwater facilities must not harbor mosquito larvae or rodents that pose a threat to public health or that undermine facility structures. Record the time/date, weather, and site conditions when vector activity observed. Record when vector abatement started and ended.

Operations and Maintenance Log

Date	Work Performed By	Type of Work	Notes	Initials

3.3.2.2 Site-Specific O&M Plans

For the Performance Approach, BES requires a site-specific O&M Plan for each facility type in the permitted development. The plan must fully address site and stormwater infrastructure requirements including all stormwater management facilities and conveyance features. It is a component of the stormwater report. The organization of the plan must follow the outline in Table 3-13.

Table 3-13. O&M Plan Outline

I. Description
• Summary of the onsite stormwater system • Table identifying each stormwater facility and conveyance feature, including stormwater source, square footage managed, and discharge location • Location of stormwater facilities and conveyance features in relation to permanent structures or landmarks
II. Inspection and Visual Indicators of Diminished Performance
• Inspection timing and frequency for stormwater facilities and conveyance features • Definition of what storm sizes require additional inspections • Description of visual indicators that trigger maintenance activities
III. Maintenance Activities
• Specific 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. Financial Responsibility
• Designation and contact information of entity responsible for site O&M
V. Inspection and Maintenance Logs
• Instructions for maintaining required logs

I. Description

The description must include a summary of the onsite stormwater system, a table identifying each stormwater facility and conveyance feature, and a plan showing the location of stormwater facilities and conveyance features in relation to permanent structures or landmarks.

Summary

The summary must adequately describe the overall stormwater management objectives and the responsibilities of the property owner. Reference the Stormwater Hierarchy, specifying whether the managed stormwater is infiltrated onsite or discharged offsite (see Section 1.3). Include a description of each type of facility servicing the site and the impervious surface of the catchment area draining to the facilities. Describe the stormwater system in the area impacted by the development, including details about the function of each stormwater management facility, discharge locations of each facility, and all natural and constructed conveyance features such as drainage reserves, culverts, and outfalls.

ADDITIONAL DOCUMENTATION FOR SPECIFIC FACILITY DESIGNS

The O&M Plan for ecoroofs with 6 inches or more of growing media and drywells under buildings require additional documentation:

- For ecoroofs with 6 inches or more of growing media, show how the application of irrigation water will be controlled per the irrigation requirements in Section 3.2.1.1.
- For drywells under buildings, specify how maintenance access will be provided and how the long-term capacity of the drywells will be protected through maintenance practices.

Table

Include a table listing each stormwater facility and conveyance feature. For each stormwater facility, the table should identify the facility type, size, location, catchment area size (in square feet), catchment area type (e.g., rooftop, parking lot, or road), the hierarchy level being met, and the access point(s). For each facility that does not fully infiltrate the 10-year storm, identify the offsite discharge location. Unless discharge is to the combined sewer system, include the name of the receiving water (e.g., stream or river) and the flow path (e.g., overland flow or via a storm-only sewer system).

Plan

The site plan must identify the location of each stormwater facility and conveyance feature. Provide details about the locations with distances from permanent structures or GPS coordinates.

II. Inspection and Visual Indicators of Diminished Performance

This section of the O&M Plan must describe the inspection timing and frequency for stormwater facilities and conveyance features, define what storm sizes require additional inspections, and describe visual indicators that trigger maintenance activities.

The minimum inspection timing and frequency for all components of each stormwater facility is as follows:

- Quarterly for the first 2 years;

- Twice a year thereafter; and
- Within 48 hours of major rainfall events, defined as more than 1 inch of rain over a 24-hour period.

Some facilities may require more frequent inspections and maintenance. For example, more frequent sediment removal is required for structural detention designed without pretreatment. More frequent maintenance may be required for MSTTs if there are changes to pollutant loading or site conditions, spills, localized erosion, or large storm events. Modifications to maintenance practices or frequencies may also be needed to maintain functionality.

III. Maintenance Activities

The O&M Plan must have a separate section for each type of stormwater facility that describes the activities required to maintain the facility type and keep it in working order. Variations in facility configurations and runoff sources (e.g., runoff from rooftops, parking lots, or roadways) require different activities. The O&M Plan must describe maintenance indicators and their corrective actions.

The following sections present different types of maintenance activities that may be required in the O&M Plan. Professional services may be needed if typical maintenance practices do not resolve issues that arise.

Site Best Management Practices (BMPs)

Regular maintenance practices can reduce overall maintenance needs. Trash removal and source control practices can reduce spills and prevent pollutants from entering facilities. Remove trash, debris, and sediment from parking lots and catch basins. Identify sources of visible pollutants or spills and clean up sources to protect the stormwater system. Sweep or vacuum parking lots or other ground-level surfaces. Report all spills that threaten or enter the public sanitary or storm system by calling the BES Spill Protection and Citizen Response Hotline at 503-823-7180.

Sediment and Oil Removal and Disposal

Stormwater facilities are designed to remove pollutants by capturing sediment, dirt, leaves, and litter. Remove sediment and oil to maintain facility infiltration rates, provide adequate water quality treatment, and prevent clogging and flooding.

In vegetated facilities, remove sediment when it reaches a depth of 4 inches or when the quantity reaches 30% of total capacity as designed or measured. Sediment should also be removed when it impedes facility function (e.g., when sediment is damaging vegetation, preventing the facility from draining, blocking inlets, or causing a bypass). Remove sediment from catch basins and sedimentation maintenance holes when sediment reaches 30% of total capacity.

Remove sediment by hand unless professionals are needed for confined space entry or use of specialized equipment such as a vactor truck. Dispose of sediment per solid waste disposal requirements. Removing sediment during dry periods is easier as the material weighs substantially less when it is dry.

Vegetation Management

Check vegetated facilities quarterly for maintenance needs during the first 2 years and twice a year after that. Healthy plants play important roles: the root systems help prevent erosion, maintain infiltration rates, capture pollutants, and absorb stormwater.

Healthy vegetation must cover at least 90% of the surface area of the facility. If a facility has bare soil, or if vegetation is stressed, unhealthy, or dead, address the cause of stress and replant per the approved planting plan.

Prune or trim vegetation or roots to ensure free conveyance of stormwater and to maintain sight lines. Remove leaves or other debris. Maintain grass at a height of 4 to 9 inches. Use weed-free mulch to inhibit weeds and irrigate as needed. Remove nuisance plants and invasive plants.

The use of fertilizers, pesticides, and herbicides is strongly discouraged in all stormwater facilities because of the potential for stormwater pollution and damage to downstream systems. Use Integrated Pest Management (IPM) strategies, and if pesticides or herbicides are required, use the services of a licensed applicator and products approved for aquatic use. There are specific restrictions on the use of fertilizers, pesticides, and herbicides for ecoroofs (see Section 3.2.1.1).

Erosion, Bank Failure, and Channel Formation

Erosion in the flow path, inside or outside of a facility, can clog inlets and outlets and reduce both conveyance efficiency and infiltration rates. Forms of erosion include channels, undercutting, scouring, and slumping. Address erosion features that are more than two inches deep. Install long-term erosion control practices and fill the eroded areas.

Structural Repairs: Structural components control the conveyance of stormwater. Examples include inlets, outlets, trash racks, concrete curbs, retaining walls, maintenance holes, and check dams. Repair or replace items when damaged, loose, broken, cracked, or askew. Monitor minor damage such as dents, rust, or minor cracks in concrete for indications of when repair or replacement is required.

Ponding Water: Most stormwater facilities are designed to drain within 30 hours of the last rainfall. The O&M Plan should specify the anticipated ponding depth, infiltration rate, and drawdown time. When the facility does not drain as anticipated, inspect the facility to determine the cause. Clear clogged inlets and outlets to remove sediment that may prevent infiltration. Add vegetation as necessary to help improve infiltration.

Pests: Stormwater facilities are designed to drain quickly enough to avoid becoming breeding areas for pests. If mosquitos are present, the stormwater facility may be ponding water longer than called for by the design. Nearby standing water may also be the source. If rodents are found, remove plant debris, fruit, or nuts and contact the appropriate county vector control office for trapping and removal.

Safety: Maintain stormwater facilities to protect workers, visitors, and the public. Prune vegetation for adequate visual clearance. Avoid maintenance activities during wet weather to reduce potential worker injuries and always ensure the use of appropriate safety gear. Only personnel approved for confined space entry can enter underground stormwater facilities.

IV. Financial Responsibility

Identify the party responsible for current and ongoing O&M activities. A facility maintenance fund is recommended for both operating procedures (i.e., regular maintenance) and capital procedures (i.e., major overhauls or replacement). Costs depend on the characteristics of the facility, site, and drainage area. The general recommendation for estimating annual maintenance costs is to use 5% to 10% of the facility’s total capital cost. Routine maintenance can help keep costs down by addressing problems before they require major attention.

V. Inspection and Maintenance Logs

Portland City Code requires property owners to keep a log of inspection and maintenance activities. The log must note all inspection dates, the facility components that were inspected, maintenance activities, and repairs performed. The property owner is responsible for ensuring maintenance is completed, and records kept, even if someone other than the property owner is performing the maintenance (e.g., a facility manger or maintenance company). The City may accept other documentation (e.g., work orders, invoices, or receipts) in lieu of an inspection and maintenance log to demonstrate compliance with O&M requirements.

If maintenance is performed by an MSTT manufacturer, the manufacturer’s maintenance logs must include the same general type of information and the same level of detail.

Review of Draft O&M Documents

For projects under development review, owners can call BES at 503-823-7761 to ask for a review of the adequacy of proposed O&M Plans and draft O&M Forms. For already-constructed projects, call 503-823-5600 for form review and approval of existing O&Ms.

3.3.3 O&M Revisions

Revisions to the O&M Form Prior to Project Completion

The owner must record a new O&M Form or Plan with the county if the O&M Form or Plan requires revision, either because the O&M Form or Plan on file with the City is inaccurate or because the owner requests and receives City approval to revise it.

O&M Revisions Prior to Project Completion

If the stormwater design needs modification prior to substantial completion of the project, contact BES Development Services at 503-823-7761. For guidance on how best to update the O&M Form or Plan to reflect the built system, call the Maintenance Inspection Program at 503-823-5600.

Revisions to Recorded O&M Submittals

See Section 1.6.5 for requirements for revisions needed after project completion.

3.3.4 O&M Submittal and Recording Process

The applicant must sign the O&M Form and the signature must be notarized. The O&M Form and 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, the O&M Form meets the recording requirements in Multnomah, Clackamas, and Washington counties.

Submit recorded O&M forms and plans to BES at the following address:

> City of Portland, BES
> 1900 SW Fourth Ave., Suite 5000
> Portland, OR 97201

County Recorder's Office Information

Multnomah County Recorder
501 SE Hawthorne Blvd.
Suite 175
Portland, OR 97214
https://multco.us/recording/recording-documents
Phone: 503-988-3326

Clackamas County Recording Division
1710 Red Soils Ct., #110
Oregon City, OR 97045
http://www.clackamas.us/recording/
Phone: 503-655-8551

Washington County Recording Division
155 N. First Ave.
Suite 130, MS 9
Hillsboro, OR 97124
http://www.co.washington.or.us/AssessmentTaxation/Recording/
Phone: 503-846-8752

3.4 General Submittal Requirements

The following tables provide a summary of the main submittal components for stormwater facilities. Table 3-14 lists the basic submittal requirements by design approach, and Table 3-15 shows additional submittals that may be required based on the site and design. In some cases, the City may require information not listed in these tables.

Table 3-14. BES Submittal Requirements by Design Approach

	Design Approach			
Submittal Required	Simplified	Presumptive	Performance	SWMM Section
Site Plan	x	x	x	3.4
Landscape Plan	x	x	x	3.4
O&M Plan[1]	x	x	x	3.3
Hierarchy Level Justification	x	x	x	3.4
SIM Form w/Infiltration Test	x			3.4
Stormwater Report		x	x	3.4
Infiltration Test Report[2]		x	x	2.3

1 Record the O&M Plan in the county of the subject property, prior to issuance of the Building Permit.

2 For the Presumptive and Performance Approaches, a professional engineer or licensed professional must complete the infiltration test and report.

Table 3-15. Additional Submittal Requirements

Submittal Required	For Sites with the Following Conditions	SWMM Section
Groundwater Investigation Report	Infiltration proposed in areas with groundwater concerns, such as shallow groundwater.	2.3.1
Geotechnical Report	Sites where a geotechnical investigation is performed for a project.	2.3.3
Engineering Report	Encroachment within a structural setback.	2.3.3
Environmental Investigation Report	Infiltration proposed above or through contaminated soil or contaminated groundwater.	2.3.3
Drainage Reserve Encroachment Submittals	Encroachment into a drainage reserve or channel.	5.9
Special Circumstance Request	A design unable to meet the requirements of the Stormwater Management Manual.	1.8

Inaccurate or Incomplete Applications

BES and BDS simultaneously review development proposals. The process will be delayed by inaccurate or incomplete applications, which BDS will return to the applicant. For questions about the submittal process, call the BES Development Review Hotline at 503-823-7761.

3.4.1 Submittals Required for All Design Approaches

Land Use Review Submittals

Portland's Zoning Code may require a land use review by BDS for a proposed use or development. Land use reviews can be triggered by different sections of Portland's zoning code (e.g., base zones, overlay zones, or plan districts) or by conditions of approval from past land use approvals for a site. BDS reviews land use applications against relevant approval criteria, some of which relate directly to BES services and regulations.

BES can only initiate its review once the applicant has provided complete and accurate detail about a number of topics including, but not limited to, the following:

- Site plan information, including the locations of site utilities;
- The feasibility of infiltration;
- The stormwater hierarchy level being met, with justification;
- Documentation of access to an offsite receiving system (e.g., drainageway, storm sewer, or combined sewer), if needed;
- Delineation of any drainageways and drainage reserves;
- Designation of the areas required for stormwater facilities;
- Identification of setback conflicts (e.g., between stormwater facilities and property lines or foundations);
- Delineation of disturbance areas;
- Delineation of proposed and existing impervious surfaces; and
- How the project meets stormwater management requirements for all applicable impervious area.

If a land use review applies to both private property and the public right-of-way (see PCC 33.10.030.B), BES may require stormwater management information related to both the private development and the work in the public right-of-way. Land use applicants may need to reference the submittal requirements for both private and public projects.

Site Plans

Site plans must have a minimum scale of 1 inch to 10 ft, include a north arrow, show adequate space for the stormwater facility within any setbacks, and include the following information:

- ☐ Location, size, and type of stormwater facilities
- ☐ Proposed stormwater discharge locations
- ☐ Stormwater piping for the facility, including pipe materials, sizes, slopes, and invert elevations
- ☐ The offsite connection if the facility does not infiltrate the 10-year storm
- ☐ Typical detail for the stormwater facility (embedded on the plan sheet)

Site plans should also include the following (except for ecoroofs):

- ☐ Existing and proposed topography and elevations
- ☐ Existing and proposed impervious surfaces and type of surface
- ☐ Proposed disturbance areas
- ☐ Property lines, lot dimensions, and lot area
- ☐ Setbacks
- ☐ Building foundation footprints
- ☐ Areas with steep slopes or landslide risks
- ☐ Wells, identifying the type of well (e.g., “drinking water well”)
- ☐ Septic tanks and drain fields
- ☐ Utility lines and easements
- ☐ Type, location, and size of conveyance features if present or proposed
- ☐ Any drainageways, waterbodies, and wetlands
- ☐ Drainage reserves
- ☐ Boundary of regulatory district or area (e.g., wellhead protection area)
- ☐ Any areas with soil or groundwater contamination

Landscape Plans

A Landscape Plan must include the following:

- ☐ A planting plan that indicates which existing vegetation is to be preserved, the location of all landscape elements, Zone A (wet zone) and Zone B (moderate to dry zone) if applicable, and a description of the size, species and location of all proposed plantings (per zone if applicable).

- ☐ A plant list or table including botanic and common names; plant sizes at the time of planting; plant quantity; plant spacing; the type of container; classification as to evergreen or deciduous; and other information related to the facility-specific planting (e.g., planting method), in accordance with landscape industry standards
- ☐ The intended source of the blended soil
- ☐ The method of watering to be used for the establishment period and any permanent long-term irrigation plan (if applicable).

O&M Plans and Forms

See Section 3.3 for O&M plans and forms. The applicant must submit the required O&M documents for review and approval before the permit can be issued.

For O&M plans and forms for drainageways, drainage reserves, culverts, and outfalls, see Section 5.10.

3.4.2 Simplified Approach – SIM Form

The SIM Form is for stormwater facilities designed using the Simplified Approach (see Section 2.1.2 for Simplified Approach restrictions). Each tax lot is required to manage the stormwater it generates on the same lot to the maximum extent practicable. Complete the SIM Form in full, providing the following information.

Project Information: Include the name and contact information of the SIM Form preparer and project contact or property owner as appropriate. Include the project site address and/or tax lot R number, type of development, and total new impervious surfaces proposed. New impervious surfaces should match proposed new roof and paved areas as proposed in the submitted site plans.

Site Characteristics: Note the site characteristics that could impact the methods or ability to safely manage stormwater onsite, including steep slopes, springs, seeps, and high groundwater. If a geotechnical report has been completed for the proposed development, include the report as an attachment to the SIM Form submittal. If infiltration tests have been completed as part of a prior associated land use case, note the land use case permit number and note the tested infiltration rates in the test results section on the back of the form.

Infiltration Testing: Follow the infiltration testing procedure outlined on the SIM Form. Infiltration test results will dictate what type of stormwater facility can be utilized. If tested infiltration rates are greater than or equal to 2 in/hr, then onsite infiltration is required unless there are constraints to infiltration.

Proposed Stormwater Facilities: Complete the table with information about the type and size of each proposed stormwater facility and the area managed by each facility type. Applicants are encouraged to review the detailed descriptions and requirements of each facility type (provided earlier in this chapter) before completing this section of the form.

SIMPLIFIED APPROACH FORM

PROJECT INFORMATION WORKSHEET

CITY OF PORTLAND
Stormwater Management Manual

Project/Permit Number: ______________________

Land Use Case Number: ______________________

Contact Name: ______________________

Phone: ______________________

Email: ______________________

Site Address/R Number(s) for all parcels:

____

____

Project Description: ______________________

Existing impervious area: __________ f²

Total NEW impervious area: __________ f²

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

S.3 Geotech Report? ☐ Yes ☐ No

S.4 Infiltration Test? ☐ Yes ☐ No

See back of form for required certifications.

SIMPLE PIT INFILTRATION TEST PROCEDURE

The person performing this test does not need a professional credential.

Test instructions:

1. Conduct the test in and/or near the location of the proposed infiltration facility.
2. Excavate a 2' by 2' pit to a depth of: 2' below grade for facilities less than 2' deep or 3' below grade for facilities greater than 2' deep. Check for standing water or hardpan soil preventing excavation. If either is present, document conditions on this form and **do not** proceed with the test.
3. Fill the pit with at least 12 inches of water and record the initial water depth and the time when the test starts. Check the water depth at regular intervals until all of the water has been absorbed or for 1 hour, whichever occurs first. Record the time and final water depth at the end of the test.
4. Repeat the process two more times for a total of three rounds. Conduct the tests in succession to accurately characterize the soil's infiltration rates at different levels of saturation. The third test provides the best measure of the infiltration rate when saturated.
5. Record infiltration test data in the table below and certify the results. Uncertified test results will not be accepted.

Required Infiltration Testing

Date of Test: ______________________

Depth of Excavation (ft): ______________________

Depth of Proposed Facility: ______________________

	TEST 1	TEST 2	TEST 3
A. Time *(of day)*			
B. Duration *(minutes; 1 hour maximum)*			
C. Initial Water Depth *(inches)*			
D. Final Water Depth *(inches)*			
E. Infiltration Rate* *(inches/hour)*			

*Infiltration Rate = Initial Depth *(in)* – Final Depth *(in)* / Duration of Test *(hours). hours = minutes/60*

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

Proposed Stormwater Facilities

Please note: Each individual tax lot is required to manage the stormwater runoff it generates on the same lot to the maximum extent feasible (for new construction or redevelopment). The following table includes accepted Simplified Approach facilities as described in Chapters 2 & 3 of the *2020 Stormwater Management Manual*. Copies of the manual are available online at www.portlandoregon.gov/bes/SWMM**.**

STORMWATER FACILITY TYPE	AREA DRAINING TO FACILITY (SF)	FACILITY SIZING FORMULA	FACILITY SIZE (surface area of facility)
Ecoroof		Area x 1 (1:1 ratio)	
Pervious Pavement		Area x 1 (1:1 ratio)	
Rain garden		Area x 0.10	
Basin		Area x 0.09	
Planter		Area x 0.06	
Filter Strip		See sizing table in SWMM Section 3.3.2.1	
Driveway Center Strip		Min. width is 3 ft; max. length is 50 ft if slope is 10-15% (max. slope is 15%).	
Drywell		See Maximum Catchment Area Managed by a Single Drywell Table below	(Drywell diameter, depth number)
Soakage Trench		25 ft^2 of soakage trench for every 500 ft^2 of impervious area. (Depth = 1.5 ft; width & length vary)	
Surface Sand Filter		Area x 0.06	
TOTAL IMPERVIOUS AREA (Managed, new, and redeveloped)		Total impervious area must equal the total **NEW AND REDEVELOPED** impervious area being proposed.	

Maximum Catchment Area Managed by a Single Drywell (ft^2)

MATERIAL Ring Diameter	PLASTIC 24 inches	CONCRETE 28 inches	CONCRETE 48 inches
2 ft deep	500 ft^2	NA	NA
5 ft deep	NA	1,000 ft^2	2,500 ft^2
10 ft deep	NA	2,500 ft^2	4,500 ft^2
15 ft deep	NA	3,500 ft^2	5,000 ft^2

No more than 2 plastic drywells allowed per catchment area.

Required Certifications

SIMPLE PIT TEST

____

Name of Tester

____

Signature of Tester

____

Date

PERSON RESPONSIBLE FOR APPLICATION ACCURACY

____

Contact Name–Printed

____

Signature

____

Date

3.4.3 Presumptive & Performance Approach – Stormwater Report

The stormwater report provides technical documentation concerning the project. Submit the report with the permit application. If submitted in the form of a hard copy, reports should be paginated and securely fastened (including maps and exhibits). If submitted digitally, submit a single PDF.

The stormwater report must adequately document how the proposed development meets the stormwater requirements at the time of development. It must include the following items.

- ☐ **Cover Sheet**
  - ☐ Project name
  - ☐ Property owner
  - ☐ Site address
  - ☐ Associated permit numbers
  - ☐ Submittal date
  - ☐ The engineer of record and their full contact information

- ☐ **Designer's Oregon registration stamp, signature, and certification:**
  I hereby certify that this Stormwater 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."

- ☐ **Table of Contents**

- ☐ **Project Overview and Description**
  - ☐ Vicinity map
  - ☐ Watershed
  - ☐ Drainage and conveyance given existing site conditions
  - ☐ Type of development or proposed improvements
  - ☐ Regulatory district or area (e.g., wellhead protection area)
  - ☐ Property zoning
  - ☐ Existing versus post-construction conditions
  - ☐ Permits required (local, state, federal)

- ☐ **Methodology**
  - ☐ Description of potential impacts to existing drainage
  - ☐ Description of techniques for mitigating impacts

- [ ] Infiltration test results or recommendations (except for ecoroofs)
- [ ] Stormwater hierarchy level, with a justification
- [ ] Narrative describing the stormwater management techniques

- [ ] **Analysis**
  - [ ] Assumptions and calculations. For the Presumptive Approach, this is the PAC report. For the Performance Approach, include design storms, computation methods, software used, safety factors, curve numbers, design coefficients, and variations from the norm.
  - [ ] Inundation level for the 100-year storm event
  - [ ] Table of impervious surface(s) treated (including ecoroofs and permeable pavement), type of impervious surface treated (e.g., roof or parking lot), and the facility size. (See Table 3-16 as an example.)

Table 3-16. Example Catchment and Facility Summary

Impervious Surface			Stormwater Facility	
Type	Size (ft^2 or ac)	CN	Type	Size (ft^2)

- [ ] **Engineering Conclusions.** A narrative describing how the site-specific requirements of the Stormwater Management Manual are met, including any flow control and/or water quality requirements. If using the Presumptive Approach, include the PAC report. Otherwise use a table such as Table 3-17.

Table 3-17. Pre- vs. Post-Construction Flow Rates

Catchment ID	Peak Flow Rate (cfs) for a 24-hr storm								Time of Concentration	
	2-yr		5-yr		10-yr		25-yr			
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post

- [ ] **Stormwater Facility Details/Exhibits**
  - [ ] Cross-section(s) showing facility dimensions and elevations of inlets, outlets, any required freeboard, and discharge locations demonstrating gravity drainage
  - [ ] Delineated catchment area for each stormwater facility
  - [ ] Stormwater conveyance features
  - [ ] Offsite discharge location

3.4.4 Additional Submittal Requirements for Specific Facility Types

Projects with ecoroofs, permeable pavement, surface and subsurface sand filters, MSTTs, rainwater harvesting, structured detention facilities, or ponds require the submittal of additional information in the stormwater report.

Ecoroofs

Submit the following for each project proposing an ecoroof:

- Coverage (ft^2) of vegetated ecoroof areas, unvegetated ecoroof areas, vegetated areas outside the boundary of the ecoroof, and unvegetated areas outside the boundary of the ecoroof.
- A planting plan that includes a detailed water-use plan.
- Roof cross-sections and typical details.
- Details for the waterproof membrane and any root-barrier system.
- A drainage plan and the specification for the growing medium, including the growing medium's saturated weight, depth, and the name of the source of the material.
- The structural engineer's sign-off on the project.
- For ecoroofs with a growing medium depth of less than 4 inches, documentation demonstrating the design provides stormwater management benefits, per the Chapter 1 requirements, that meet or exceed the performance of a standard 4-inch ecoroof.

Permeable Pavement

Submit the following for each project proposing permeable pavement:

- Any material brand names and associated specifications.
- Documentation of how the sequence of construction activities will exclude traffic from the subgrade of the proposed paved area, and how the paving will be protected from construction traffic and sediment after installation.

Additionally, BES may require the following:

- For pervious concrete, a written statement from the supplier concerning the structural integrity and hydraulic performance of the material.
- A protection plan for the permeable pavement.

Surface Sand Filters and Subsurface Sand Filters

For each project proposing the use of a surface sand filter, submit the results of a sieve analysis to confirm compliance with the filter sand specification.

MSTTs

Submit the following for each project proposing the use of an MSTT:

- A letter from the manufacturer certifying the project has been designed to the manufacturer’s specifications (prior to building permit plan approval).
- Flow-rate calculations to demonstrate the MSTT will perform within the approved sizing standards.
- Identification of the high-flow bypass.
- Facility dimensions and setbacks from property lines and structures.
- A profile view of the facility, including typical cross-sections with dimensions.
- Documentation of stormwater piping, including materials, sizes, and slopes.
- Any necessary documentation demonstrating compliance with the specific conditions of approval for the device.
- Designation of access routes for equipment maintenance.

Rainwater Harvesting

Submit the following for each project proposing the use rainwater harvesting:

- Hydraulic calculations demonstrating how the rainwater harvesting system contributes to meeting flow control requirements.
- A description of how the system overflow connects to an approved stormwater disposal location.
- A description of how the larger project meets all of the stormwater management requirements that apply to the site.

BDS will review the submittals and confirm compliance with all plumbing code requirements.

Structured Detention Facilities

For each project proposing the use of a structured detention facility, submit calculations to demonstrate the stability of the structure where ballasting with concrete or earth backfill, providing concrete anchors, or other counteractive measures as required.

Ponds

For each project proposing the use of a pond, submit plans that show maintenance access routes for the pond. For wet ponds and extended wet ponds, submit a water budget for BES review that demonstrates the base flow will prevent water stagnation and matting of alga. For ponds with a retaining wall, submit detailed structural design calculations for the retaining wall.

3.5 Plant Lists

The plants on the Ecoroof Plant List and the Private Stormwater Facilities Plant List meet the requirements of this manual. Other plants may be appropriate for private facilities and can be used with BES approval. Provide a brief narrative describing the suitability of the plant selection(s). Other references include the Portland Plant List for native plant lists and the Bureau of Development Services Tree and Landscaping Manual - Plant Materials for plant suggestions that meet required landscaping and screening goals.

Plants on the Portland Nuisance Plant List and Required Eradication List are prohibited in stormwater management facilities or drainageways (See Section 4.1 of the Portland Plant List).

Ecoroof Plant List

Ecoroof Plant List							
	Botanic Name	**Common Name**	**NW Native**	**Evergreen**	**Potential Height**	**Full Sun**	**Partial Shade**
Succulents	*Delosperma cooperi*	Ice Plant	N	Y	4”	X	X
	Delosperma nubigenum	Ice Plant	N	Y	2”	X	X
	Opuntia spp.	Prickly-Pear Cactus	N	N	5”	X	X
	Sedum acre	Biting Stonecrop	N	Y	2”	X	X
	Sedum album	White Stonecrop	N	Y	3”	X	X
	Sedum divergens	Pacific Stonecrop	Y	Y	3”	X	X
	Sedum hispanicum	Spanish Stonecrop	N	Y	3”	X	X
	Sedum kamtschaticum	Kirin-so	N	N	6”	X	X
	Sedum lanceolatum	Lance-leaved Stonecrop	Y	N	4”	X	X
	Sedum oreganum	Oregon Stonecrop	Y	Y	4”	X	X
	Sedum oregonense	Creamy Stonecrop	Y	Y	4”	X	X
	Sedum rupestre	Crooked Stonecrop	N	Y	6”	X	X
	Sedum sexangulare	Tasteless Stonecrop	N	Y	4”	X	X
	Sedum spathulifolium	Broad-leaved Stonecrop	Y	Y	4”	X	X
	Sedum spurium	Two-row Stonecrop	N	Y	6”	X	X
	Sedum takesimense	Gold Carpet Stonecrop	N	Y	9”	X	X
	Sedum telephium	Autumn Joy	N	N	24”	X	X
	Sempervivum tectorum	Hens and Chicks	N	Y	6”	X	X
Herbaceous Plants	*Achillea millefolium*	Common Yarrow	Y	N	36”	X	X
	Allium acuminatum	Hooker’s Onion	Y	N	6”	X	X
	Allium cernuum	Nodding Onion	Y	N	12”	X	X
	Antennaria neglecta	Field Pussytoes	Y	N	4”	X	X
	Arenaria montana	Sandwort	N	N	4”	X	X
	Aurinia saxatilis	Basket-of-Gold	N	N	6”	X	X
	Campanula rotundifolia	Common Harebell	Y	N	8”	X	X
	Dianthus spp.	Dianthus	N	N	12”	X	X
	Erigeron compositus	Fleabane	N	N	12”	X	X

Ecoroof Plant List								
	Botanic Name	**Common Name**	**NW Native**	**Evergreen**	**Potential Height**	**Full Sun**	**Partial Shade**
Herbaceous Plants	*Erigeron glaucus*	Beach Aster	Y	N	6”	X	X
	Festuca idahoensis	Idaho Fescue	Y	Y	12”	X	X
	Fragaria chiloensis	Coastal Strawberry	Y	Y	6”	X	X
	Fragaria virginiana	Wild Strawberry	Y	Y	6”	X	X
	Gaillardia aristata	Blanket Flower	N	N	20”	X	X
	Gazania linearis	Gazania	N	N	6”	X	X
	Koeleria macrantha	Junegrass	Y	N	24”	X	X
	Lobularia maritima	Sweet Alyssum	N	N	12”	X	X
	Phlox douglasii	Tufted Phlox	Y	N	4”	X	X
	Polypodium glycyrrhiza	Licorice Fern	Y	Y	12”	X	X
	Polystichum munitum	Sword Fern	Y	Y	24”	X	X
	Potentilla nepalensis	Nepal Cinquefoil	N	N	14”	X	X
	Potentilla neumanniana	Cinquefoil	N	N	14”	X	
	Prunella vulgaris lanceolata	Self-Heal	Y	N	4”	X	X
	Silene acaulis	Moss Campion	Y	N	3”	X	X
	Thymus serphyllum	Creeping Thyme	N	N	3”	X	
	Veronica liwanensis	Turkish speedwell	N	N	2”	X	X
Accent Plants	*Camassia quamash*	Common Camas	Y	N	8”	X	X
	Clarkia amoena	Farewell-to-Spring	Y	N	7”	X	X
	Gilia capitata	Globe Gilia	Y	N	18”	X	X
	Linaria reticulata	Purplenet Toadflax	N	N	20”	X	X
	Linum perenne	Blue Flax	Y	N	8”	X	X
	Lupinus bicolor	Two-Colored Lupine	Y	N	5”	X	X
	Madia elegans	Elegant Tarweed	Y	N	18”	X	X
	Nemophila menziesii	Baby Blue Eyes	Y	N	5”	X	X
	Phacelia campanularia	Desert Bluebells	N	N	10”	X	X
	Plectritis congesta	Sea Blush	Y	N	5”	X	X
	Triteleia ixoides	Golden Star	Y	N	10”	X	X

*These plants are also listed in the Bureau of Development Services Tree and Landscaping Manual Suggested Plant List and may be appropriate for meeting screening requirements.

Private Stormwater Facilities Plant List

	Botanic Name	Common Name	Zone	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing	Full Sun	Partial Shade
Herbaceous Plants	*Athyrium filix-femina*	Lady Fern	B		X	Y	N	36"	24"		X
	Bromus carinatus	California Brome Grass	A		X	Y	Y	18"	12"	X	X
	Bromus sitchensis	Alaska Brome	A		X	Y	Y	18"	12"	X	X
	Bromus vulgaris	Columbia Brome	A		X	Y	Y	18"	12"	X	X
	Carex deweyanna	Dewey Sedge	A	X	X	Y	Y	36"	12"	X	X
	Carex densa	Dense Sedge	A	X	X	Y	N	24"	12"	X	X
	Carex obnupta	Slough Sedge	A	X	X	Y	Y	4'	12"	X	X
	Carex stipata	Sawbeak Sedge	A	X	X	N	Y	20"	12"	X	X
	Carex testacea	New Zealand Orange Sedge	A	X	X	N	Y	24"	12"	X	X
	Carex vesicaria	Inflated Sedge	A	X	X	Y	Y	36"	12"		X
	Deschampsia cespitosa	Tufted Hair Grass	A/B	X	X	Y	Y	36"	12"	X	X
	Eleocharis acicularis	Needle Spike Rush	A	X	X	Y	Y	30"	12"		X
	Eleocharis ovata	Ovate Spike Rush	A	X	X	Y	Y	30"	12"		X
	Eleocharis palustris	Creeping Spike Rush	A		X	Y	Y	30"	12"		X
	Elymus glaucus	Blue Wild Rye	B		X	Y	Y	24"	12"	X	X
	Festuca occidentalis	Western Fescue Grass	A		X	Y	Y	24"	12"	X	X
	Festuca rubra	Red Fescue	B		X	Y	Y	24"	12"	X	X
	Glyceria occidentalis	Western Manna Grass	A		X	Y	Y	18"	12"		X
	**Helictotrichon sempervirens*	Blue Oat Grass	B		X	N	Y	24"	12"	X	
	Iris douglasiana	Douglas Iris	B		X	Y	y	18"	12"	X	X
	Iris sibirica	Siberian Iris	A	X	X	N	y	36"	12"	X	X
	Iris tenax	Oregon Iris	B		X	Y	y	18"	12"	X	X
	Juncus balticus	Baltic Rush	A	X	X	y	y	20"	12"	X	X
	Juncus effusus var. pacificus	Soft rush	A	X	X	Y	Y	36"	12"	X	X
	Juncus ensifolius	Dagger-leaf Rush	A	X	X	N	y	10"	12"	X	X

	Botanic Name	Common Name	Zone	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing	Full Sun	Partial Shade
Herbaceous Plants	**Juncus patens*	Spreading Rush	A	X	X	N	Y	36"	12"	X	X
	Juncus tenuis	Slender Rush	A	X	X	Y	Y	36"	12"	X	X
	**Liriope muscari* 'Big Blue'	Big Blue Liriope	A/B	X	X					X	X
	Lupinus bicolor	Bicolor Lupine	B		X	Y	N	18"	12"	X	X
	Lupinus polyphyllus	Large-leaved Lupine	A/B		X	Y	N	36"	12"	X	X
	**Polystichum munitum*	Sword Fern	A/B		X	Y	Y	24"	24"		X
	Schoenoplectus americanus	American Bulrush	A	X	X	Y	Y	30"	12"	X	X
	Scripus microcarpus	Small Fruited Bulrush	A		X	Y	Y	24"	12"	X	X
	Scripus validus	Softstem Bulrush	A	X	X	N	y	5'	12"	X	X
	Sisyrinchium californicum	Yellow-eyed Grass	A/B	X	X	N	Y	6"	12"	X	X
	Symphyotrichum subspicatum	Douglas' Aster	B		X	Y	N	36"	12"	X	X
	Veronica liwanensis	Speedwell	A		X	N	y	2"	12"	X	X
Groundcovers	**Arctostaphylos uva-ursi*	Kinnickinnick	B		X	Y	Y	6"	12"	X	X
	**Berberis (Mahonia) repens*	Creeping Oregon Grape	B		X	Y	Y	12"	12"	X	X
	**Fragaria chiloensis*	Coastal Strawberry	B		X	Y	Y	6"	12"	X	X
	Fragaria vesca	Woodland Strawberry	B		X	Y	Y	10"	12"	X	X
	Fragaria virginiana	Wild Strawberry	B		X	Y	Y	10"	12"	X	X
	Sedum oreganum	Oregon Stonecrop	B			X	Y	4"	12"	X	X
Small Shrubs	*Baccaris pilularis* 'Dwarf'	Dwarf Coyote Bush	B		X	Y	Y	3'	24"	X	X
	**Berberis (Mahonia) aquifolium*	Oregon Grape	B		X	Y	Y	4'	3'	X	X
	**Berberis nervosa*	Dull Oregon Grape	B		X	Y	Y	24"	24"		X
	**Ceanothus velutinus*	Snowbrush	B		X	Y	Y	4'	3'	X	
	**Cistus spp.*	Various rock rose species	A/B	X	X	N	Y	3'	3'	X	
	Cornus sericea 'Kelseyii'	Kelsey Dogwood	B		X	N	N	24"	24"	X	X
	**Hebe spp.*	Various hebe species	B		X	N	Y	2-3'	2-3'	X	

	Botanic Name	Common Name	Zone	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing	Full Sun	Partial Shade
Small Shrubs	**Ilex glabra* ‘Shamrock’, ‘Compacta’	Inkberry	A/B	X	X	N	Y	4’	4’	X	X
	**Lavendula spp.*	Lavender species	B		X	N	Y	3’	24”	X	
	**Lonicera nitida*	Box Honeysuckle	B		X	N	Y	4’	4’	X	X
	**Paxistima myrsinites*	Oregon Boxwood	B		X	Y	Y	3’	4’		X
	Rosa gymnocarpa	Baldhip Rose	B		X	Y	N	3'	3'	X	X
	Rosa nutkana	Nootka Rose	B		X	Y	N	8'	3'	X	
	**Rosa pisocarpa*	Swamp Rose	A/B	X	X	Y	N	8'	3'	X	X
	**Spirea betulifolia*	Birchleaf Spirea	A/B	X	X	N	N	3’	24”	X	X
	**Spirea x bumalda cvs.*	Bumald Spirea	A/B	X	X	N	N	3’	24”	X	X
	**Spirea densiflora*	Sub-Alpine Spirea	A/B	X	X	N	N	3’	24”	X	X
	**Spirea japonica cvs.*	Various spirea cultivars	A/B	X	X	Y	N	3’	24”	X	X
	**Symphoricarpos alba*	Common Snowberry	B		X	Y	N	6'	3'	X	X
	**Therorhodion (Ledum) glandulosum*	Trapper’s Tea	A/B	X	X	X	Y	1’-4’	2’		X
	**Thuja plicata dwarf and semi-dwarf species*	Semi-dwarf Western Red Cedar	A/B		X	Y	Y	3’	3’	X	X
	**Vaccinium ovatum*	Evergreen Huckleberry	A/B	X	X	Y	Y	3’	3’	X	X
	**Viburnum davidii*	David viburnum	A/B	X	X	Y	N	3’	3’	X	X
Large Shrubs	**Arbutus unedo*	Strawberry Tree	B		X	N	Y	10’	10’	X	X
	**Acer circinatum*	Vine Maple	A/B		X	Y	N	15'	10'	X	X
	**Amelanchier alnifolia*	Western Serviceberry	B		X	Y	N	20'	10'	X	X
	Ceanothus sanguineus	Oregon Redstem Ceanothus	B		X	Y	N	7'	4'	X	
	**Ceanothus thyrsiflorus*	Blueblossom	B		X	Y	Y	6’	6’	X	X
	**Cornus sericea*	Red-twig Dogwood	A/B	X	X	Y	N	6'	4'	X	X
	**Euonymus japonicas*	Japanese euonymus	A/B		X	N	Y	6’	4’	X	X
	**Fragula (Rhamnus) californica*	Coffeeberry (sm. cultivars)	B		X	N	Y	6’	6’	X	X
	**Holodiscus discolor*	Oceanspray	B		X	Y	N	6'	4'	X	X

	Botanic Name	Common Name	Zone	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing	Full Sun	Partial Shade
Large Shrubs	**Ilex cornuta*	Chinese Holly	B		X	N	Y	10’	4’	X	X
	**Ilex crenata*	Japanese Holly	B		X	N	Y	8’	4’	X	X
	Lonicera involucrata	Black Twinberry	B		X	Y	N	5'	4'	X	X
	**Morella (Myrica) californica*	Pacific Wax Myrtle	A/B	X	X	Y	Y	10’	10’	X	X
	**Nandina domestica*	Heavenly Bamboo	A/B	X	X	N	Y	6’	3’	X	X
	Oemleria cerasiformis	Indian Plum	B		X	Y	N	6'	4'	X	X
	**Philadelphus lewisii*	Wild Mock Orange	B		X	Y	N	6'	4'	X	X
	**Physocarpus capitatus*	Pacific Ninebark	A/B	X	X	Y	N	10'	3'	X	X
	**Ribes sanguineum*	Red-Flowering Current	B		X	Y	N	8'	4'	X	X
	Rubus parviflorus	Thimbleberry	B		X	Y	N	8'	4'	X	X
	Rubus spectabilis	Salmonberry	A	X	X	Y	N	10'	4'	X	X
	Salix purpurea ‘Nana’	Blue Arctic Willow	B		X	N	N	8'	6'	X	X
	Salix stichensis	Sitka Willow	A	X	X	Y	N	20'	6'	X	X
	Sambucus nigra ssp. cerulea	Blue Elderberry	B		X	Y	N	10'	10'	X	X
	Sambucus racemose var. arborescens	Red Elderberry	B		X	Y	N	10'	10'	X	X
	**Spiraea douglasii*	Douglas’ Spirea	A/B	X	X	Y	N	7'	4'	X	X
	**Thuja occidentalis*	American Arborvitae (Emerald)	B		X	N	Y	12’	3’	X	X
	**Viburnum cinnamomifolium*	Cinnamon Leaf Viburnum	B		X	N	Y	8’	8’	X	X
	Viburnum edule	Highbush Cranberry	A/B	X	X	Y	N	6'	4'	X	X
	**Viburnum tinus*	Laurustinus viburnum	A/B	X	X	Y	N	6’	5’	X	X
Trees	**Abies grandis*	Grand Fir	B		X	Y	Y	150'	-	X	X
	**Acer campestre*	Hedge Maple	A/B			N	N	50’	-	X	X
	**Acer griseum*	Paperbark Maple	B		X	N	N	30'	-	X	X
	**Acer macrophyllum*	Big Leaf Maple	B		X	Y	N	60'	-	X	X
	**Alnus rhombifolia*	White Alder	A/B			Y	N	100’	-	X	X

	Botanic Name	Common Name	Zone	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing	Full Sun	Partial Shade
Trees	**Alnus rubra*	Red Alder	A		X	Y	N	80'	-	X	X
	Arbutus menziesii	Madrone	B		X	Y	Y	35'	-	X	
	**Calocedrus decurrens*	Incense Cedar	B	X	X	Y	Y	100’	-	X	X
	**Celtis occidentalis*	Common Hackberry	A/B	X	X	N	N	100’	-	X	X
	**Celtis reticulata*	Western Hackberry	B		X	N	N	30’	-	X	X
	Crataegus douglasii	Black Hawthorn	A		X	Y	N	40'	-	X	X
	Crataegus gaylussacia (suksdorfii)	Suksdorf’s Hawthorne	A/B			Y	N	40’	-	X	X
	**Gleditsia tricanthos*	Honeylocust	A/B			N	N	40’	-	X	
	Malus fusca	Pacific Crabapple	A	X	X	Y	N	30'	-	X	X
	**Metasequoia glyptostroboides*	Dawn Redwood	B		X	N	N	80'	-	X	
	**Nyssa sylvatica*	Tupelo, sour gum	A/B			N	N	75’	-	X	X
	**Populus tremuloides*	Quaking Aspen	A		X	Y	N	40'	-	X	X
	Prunus emarginata var. mollis	Bitter Cherry	A/B	X	X	Y	N	50'	-	X	X
	**Pseudotsuga menziesii*	Douglas Fir	B		X	Y	Y	200'	-	X	X
	**Quercus bicolor*	Swamp Oak	A/B			N	N	60’	-	X	X
	**Quercus chrysolepis*	Canyon Live Oak	A/B			Y	Y	40’	-	X	X
	**Quercus garryana*	Oregon White Oak	B		X	Y	N	100'	-	X	X
	**Quercus phellos*	Willow Oak	A/B			N	N	90’	-	X	
	Quercus shumardii	Shumard Oak	A/B	X	X	N	N	60’	-	X	
	**Quercus wislizenii*	Interior Live Oak	A/B			N	Y	70’	-	X	
	**Rahmnus purshiana*	Cascara	A/B	X	X	Y	N	30'	-	X	X
	Salix exigua var. Columbiana	Columbia Willow	A/B	X	X	Y	N	13'	-	X	
	Salix hookeriana	Hooker's Willow	A/B	X	X	Y	N	15'	-	X	X
	Salix lasiandra var. lasiandra	Pacific Willow	A	X	X	Y	N	13'	-	X	X
	Salix scouleriana	Scouler's Willow	A/B	X	X	Y	N	15'	-	X	X

	Botanic Name	Common Name	Zone	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing	Full Sun	Partial Shade
Trees	**Taxodium distichum*	Bald Cypress	A/B			N	N	100’	-	X	
	**Thuja plicata*	Western Red Cedar	A		X	Y	Y	150'	-	X	X
	**Thuja plicata* ‘Hogan’	Hogan Western Red Cedar	A/B			Y	Y	50’	-	X	X
	**Tsuga heterophylla*	Western Hemlock	A		X	Y	Y	125'	-	X	X
	Zelkova serrata	Japanese Zelkova	A/B	X	X	N	N	45’	-	X	

*These plants are also listed in the Bureau of Development Services Tree and Landscaping Manual Suggested Plant List and may be appropriate for meeting screening requirements.

Grassy Swale Native Seed Mix

This is a recommended mix, but other mixes are also permitted. Percentages are by weight, 90% PLS (pure live seed):

Hordeum brachyantherum (Meadow Barley) = 25%
Danthonia californica (California Oat-grass) = 15%
Elymus glaucus (Blue Wild Rye) = 10%
Bromus carinatus (California Brome) = 10%
Festuca romerii (Roemer's fescue) = 10%
Deschampsia cespitosa (Tufted hairgrass) = 10%
Agrostis exarata (Spike bentgrass) = 10%
Alopecurus geniculatus (Water foxtail) = 5%
Deschampsia elongata (Slender hairgrass) = 5%

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Chapter 4. Public Facilities in the ROW

4.1. Introduction

This chapter provides requirements and guidance for designing public facilities, facilities that manage stormwater in or from the right-of-way (ROW), to meet the requirements of Chapter 1. This chapter provides design, establishment, and submittal requirements. Design of these stormwater facilities will be reviewed by the Bureau of Environmental Services (BES) through the public works permit process.

Project designers may also use this chapter to design facilities in private streets, which will be reviewed by BES and the Bureau of Development Services (BDS) through applicable land use and/or permit reviews. For facilities in private streets, the ownership and operations and maintenance requirements in Chapter 3 govern.

4.1.1. Public Facilities on Private Property

Public facilities located on private property (i.e., on parcels) must be located within a public sewer easement dedicated to the City of Portland.

4.2. Facility Design Requirements

This section describes facility-specific design guidelines and requirements for the following public stormwater facilities: vegetated surface facilities (i.e., green streets), sumps, manufactured stormwater treatment technologies (MSTTS), permeable pavement, tree credits, filter strips, and structured detention.

4.2.1. Vegetated Surface Facilities (Green Streets)

Curb extensions are street-side landscape areas that store, filter, and often infiltrate stormwater runoff. The curb extension shown above does not use the furnishing zone. Photo credit: Henry Ngan.

Vegetated stormwater facilities in the public ROW are called green streets. Green streets intercept stormwater from the street gutter. They temporarily store runoff on the surface, filter the runoff through blended soil, and allow the runoff to infiltrate into the ground or provide a connection to the receiving system when conditions preclude infiltration.

Green streets can be configured in various ways within the ROW (see Figure 4-1). The facilities may be located between the curb and sidewalk in the furnishing zone/planting strip (see Figure 4-2) or the curb may be extended into the street to accommodate a facility (i.e., a curb extension) (see Figure 4-3). The sides may be comprised of a vertical concrete wall (i.e., a planter wall), sloped vegetated sides, or a combination of the two (see Figure 4-4). Considerations for Green Street placement and design include stormwater requirements, the presence of utilities, existing and potential trees, potential loss of on-street parking spaces, pedestrian crossings, transit access, sidewalks, safe access for maintenance, and narrowing of the road.

Figure 4-1. Parts of the Right-of-Way

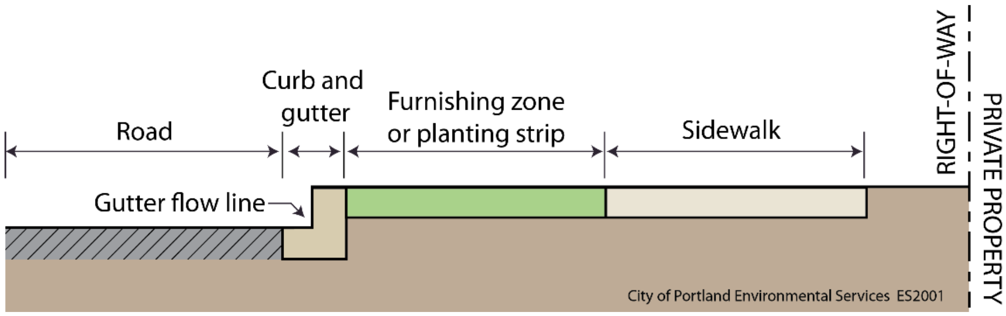


Figure 4-2. Facility within Furnishing Zone or Planting Strip (Plan View)

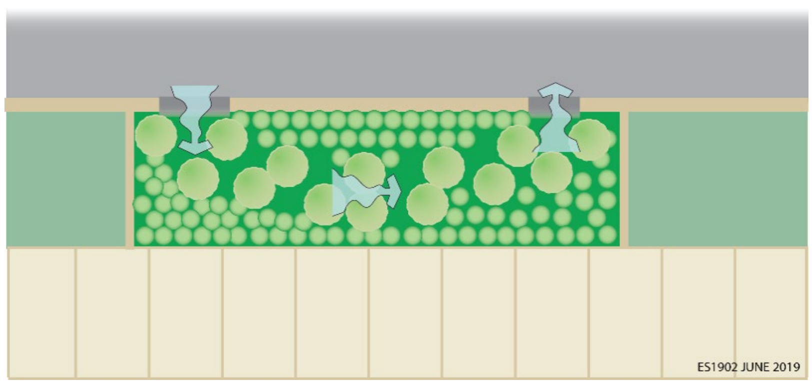


Figure 4-3. Curb Extension or Facility Extending Beyond the Curb (Plan View)

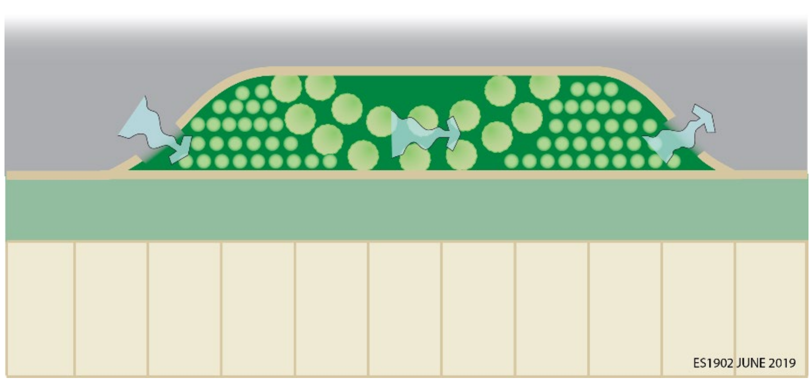
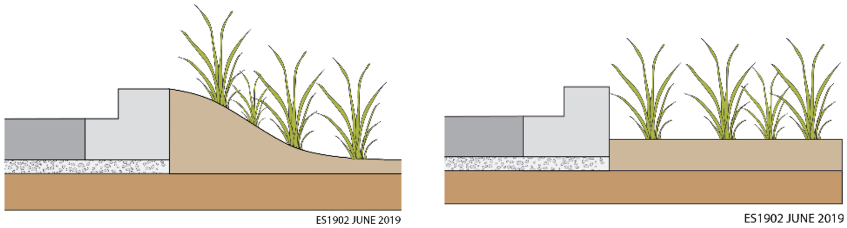


Figure 4-4. Sloped Sides and Vertical Planter Wall (Section Views)



4.2.1.1. General Site Design Guidelines

Green streets must exist alongside many other uses in the right-of-way. This section discusses how the placement and design of green streets should consider other uses to meet citywide goals, including pedestrian circulation, barriers, existing sidewalks, maintenance access, future development, tree coordination, utility coordination, and setbacks. This section provides additional site design guidance specific to curb extensions and planting strip facilities.

Pedestrian circulation

If an intersection is a marked crosswalk, the markings for the crosswalk perpendicular to the facility should either be aligned with the edge of the facility or pulled back from the facility to prevent a visually impaired pedestrian from walking into the facility. See Figure 4-5 and Figure 4-6 for acceptable and unacceptable striping alignments.

Figure 4-5. Acceptable: Crosswalks Align with Pedestrian Areas

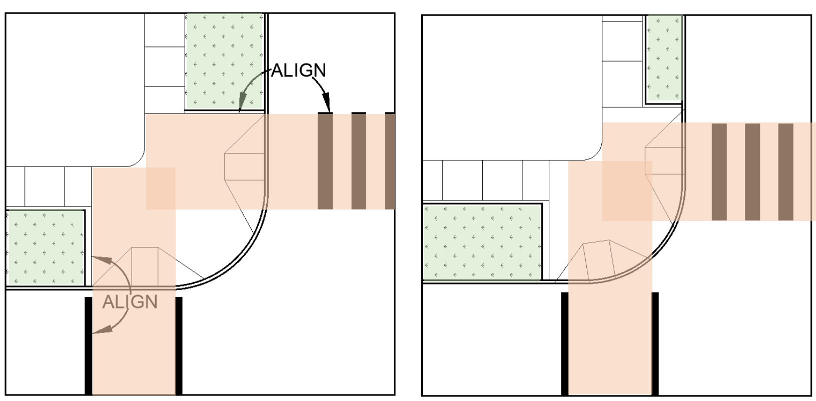
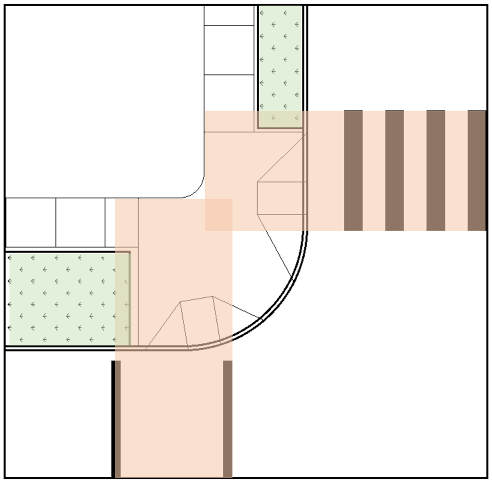


Figure 4-6. Unacceptable: Crosswalks Lead into Stormwater Facilities



A design with a sidewalk that leads into a facility (Figure 4-8) can be unsafe for pedestrians who are expecting the sidewalk to continue. Include a transition or barrier between the end of the sidewalk and the facility such as planting a tree or using other landscape on the ground plane; installing a sign or power/light pole, if either is needed in the location; or installing a railing-type barrier (see Figure 4-7).

Figure 4-7. Acceptable: Landscape, Tree, Pole, or Barrier Indicates Facility Edge

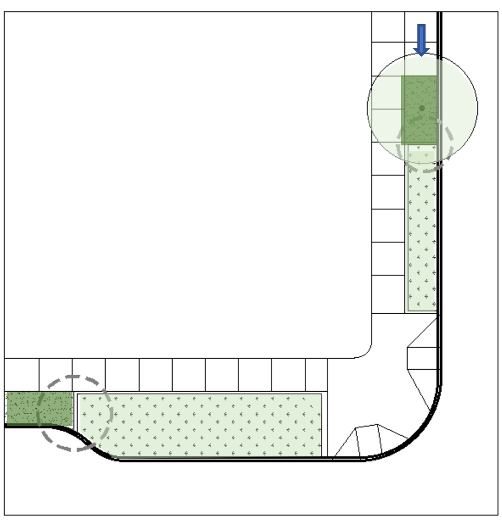
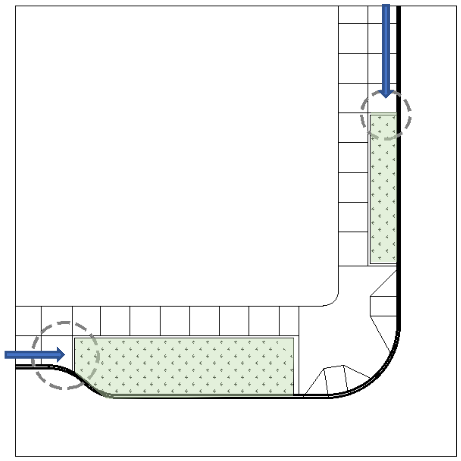


Figure 4-8. Unacceptable: Example of a Sidewalk Leading into a Stormwater Facility



Barriers

The interface between stormwater facilities and pedestrian areas requires design consideration. The transition is typically made with a 3:1 slope or a planter wall with a 4-inch high curb along the sidewalk. In some cases, barriers or a pedestrian handrail may be required in addition to or instead of the 4-inch curb. Locations where additional separation should be considered in the design include facilities adjacent to transit stops and where a sidewalk leads into a facility. First, consider using typical furnishing zone features such as a planting strip, street tree, or utility pole. If those are infeasible, then consider using a handrail. Handrails should be discussed with Portland Bureau of Transportation (PBOT) and BES staff. Use Oregon Department of Transportation Details RD770 Pedestrian Handrail and RD771 Pedestrian Handrail Details for pedestrian handrails.

Existing Sidewalks

Green streets are often installed as a retrofit in a location with existing improvements including sidewalks. During construction of green streets, sidewalks must be repaired where new construction meets the existing sidewalk. Repairs are required in locations with a vertical or horizontal displacement greater than or equal to 0.5 inch, as shown on the City of Portland Standard Construction Specifications Drawing P-554. Many existing sidewalks are old and unable 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 shown in City of Portland Standard Construction Specifications Drawing P-554 should be evaluated by PBOT staff during the design process.

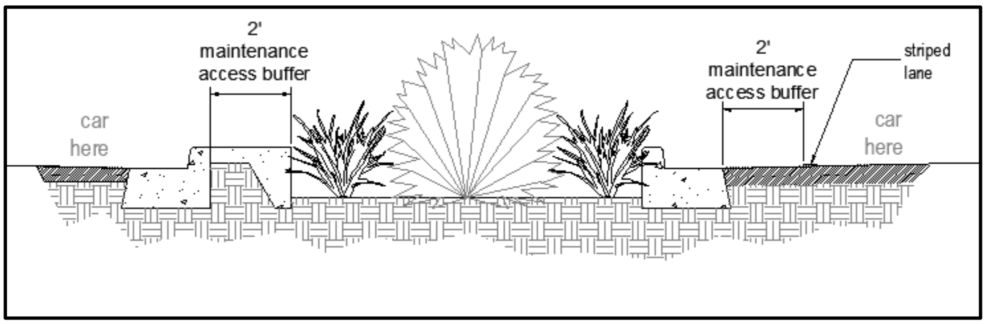
Maintenance Access

When designing facilities along streets, consider the safety of future maintenance staff and the logistics of accessing the facility to perform maintenance.

PARKING: The facility should be no more than 200 feet from a legal parking space to allow maintenance staff to park near the facility. For sites with no obvious nearby parking, alternative options should be considered (e.g., installation of a mountable curb and thickened sidewalks to allow for temporary vehicle parking).

TRAFFIC BUFFER: For median facilities or facilities without an adjacent sidewalk, consider a 2-ft paved setback from a vehicle or transit travel lane that is either inside or outside the facility (see Figure 4-9). An outside setback must be striped. If these basic guidelines cannot be met, discuss options with PBOT and BES staff.

Figure 4-9. Maintenance Traffic Buffers for Median Island Facilities



Future Development

The development potential of adjacent property should be considered when placing facilities. For example, an undeveloped or underdeveloped lot might require a driveway in the future, which could conflict with a surface stormwater facility. Contact BDS to determine if a development inquiry or building permit exists for adjacent properties. Check GIS and/or Portland Maps for permit activity on a property.

Tree Coordination

Consider different facility configurations that provide opportunities to preserve existing street trees and maximize opportunities for new street trees.

Existing functional trees should only be removed under extraordinary circumstances. The presence of mature street trees, including the amount of tree debris that will enter a downstream facility, may necessitate a forebay or selection of a different location. Protect trees and roots during construction of an adjacent facility. See Title 11 and consult Urban Forestry for tree protection requirements.

Space allowances for new large canopy trees should be maximized. Prioritize planting locations outside of stormwater facilities. There are many considerations for tree selection. Street tree planting must adhere to Title 11 tree planting requirements the City of Portland Street Tree Planting Standards. New and existing trees may help reduce the size of the required stormwater facility. See section 4.2.5, Tree Credits.

In some cases, stormwater facilities will allow for a larger tree than the planting strip; this is preferable to a small tree outside of a stormwater facility. Incorporate the planting strip into a curb extension if it provides an opportunity to plant a larger tree. Tree choice must be suitable for the width of the stormwater facility and in accordance with the Urban Forestry Approved Street Tree Planting Lists to ensure maximum potential tree canopy. See the plant list (Table 4-5) for more information about tree selection.

Trees are not permitted in fully lined facilities.

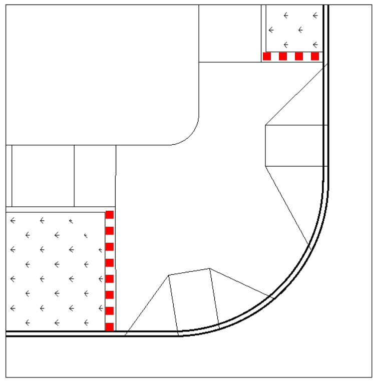
Utility Coordination

The presence of private (i.e., gas, communications, and electric) and City-owned (i.e., water, sewer, and storm) utilities impact the placement of stormwater facilities. See City of Portland Standard Drawing P-331:Utility Coordination Sewer Service Requirements Under Green Street, P-332:Utility Coordination Water Service Line Sleeving, and P-333:Utility Coordination Water Asset Clearances for setbacks from water lines and other requirements. Some utilities need to be moved, replaced, or provided extra protection. Early coordination with the utility owner may be needed, as some work in the ROW can only be performed by the utility owner.

Signs

Because signs are often placed at corners, use a 12-inch wide planter wall to accommodate surface-mounted signs adjacent to the pedestrian ramp. The planter wall parallel with the sidewalk should be 6-inches wide (see Figure 4-10). Do not install signs and footing inside stormwater facilities.

Figure 4-10. 12-inch Planter Wall for Sign Installation



Setbacks

Infiltrating vegetated stormwater facilities must be set at least 10 ft from building foundations, as measured from the edge of the facility. In some cases, this setback can be reduced with the addition of a partial liner. There are no setback requirements for lined facilities. See Section 2.2.4 for more information on setbacks.

4.2.1.2. Additional Site Design Guidelines for Curb Extensions

Curb extensions extend the curb line into the street and can either remain separate from or incorporate the planting strip into the facility. Curb extensions pair well with pedestrian safety improvements.

Design curb extensions for optimal stormwater collection and to fit into the existing streetscape. If feasible, designers should preserve existing ROW amenities such as walkways, landscaping, street trees, transit access, and utilities. Curb extensions sometimes result in loss of parking; limit impacts to on-street parking.

Street Classification

Curb extensions typically work best on streets classified by PBOT as local service streets. The design considerations described below are primarily for this application. Some streets with higher traffic classifications can accommodate curb extensions using similar design considerations. However, the review of curb extensions on higher classification streets requires more scrutiny to ensure safety for vehicles, pedestrians, and maintenance crews; accommodate greater sediment loads; allow for adequate sizing of the facility; and avoid conflicts with future transportation system demands (e.g., future travel lanes, bike lanes, or turn lanes that would potentially conflict with a curb extension). Other facility types may be more appropriate for high-traffic areas.

Dimensions

LENGTH**:** A minimum length of 30 feet is required to accommodate a mid-block curb extension. Mid-block curb extensions will typically require PBOT Alternative Review. Long facilities can require pedestrian crossings to connect with pedestrian ramps on the opposite side of the street (see Figure 4-11).

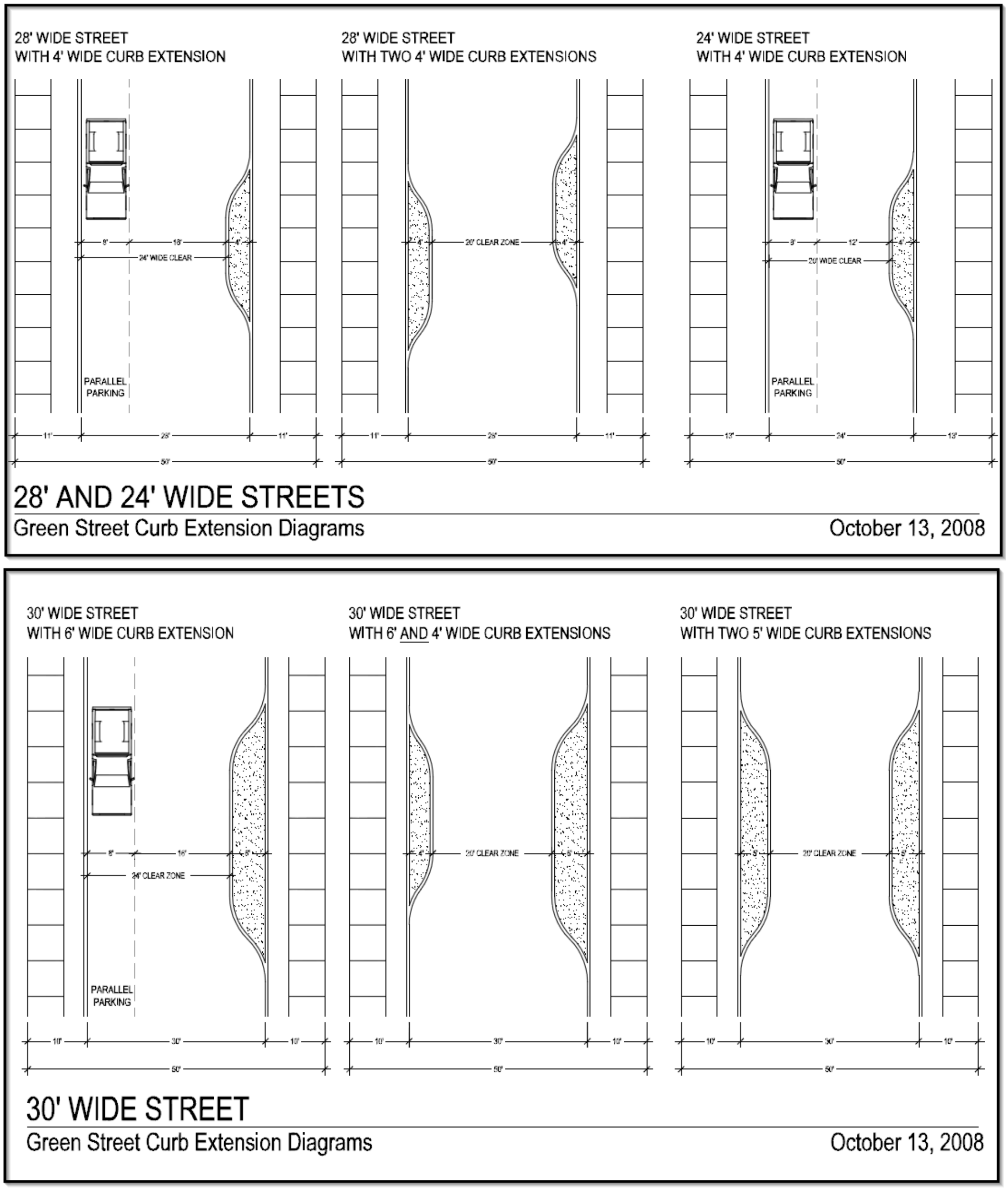
The length of end-of-block curb extensions will be determined by parking, proximity to driveways, and meeting stormwater requirements. There is not a minimum length.

Figure 4-11. Pedestrian Ramp Aligned with the Opposite Corner

SOURCE: Google Street View

WIDTH: The minimum curb extension width is 4 feet from the established flow line or face of curb. Typical widths vary from 4 to 6 feet, as measured from the face of the existing curb at the outside edge of the street to the face of the new curb adjacent to the travel lane. PBOT must approve the width of each curb extension, which varies with site-specific factors such as existing street width, on-street parking, bike lanes, traffic engineering considerations, and conflicts with utilities such as water lines. Maintain a distance of 20 ft between curbs on opposite sides of the street on all local, two-way residential streets per Portland Fire Bureau requirements, unless specific exceptions are approved (see Figure 4-12). Streets with widths of 32 ft or more may have curb extensions up to 6-ft wide on one or both sides. See SW-304 and SW-305 for stormwater curb extension geometry and typical sections.

Figure 4-12. Street Widths for Curb Extensions, Residential Streets



Green Street Curb Extension Diagrams are provided by PBOT and are a result of emergency access agreements with the Portland Fire Bureau.

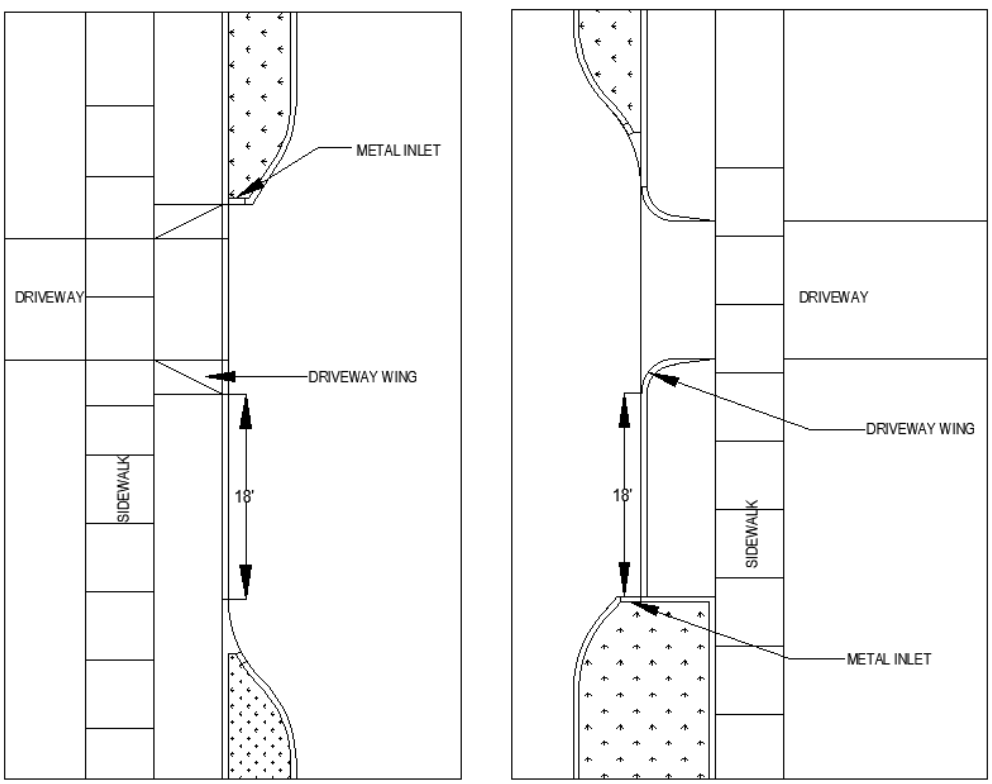
CROSS-SECTION: Designers of curb extensions should prioritize the use of planter walls to maximize the amount of runoff managed within the available area.

Parking

Curb extensions often occupy space used for on-street parking. Position curb extensions to efficiently preserve on-street parking, placing them immediately adjacent to a driveway/ramp wing to fully remove parking, or at least 18 ft from a driveway/ramp wing to allow for parking (see Figure 4-13). Curb extensions are well suited for corners where parking is already prohibited.

Consider impacts to parking availability for adjacent property owners. When possible, center surface stormwater facilities between properties (e.g., centered on property lines perpendicular to the facility) to avoid placing the burden on a single property. This technique can allow for at least one on-street parking space to be retained on each property frontage. Projects should avoid removing parking entirely along frontages without driveways or other off-street parking areas.

Figure 4-13. Parking Spaces, Curb Extensions, and Driveways

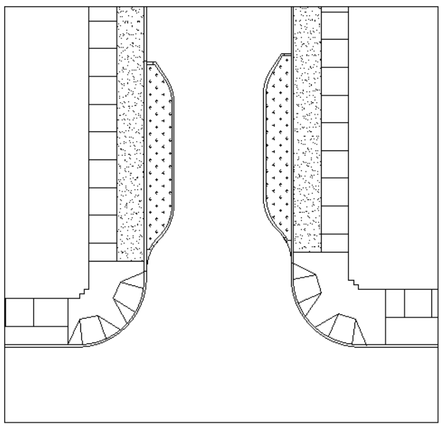


Corners and Pedestrian Ramps

There are three types of curb extensions at corners: a curb extension that just incorporates the pedestrian ramp, a stormwater curb extension that only extends the curb to accommodate a stormwater facility, and a full curb extension that incorporates the stormwater facility and the pedestrian ramp. PBOT determines when a stormwater curb extension requires construction of other curb extensions.

Subject to PBOT approval, a single stormwater curb extension can be placed on one side of a corner without incorporating the corner ramp into the extension. When approved, stormwater curb extensions must start at the end of the pedestrian ramp wing (see Figure 4-14).

Figure 4-14. Corners and Pedestrian Ramps

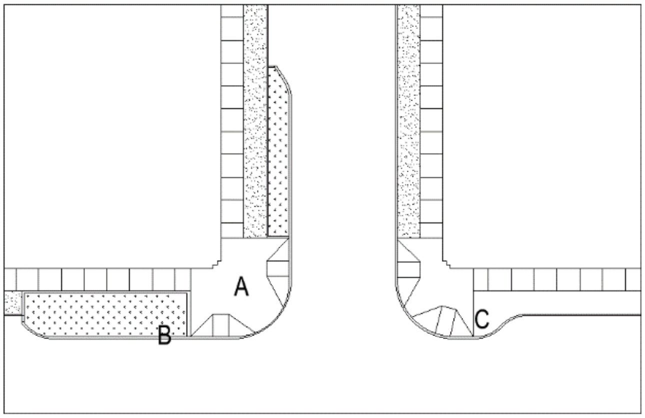


Stormwater curb extensions proposed on both faces of a corner must be constructed as full curb extension incorporating the stormwater facility and the corner ramps (see Figure 4-15, location A). The specific geometry requirements for a full corner curb extension are determined by PBOT traffic engineers according to site conditions.

In a Pedestrian District or City Walkway per the City's Transportation System Plan, curb extensions and pedestrian ramps must be combined (Figure 4-15, location A). PBOT may also require a combined curb extension and ramp if shortening the crossing distance for pedestrians enhances safety, or if the street is a designated Safe Routes to School and on a higher classification street.

In some cases curb extensions on the far side (per the direction of vehicle travel) of an intersection (Figure 4-15, location B) may require a curb extension on the near side (Figure 4-15, location C) so that oncoming traffic can anticipate the change in curb alignment, as determined by PBOT traffic engineers.

Figure 4-15 Acceptable Curb Extension Configurations



The City considers the addition of a curb extension to an existing ROW to be an alteration of the ROW. As a result, City of Portland capital improvement projects are required to improve adjacent corners that do not have pedestrian ramps or do not meet current standards. The improvements must include new two-directional ramps meeting PBOT and ADA requirements or equivalent (see Figure 4-16). These ramps can be placed in different locations based on PBOT input. For curb extensions installed in the middle of the street block, ramps may be constructed at either adjacent intersection. Determine the location through consultation with PBOT (see Figure 4-17). After all corners at adjacent intersections or designated mid-block crossings have ADA access, no additional directional ramps or their equivalent are required (see Figure 4-18). See the City of Portland Standard Construction Drawing P-548 – Sidewalk Ramp with Furnishing Zone Placement Options.

Figure 4-16. Corner Ramp Triggers, Example 1

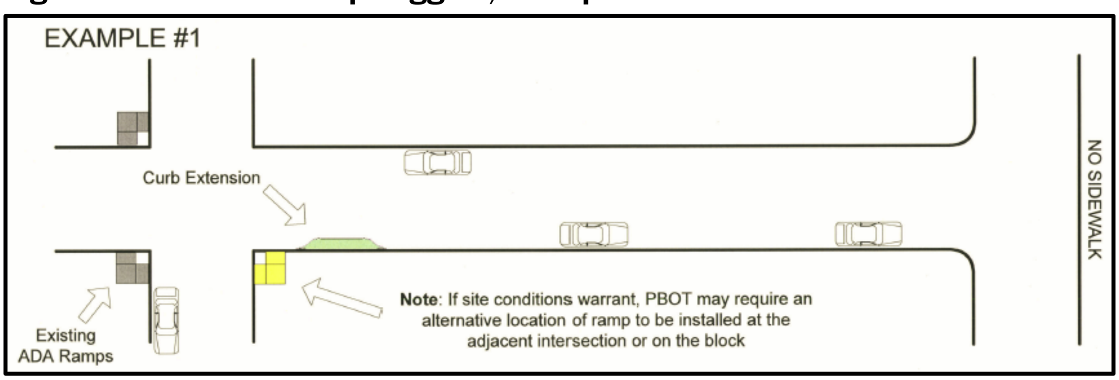


Figure 4-17. Corner Ramp Triggers, Example 2

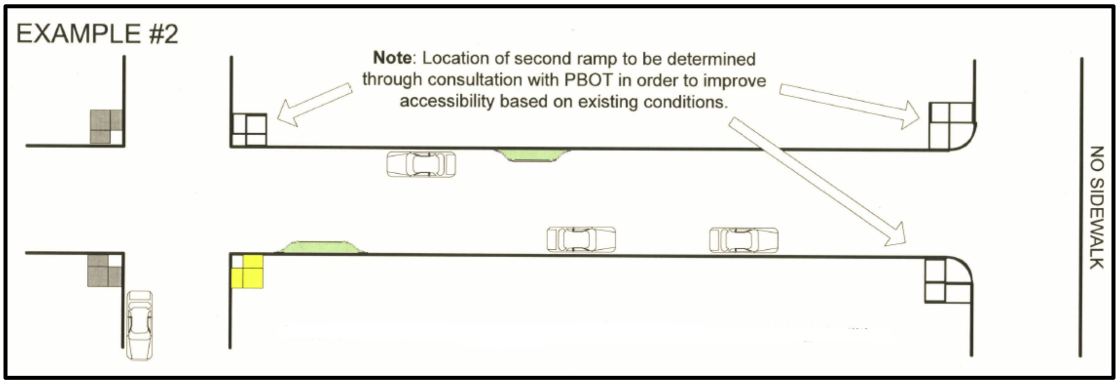
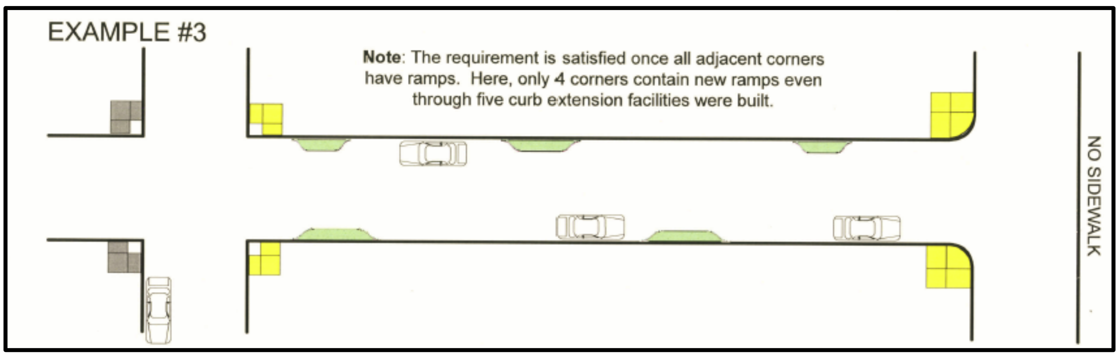


Figure 4-18. Corner Ramp Triggers, Example 3



To reduce the amount of stormwater runoff that flows across a pedestrian zone at the base of the ramps, an overflow inlet may be required within the facility or a street inlet may be required between the facility outlet and the ramp. Drainage through a pedestrian area is discouraged but may be considered with PBOT approval.

4.2.1.3. Additional Site Design Guidelines for Furnishing Zone/Planting Strip Facilities

Facilities in the furnishing zone or planting strip vary depending on whether they have side slopes or they have flat bottoms and planter walls. (See Figure 4-2 and Figure 4-4). These facilities have site design considerations that are different from those of curb extensions.

Dimensions

LENGTH: Provide pedestrian access from sidewalks to parking spaces by placing a carriage walk approximately every 20 ft in commercial districts and approximately every 30 ft in residential areas. Add a carriage walk to align with paths to front doors and housing access or other obvious pedestrian connections. In some cases, the carriage walk may include a trench grate to pass stormwater runoff between the two facilities, but this is not the preference. See detail SW-311.

WIDTH: Minimum facility widths vary depending on whether the facility has sloped sides or planter walls. Side slopes are not allowed in PBOT Pedestrian Districts adjacent to sidewalks.

- Planter walls only: The minimum planter width is 3 feet, measured from the back of curb to the face of planter wall. The minimum planter width is 4 feet if the planter includes a tree.
- Planter wall and sloped side combined: The width will vary when a facility has a sloped configuration on one side (street or sidewalk) and a planter wall on the other. A 2-foot flat bottom is required for this configuration.
- Sloped sides only: The minimum width when both sides are sloped is approximately 11 feet-6 inches, as measured from the back of curb to the sidewalk and including a 2-foot flat bottom.

PARKING: If parking is allowed along a stormwater facility, a 2.5-foot (P-303) or a 1-foot step-out (P-304) is required. A 2.5-foot step-out is required in pedestrian districts, commercial zones, and residential areas with frequent parking turnover. A 1-foot step-out can only be used on residential streets.

4.2.1.4. Stormwater Design Requirements

Vegetated surface facilities must be designed using the Presumptive Approach (Section 2.5.2) and the Presumptive Approach Calculator (PAC). In limited cases the Performance Approach can be used to meet specific project design goals (e.g., basement sewer backup relief). They can be designed as infiltration, partial-infiltration, or lined facilities.

Soil Suitability for Infiltration

Site conditions (e.g., the soil's infiltration rate, slope) will determine whether the facility should be designed as a full infiltration, partial infiltration, or lined facility. See Section 2.3 for infiltration testing and related subsurface investigations.

Sizing

The surface area and depth of a facility varies. The PAC allows the designer to size stormwater facilities using native soil infiltration rates, the time of concentration and curve number. Using the PAC, a facility can be designed with side slopes or vertical planter walls.

Slopes
The longitudinal slope of facilities should typically be designed to match the road grade. If the road is steeper than 10% design modifications may be required. The maximum side slope adjacent to pedestrian circulation is 3:1 with a 1-foot buffer.

Ponding Depth
Facility ponding depth may vary, with a typical average of up to 9 inches. Typically, this results in about 19 inches of vertical drop from the top of the adjacent planter wall to the finished grade of the facility, or 15 inches of vertical drop from the adjacent sidewalk to the finished grade. This may vary due to site-specific conditions and/or maintenance cycles. Facilities adjacent to schools, parks, and playgrounds warrant limiting the average ponding depth to 6 inches.

Set the overflow elevation to whichever is lowest:

- 2 inches below the lowest sidewalk elevation;
- 2 inches below the lowest top of the curb or planter wall elevation;
- Equal to the beehive rim elevation;
- Equal to the gutter flow line at the upstream inlet; or
- Equal to the check dam notch elevation.

Inlets
INLET REQUIREMENTS FOR CURB EXTENSIONS: The inlet at the entrance of a curb extension typically aligns directly with the street gutter, so gutter runoff does not need to be redirected to enter the facility. This makes curb extension inlets highly effective at capturing runoff. In these cases, sediment and debris accumulation are a bigger challenge than inlet design in directing flows into the facility.

- 0% to 5% slope: Install one inlet at the entrance of the facility, plus an additional inlet every 30 ft along the length of the curb extension. Modify the inlet locations to coordinate with check dams by placing inlets immediately after each check dam, at the high end of the bay.
- 5% to 10% slope: Install one inlet at the entrance of the facility, plus an additional inlet every 20 ft along the length of the curb extension. Place inlets immediately after check dams, at the high end of the bay.
- Greater than 10% slope: Use the inlet configuration for facilities on 5% to 10% slopes but additional modifications may be required such as the use of P-305: Metal Inlet Modified with G-1 or G-2.

INLET REQUIREMENTS FOR FACILITIES LOCATED IN THE PLANTING STRIP: More detailed requirements for inlets are necessary for facilities in the planting strip because gutter flow must turn 90 degrees into the facility. Determine the number of inlets required for the design storm, slope, and catchment area using Table 4-1, Table 4-2, or Table 4-3. Per the tables, for slopes of 6% and more, the first inlet should be a P-305: Metal Inlet Modified with G-1 or G-2.

The standard inlet configurations in the tables were determined using gutter flow calculations. All configurations assume a 2-inch depression at the inlet, an 18-inch typical gutter width or 12-inch gutter width when adjacent to bike lanes, and a 3% road crown. Calculations assume a standard clogging factor of 30% for typical metal inlets and 35% for metal inlets modified with G-1 or G-2.

Table 4-1. Number of Inlets Required for Water Quality Storm

1.5-ft or 2-ft Inlets, 2-Inch Depressed Curb										
Drainage Area, ft^2	All Metal Inlets					First Inlet Is Metal w/G-1 or G-2, All Others Are Metal Inlets				
	LONGITUDINAL SLOPE									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
500	1	1	1	1	1	1	1	1	1	1
1,000	1	1	1	2	2	2	2	2	2	2
1,500	2	2	2	2	2	2	2	2	2	2
2,000	2	2	2	2	2	2	2	2	2	2
2,500	2	2	2	2	2	2	2	2	2	2
3,000	2	2	2	2	2	2	2	2	2	2
3,500	2	2	2	2	2	2	2	2	2	3
4,000	2	2	2	2	2	2	2	2	3	3
4,500	2	2	2	2	2	2	3	3	3	3
5,000	2	2	2	2	2	3	3	3	3	3
5,500	2	2	2	2	2	3	3	3	3	3
6,000	2	2	2	2	3	3	3	3	3	3
6,500	2	2	2	2	3	3	3	3	3	3
7,000	2	2	2	3	3	3	3	3	3	3
7,500	2	2	2	3	3	3	3	3	3	3
8,000	2	2	2	3	3	3	3	3	3	3
8,500	2	2	3	3	3	3	3	3	3	4
9,000	2	2	3	3	3	3	3	3	3	4
9,500	2	2	3	3	3	3	3	3	4	4
10,000	2	2	3	3	3	3	3	4	4	4

Number of 18-inch or 24-inch inlets required for the runoff from the water quality storm to enter the facility. When the facility has a 6% slope or more, the first inlet must be P-305: Metal Inlet Modified with G-1 or G-2.

Table 4-2. Number of Inlets Required for 10-Year Design Storm

1.5-ft Inlets, 2-Inch Depressed Curb										
Drainage Area, ft^2	**All Metal Inlets**					**First Inlet Is Metal w/G-1 or G-2, All Others Are Metal Inlets**				
	LONGITUDINAL SLOPE									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
500	2	2	2	3	3	3	3	3	3	3
1,000	2	3	3	3	4	4	4	4	4	4
1,500	3	3	4	4	4	4	4	4	4	4
2,000	3	4	4	4	5	5	5	5	5	5
2,500	3	4	5	5	5	5	5	5	5	5
3,000	4	4	5	5	6	6	6	6	6	6
3,500	4	5	5	6	6	6	6	6	6	6
4,000	4	5	5	6	6	6	6	6	6	6
4,500	4	5	5	6	7	7	7	7	7	7
5,000	4	5	6	6	7	7	7	7	7	7
5,500	5	6	6	7	7	7	7	7	7	7
6,000	5	6	6	7	7	7	7	7	7	7
6,500	5	6	7	7	8	8	8	8	8	8
7,000	5	6	7	7	8	8	8	8	8	8
7,500	5	6	7	8	8	8	8	8	8	8
8,000	5	6	7	8	8	8	8	8	8	8
8,500	5	7	7	8	9	9	9	9	9	9
9,000	6	7	8	8	9	9	9	9	9	9
9,500	6	7	8	8	9	9	9	9	9	9
10,000	6	7	8	9	9	9	9	9	9	9

2-ft Inlets, 2-Inch Depressed Curb										
Drainage Area, ft^2	All Metal Inlets					First Inlet Is Metal w/G-1 or G-2, All Others Are Metal Inlets				
	LONGITUDINAL SLOPE									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
500	1	2	2	2	2	2	2	2	2	3
1,000	2	2	2	3	3	3	3	3	3	3
1,500	2	2	3	3	3	3	4	4	4	4
2,000	2	3	3	3	4	4	4	4	4	4
2,500	3	3	3	4	4	4	4	4	4	4
3,000	3	3	4	4	4	4	4	4	4	4
3,500	3	3	4	4	4	4	4	4	4	4
4,000	3	4	4	4	5	5	5	5	5	5
4,500	3	4	4	5	5	5	5	5	5	5
5,000	3	4	4	5	5	5	5	5	5	5
5,500	3	4	5	5	5	5	5	5	5	5
6,000	4	4	5	5	6	6	6	6	6	6
6,500	4	4	5	5	6	6	6	6	6	6
7,000	4	5	5	6	6	6	6	6	6	6
7,500	4	5	5	6	6	6	6	6	6	6
8,000	4	5	5	6	6	6	6	6	6	6
8,500	4	5	6	6	6	6	6	6	6	6
9,000	4	5	6	6	7	7	7	7	7	7
9,500	4	5	6	6	7	7	7	7	7	7
10,000	4	5	6	6	7	7	7	7	7	7

Number of 18-inch or 24-inch inlets required for the runoff from the 10-year design storm to enter the facility. When the facility has a 6% slope or more, the first inlet must be P-305: Metal Inlet Modified with G-1 or G-2.

Table 4-3. Number of Inlets Required for 25-Year Design Storm

1.5-ft Inlets, 2-Inch Depressed Curb

Drainage Area, ft²	**All Metal Inlets**					**First Inlet Is Metal w/G-1 or G-2, All Others Are Side Inlets**				
	LONGITUDINAL SLOPE									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
500	2	2	2	2	2	2	2	2	2	2
1,000	2	3	3	3	3	2	2	3	3	3
1,500	3	3	4	4	4	4	4	4	4	4
2,000	3	4	4	5	5	5	5	5	5	5
2,500	4	4	5	5	6	6	6	6	6	6
3,000	4	5	5	6	6	6	6	6	6	6
3,500	4	5	5	6	6	6	6	6	6	6
4,000	4	5	6	6	7	7	7	7	7	7
4,500	4	5	6	7	7	7	7	7	7	7
5,000	5	6	6	7	7	7	7	7	7	7
5,500	5	6	7	7	8	8	8	8	8	8
6,000	5	6	7	7	8	8	8	8	8	8
6,500	5	6	7	8	8	8	8	8	8	8
7,000	5	6	7	8	8	8	8	8	8	8
7,500	5	7	7	8	9	9	9	9	9	9
8,000	6	7	8	8	9	9	9	9	9	9
8,500	6	7	8	9	9	9	9	9	9	9
9,000	6	7	8	9	9	9	9	9	9	9
9,500	6	7	8	9	10	10	10	10	10	10
10,000	6	7	8	9	10	10	10	10	10	10

2-ft Inlets, 2-Inch Depressed Curb

Drainage Area, ft²	All Metal Inlets					First Inlet Is Metal w/G-1 or G-2, All Others Are Side Inlets				
	LONGITUDINAL SLOPE									
	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
500	1	2	2	2	2	2	2	2	2	2
1,000	2	2	3	3	3	3	3	3	3	3
1,500	2	3	3	3	3	3	3	3	3	3
2,000	2	3	3	4	4	4	4	4	4	4
2,500	3	3	4	4	4	4	4	4	4	4
3,000	3	3	4	4	4	4	4	4	4	4
3,500	3	4	4	4	5	5	5	5	5	5
4,000	3	4	4	5	5	5	5	5	5	5
4,500	3	4	5	5	5	5	5	5	5	5
5,000	3	4	5	5	6	6	6	6	6	6
5,500	4	4	5	5	6	6	6	6	6	6
6,000	4	5	5	6	6	6	6	6	6	6
6,500	4	5	5	6	6	6	6	6	6	6
7,000	4	5	5	6	6	6	6	6	6	6
7,500	4	5	6	6	7	7	7	7	7	7
8,000	4	5	6	6	7	7	7	7	7	7
8,500	4	5	6	6	7	7	7	7	7	7
9,000	4	5	6	7	7	7	7	7	7	7
9,500	5	6	6	7	7	7	7	7	7	7
10,000	5	6	6	7	7	7	7	7	7	7

Number of 18-inch or 24-inch inlets required for the runoff from the 25-year design storm to enter the facility. When the facility has a 6% slope or more, the first inlet must be [P-305: Metal Inlet Modified with G-1 or G-2](#).

Forebays

Notched forebay details P-306 and SW-310 are required for facilities with the following street classifications or site characteristics:

- Primary and secondary arterials, collector streets, and streets with higher classifications.
- Streets that PBOT sands (e.g., snow routes and steep streets).
- Streets or sites downgradient from unpaved roads and parking lots.
- Streets adjacent to farmland.
- Other areas where BES has determined unusual sediment loads are likely.

Drawing P-306 may be modified for small facilities to be no larger than 25% of the facility area.

Outlets

Facilities that do not fully infiltrate the 10-year design storm must overflow to an approved discharge point such as the adjacent curb and gutter, a storm sewer, sump, or open channel drainageway (e.g., a creek or stream). It is acceptable for stormwater runoff to flow into a facility and then back out, via an outlet notch or inlet, if the overflow does not impede pedestrian routes.

A beehive inlet inside of the facility is an alternative outlet. A beehive inlet cannot connect directly to a combined sewer main without a maintenance hole or other structure unless the project designer can demonstrate that odors will not be conveyed to the surface.

Liners

Full or partial liners are required in stormwater facilities for certain site-specific conditions including the presence of contaminated soil or contaminated groundwater, undocumented fill, landslide risks, and where infiltration facility setbacks cannot be met (see Sections 2.2.4 and 2.2.5). The Full or partial liners may be required to protect adjacent drinking water facilities, on higher classification streets to protect the road bed, or where site specific

Attach geomembrane liners per P-340: Liner Attachment and Pipe Boot.

The required liner thickness is determined by the reason for the liner, as listed below.

- 30-mil HDPE (standard liner): Use for partial liner for water main protection, and as a full or partial liner for foundation protection.

- 24-mil HDPE: Use for partial liners required on street-side curb and gutters on streets classified as neighborhood collectors or higher, on local streets with transit routes, on streets with higher traffic volumes, or at the discretion of the city engineer.
- 40-mil HDPE: Use for full liners in the Columbia South Shore Well Field Wellhead Protection Area and contaminated sites.

Fully-lined facilities in combined sewer areas are allowed only where there are local or regional capacity problems and where flow control or other benefits provided by lined systems are needed.

Piping
When an underdrain system is needed, use a 4-inch slotted pipe. See Drawings SW-316, SW-317 and SW-318 for typical details. Refer to the City of Portland Sewer and Drainage Facilities Design Manual for requirements for connections from a facility to an inlet, maintenance hole, or pipe.

Underdrain Orifices
Orifices may be required to meet flow control requirements. See Section 2.5.3.5 for design standards and general sizing requirements for projects using orifices. The minimum allowable orifice diameter is 3/8-inch for an underdrain taking filtered flow. See Drawing SW-317.

Check Dams
Check dams may be required perpendicular to the flow line to encourage water to pond and filter through the blended soil and, if the facility is an infiltration facility, to infiltrate into the ground. Locate check dams per the PAC to maximize volume. See SW-312, SW-313, SW-314, and SW-315 for typical details.

Storage Zone
Minimize subsurface storage zones for the health of the plants. If used, the drainage layer should be comprised of ¼"-No.10 washed angular aggregate. Geotextile fabric is prohibited. See detail SW-316 for more information about configuration requirements.

Blended Soil
Public facilities must use the most current version of the Blended Soil Specification for Vegetated Stormwater Systems from the City of Portland Standard Construction Specifications or the most current special specification.

See detail SW-316 for configurations and required soil depths.

Vegetation
The entire facility area must be planted with vegetation. The facility area includes the bottom and side slopes. Facilities should be planted so they do not block traffic sight lines.

See details SW-323, SW-324, and SW-325 for ROW stormwater facility planting templates. Plants typically are specified in #1 containers and planted 12 inches on center (O.C.) with triangular spacing.

PLANTING ZONES: Stormwater facilities have up to two planting zones based on the level of stormwater inundation (see Figure 4-19).

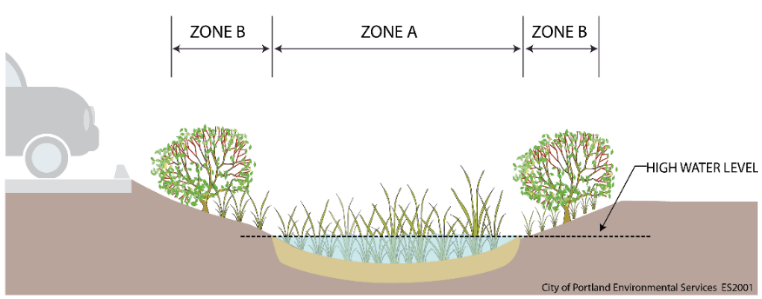
Zone A: This zone extends from the facility bottom to the designed high-water mark. It has moist to wet soils, and plants located here must tolerate intermittent inundation. Facilities with planter walls and a flat bottom are entirely Zone A.

Zone B: This zone includes the side slopes, extending from the designed high-water line up to the edge of the facility. It typically has drier to moist soils, with the moist soils further down the side slopes. Plants in this zone should be drought-tolerant and help stabilize the slopes.

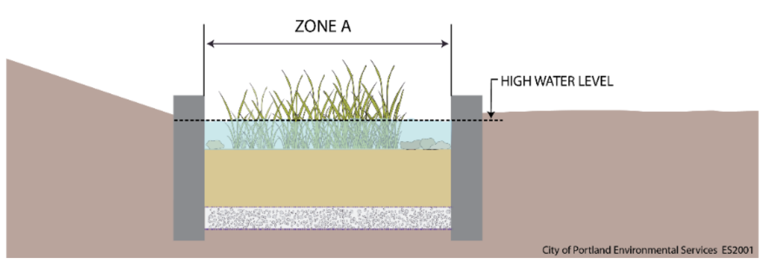
Areas outside Zone A and Zone B or above the freeboard are not considered part of the facility and are not covered by these requirements.

Figure 4-19. Stormwater Facility Planting Zones

Facility with sloped sides



Facility with planter walls and flat bottom



PLANT LISTS: Table 4-4 shows plants that must be used in green streets. Table 4-5 shows trees that may be used in green streets.

Table 4-4. Plant List for Vegetated Stormwater Facilities (Green Streets)

	Botanic Name	Common Name	Zone	NW Native	Evergreen	Potential Height	O.C. Triangular Spacing
Herbaceous Plants	*Carex morrowii* ‘Ice Dance’	Ice Dance Japanese Sedge	A/B	N	N	12"	12”
	Carex obnupta	Slough Sedge	A	Y	Y	48"	12"
	Juncus patens	Spreading Rush	A	y	Y	36"	12"
	Liriope muscari ‘Big Blue’	Big Blue Lilyturf	A/B	N	Y	12-18”	12"
Groundcovers	*Arctostapylos uva–ursi*	Kinnickinnick	B	Y	Y	6"	12"
	Fragaria chiloensis	Coastal Strawberry	B	Y	Y	6"	12"
	Rubus calcynoides (pentalobus)	Creeping Raspberry	B	N	Y	6"	12"
Accent Plants	*Camassia leichtlinii*	Great Camas	A/B	Y	N	24-36”	*
	Camassia quamash	Common Camas	A/B	Y	N	12-30”	*
	Iris douglasiana	Douglas Iris	B	Y	Y	18"	*
	Narcissus spp.	Daffodil	A/B	N	N	12"-18”	*

	Botanic Name	Common Name	Zone	NW Native	Evergreen	Potential Height	O.C. Triangular Spacing
Small Shrubs	*Cornus sericea* 'Kelseyi'	Kelsey Red Osier Dogwood	A/B	N	N	36"	24"
	Lavandula angustifolia 'Hidcote Blue'	Hidcote Blue English Lavender	B	N	Y	24-36"	24"
	Mahonia (Berberis) repens	Creeping Oregon Grape	A/B	Y	Y	30"	24"
	Nandina domestica 'Moon Bay'	Moon Bay Heavenly Bamboo	A/B	N	Y	36"	24"
	Nandina domestica 'Nana'	Dwarf Heavenly Bamboo	B	N	Y	15"	24"
	Spiraea japonica 'Walbuma'	Magic Carpet Japanese Spirea	A/B	N	N	24"	24"
	Spiraea japonica 'Goldflame'	Goldflame Japanese Spirea	A/B	N	N	48"	24"
	Spiraea japonica 'Goldmound'	Goldmound Japanese Spirea	A/B	N	N	36"	24"

*Accent plants. Intersperse among O.C. triangular spacing. These do not take the place of other plants.

Table 4-5. ***Tree List for Stormwater Facilities (Green Streets)***

	Botanic Name	Common Name	Zone	NW Native	Evergreen	Potential Height	Under Powerlines	Facility Width
Trees	*Celtis occidentalis*	Common Hackberry	A/B	N	N	50’	N	6’+
	Gleditsia triacanthos var. inermis 'Skycole'	Skyline Thornless Honeylocust	A/B	N	N	50’	N	4’+
	Nyssa sylvatica	Black Tupelo	A/B	N	N	50’	N	4’-8.4
	Nyssa sylvatica ‘Gum Drop’	Black Tupelo	A/B	N	N	50’	Y	3’-3.9’+
	Quercus bicolor	Swamp White Oak	A/B	N	N	50’	N	6’+
	Quercus shumardii	Shumard Oak	A/B	N	N	50'	N	6’+
	Rhamnus (Frangula) purshiana	Cascara Buckthorn	A/B	Y	N	25’	Y	4’-8.4
	Zelkova serrata ‘City Sprite’	Green Vase Japanese Zelkova	A/B	N	N	45’	Y	3’-8.4’
	Zelkova serrata ‘Green Vase’	Green Vase Japanese Zelkova	A/B	N	N	45’	N	4’-8.4’
	Zelkova serrata ‘Village Green’	Village Green Japanese Zelkova	A/B	N	N	35’	N	6-8.4’

The minimum size for all plants, except trees, is a #1 container. The minimum size for all balled and burlap (B&B) trees is a 2-inch caliper. No trees larger than a 3.5-inch caliper will be accepted unless approved by BES.

Planting by BES

Public works permit applicants (permittees) may choose to enter into an agreement with BES for provision of vegetation services during design and construction. This agreement is offered so permittees can benefit from BES's professional expertise in establishing and maintaining stormwater facilities. To get the most benefit from BES vegetation services, applicants are encouraged to sign up as early as possible during the concept review phase.

BES can perform the following tasks:

- Prepare a planting plan and a maintenance schedule to meet the requirements of the *Stormwater Management Manual*.
- Inspect the installed soil for final grading and depth requirements.
- Source and acquire plant material and plant per the planting plan. The City may interchange plant sizes and species due to nursery stock availability.
- Work with the permittee to ensure project implementation follows the permit, construction documents, design intent, and field conditions.
- Provide all necessary labor and other miscellaneous work incidental to completion of planting, unless otherwise specified in the agreement.
- Install project signage, as needed.
- Ensure prompt delivery of services and adequate coordination with other contractors.

Call BES at 503-823-1424 for more information. See the 2-year Maintenance Warranty section for additional services that BES can perform.

Temporary Erosion Control

If planting is not completed immediately after placing the blended soil, place erosion control fabric over the stormwater facility and surrounding area to prevent erosion during wet weather. Use North American Green C125BN or approved equivalent. Secure with 12-inch eco-stakes, 18 inches on center.

Mulch

BES allows mulch on a limited, case-by-case basis. Mulch is allowed only on facilities with side slopes that do not have a beehive overflow. The mulch must not inhibit water flow through inlets, outlets, or the flow path. Use fine to medium 100% hemlock bark that is free of dyes and pesticides.

Apply mulch when beds are clear of weeds and debris, after planting and watering-in of new plants, and after the soil surface is brought to a smooth, finished grade. Apply mulch in planted areas to an even, uniform depth of 3 inches and keep the mulch off structures, roadways, shoulders, walks, and lawns. Do not cover herbaceous plants with mulch or place mulch in contact with the stems of woody shrubs or trees. Leave the mulch surface with an even, finished appearance as approved by the City.

2-year Maintenance Warranty (Plant Establishment)
Stormwater facilities that have a public works permit and receive runoff from the public ROW become public infrastructure maintained by the City. These facilities must complete a 2-year warranty and establishment period before the facility is transferred from the permittee, generally a contractor or developer, to the City. The permittee is responsible for maintaining all stormwater management features during the 2-year maintenance warranty period. This includes maintaining and/or replacing the vegetated components, any structural or functional repairs, and other maintenance as outlined in the 2-Year Maintenance Warranty Period Plan.

The required submittals to BES are the Public Works 2-Year Maintenance Warranty Period Form and a standard 2-Year Maintenance Warranty Period Plan (Section 4.4). The former identifies the permittee responsible for maintenance, and the latter specifies maintenance practices required to establish the vegetated portions of the stormwater facility. The 2-Year Maintenance Warranty Period Plan is in effect throughout the maintenance warranty period.

Check facilities regularly for the maintenance needs identified in the 2-Year Maintenance Warranty Period Plan. If the City finds deficiencies during the warranty period, it will send a deficiency list to the permittee, allowing 15 days to complete the work after receipt of the written notice. If corrective work is not completed within the time frame, the City may correct the deficiencies itself and seek reimbursement from the permittee through the bond for all costs associated with bringing the stormwater facility into compliance.

The permittee must keep a Public Stormwater Facility Inspection Log that notes all inspection dates, facility components inspected, and maintenance or repairs made. The inspection log must document deficiencies and corrective actions taken to keep structural and vegetative components functioning as designed. The City may accept work orders, invoices, or receipts as supporting detail for the log. If deficiencies are identified by City staff during the maintenance warranty period, the permittee must provide BES with the inspection log and other documentation, as requested, to document the frequency and type of maintenance conducted.

Establishment and Maintenance by BES

Public works permit applicants may enter into an agreement with BES to maintain vegetation during the 2-year maintenance warranty period. The agreements typically include the following:

- Irrigation.
- Vegetation monitoring and replacement of dead plants.
- Sediment removal.
- Weeding, inlet clearing, and trash removal.
- Treatments specific to the agreement for maintenance.

Projects that contract BES to provide vegetation services are exempt from vegetation inspections, but the permittee is still responsible during the warranty period for other permit elements such as structural components and inlets. Permittees do not need to submit a 2-Year Maintenance Warranty Period Plan but must still complete the 2-Year Maintenance Warranty Period Form.

Contact BES at 503-823-1424 for more information.

Timeline of 2-year Maintenance Warranty Activities: The City will issue a Letter of Completion after the stormwater facilities are constructed and planted per the approved plan. The letter provides official notification that construction is complete and the 2-year maintenance warranty period has begun.

Release of 2-year Maintenance Warranty Period: The City will issue a letter to the permittee identifying any deficiencies that must be corrected to meet the 2-year maintenance warranty requirements. If the deficiencies are not corrected, the City will take enforcement actions per the permit that may include permittee liability for expenses incurred by the City to correct the deficiencies.

Two years after the maintenance warranty period begins, if the stormwater facility has passed all inspections and deficiencies have been corrected as identified by City staff, the 2-year maintenance warranty period will end and the stormwater facility will be turned over to the City for long-term maintenance.

4.2.1.5. Details

Standard Drawings:

See City of Portland Standard Drawings and Details.

P-300: Concrete Inlet, Type Metal

P-301: Concrete Inlet, Type Metal (Rotated)

P-302: Concrete Inlet, Type Metal, Metal Inlet Assembly

P-303: Concrete Inlet, Type Metal with Channel and Grate (2.5 ft step-Out)

P-304: Concrete Inlet, Type Metal with Channel and Grate (1 Ft Step-Out)

P-305: Concrete Inlet, Type Metal With G-1 Or G-2 Grate

P-306: Curb Extension Notched Forebay

P-307: Planter Walls

P-308: Curb Extension Outlet Notch

P-309: Beehive Inlet

P-310: Overflow Slotted Drain

P-331: Utility Coordination Sewer Service Requirements Under Green Street

P-332: Utility Coordination Water Service Line Sleeving

P-333: Utility Coordination Water Asset Clearances

P-340: Liner Attachment and Pipe Boot

P-256: Rain Drain to Gutter

Typical Drawings

These are typical details and are intended to be customized for the site using guidance from this chapter and the Designer Information on the drawings.

FACILITY PLAN AND SECTION VIEWS:

RELATED DETAILS:

PLANTING GUIDLINES AND TEMPLATES:

ABBREVIATIONS:

AC	ASPHALT/CONCRETE
AP	ANGLE POINT
BI	BOTTOM OF INLET ELEVATION
BP	BEGINNING POINT
CDN	CHECK DAM NOTCH ELEVATION
CN	CURB NOTCH ELEVATION
EL	ELEVATION
EX./EXIST	EXISTING
EOC	EDGE OF CONCRETE
EOP	EDGE OF PAVEMENT
EP	END POINT
FL	GUTTER FLOW LINE ELEVATION
PC	POINT OF CURVATURE
PT	POINT OF TANGENCY
ROW	RIGHT-OF-WAY
SF	STORMWATER FACILITY
S/W	SIDEWALK ELEVATION
TC	TOP OF CURB ELEVATION
VSF	VEGETATED STORMWATER FACILITY

2020SWMM–DETAILS.DWG 12/9/20 11:20 AM SPEREZ

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

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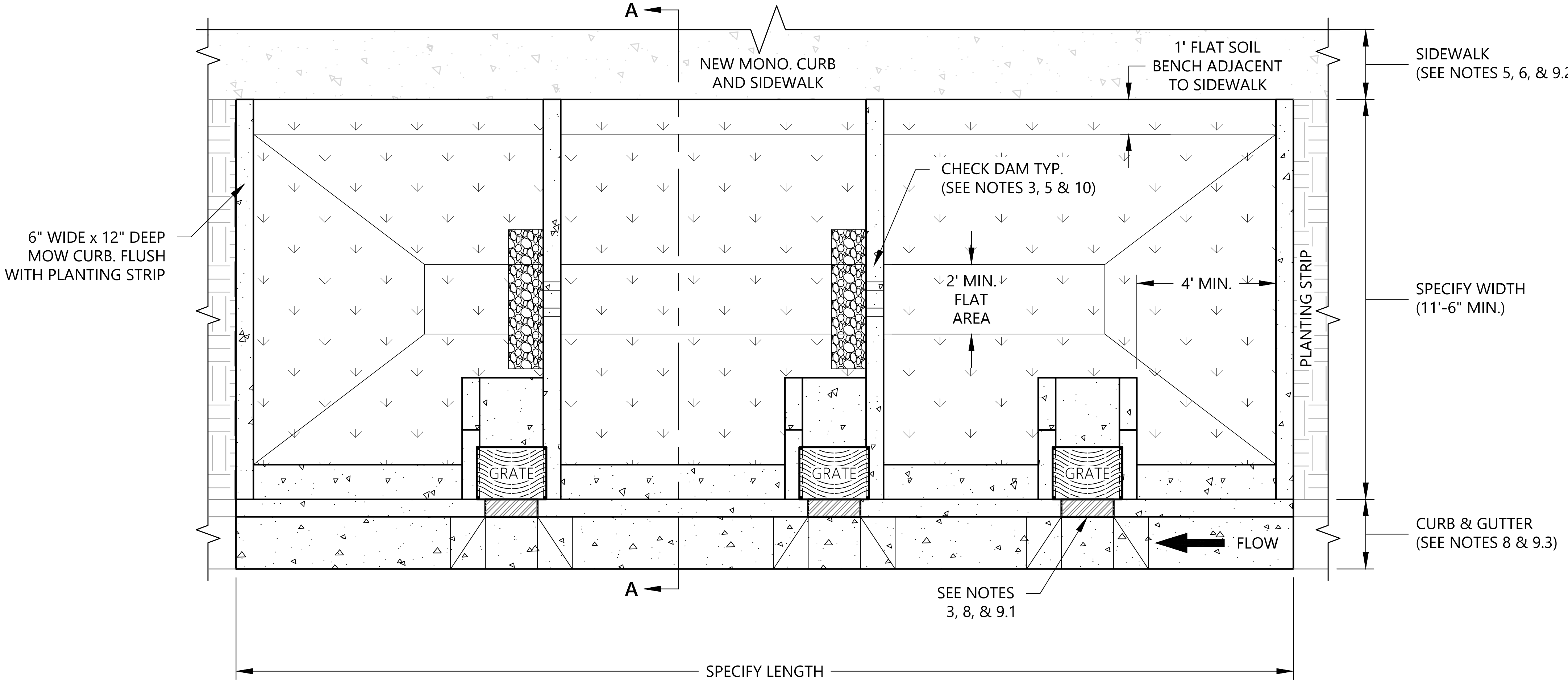
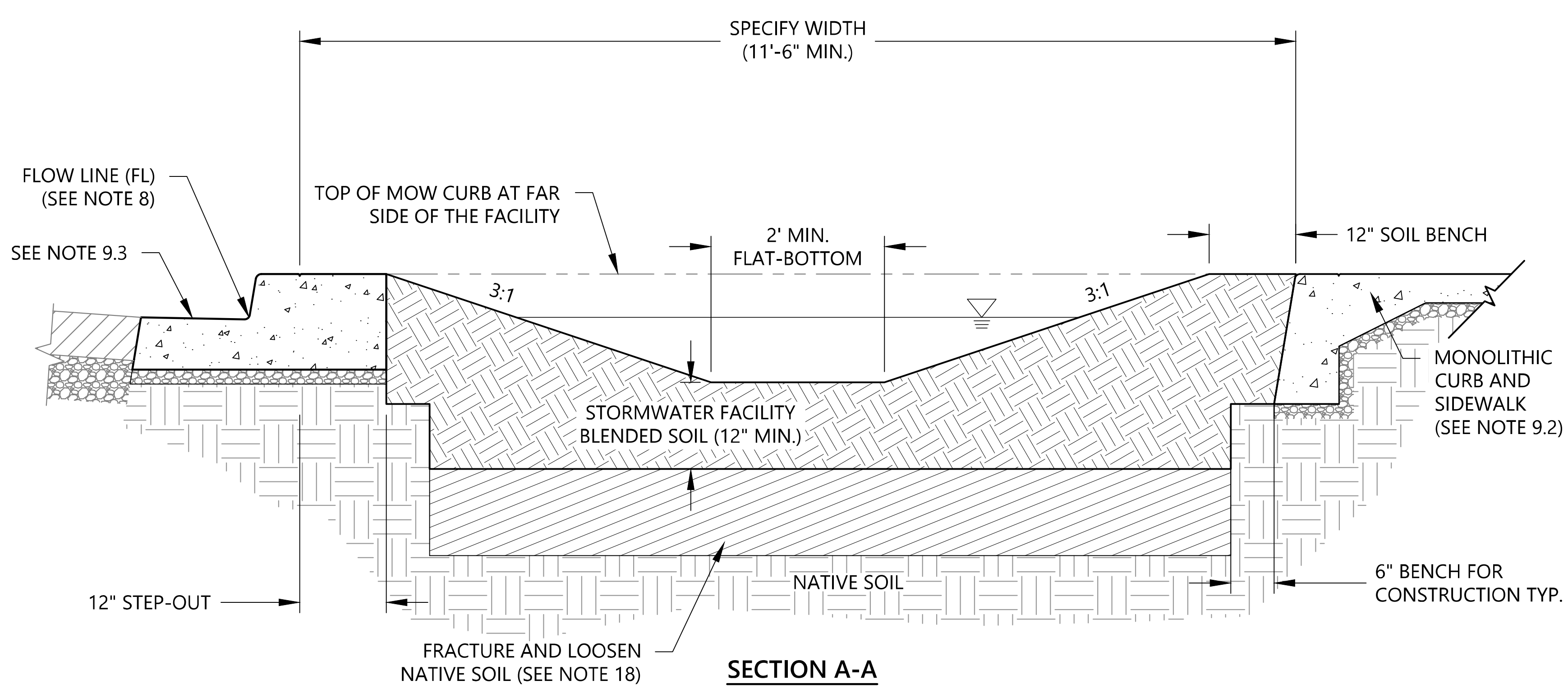


PLAN VIEW

(SWALE WITH PARKING SHOWN)



SECTION A-A

(SWALE WITH PARKING)

DESIGNER INFORMATION:

1. Adapt this plan and section view example to your engineered design. Maximize surface storage.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints.
3. Provide beginning and ending stations for each facility. Provide stations and/or dimensions and elevations for each inlet, outlet, check dam, notch and wall corner.
4. Show liner, slotted pipe, 24" depth stormwater facility blended soil, and aggregate in section when used. Refer to SWMM detail SW-316: Stormwater Configuration Sections.
5. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
6. Detail assumes top-of-curb and top-of-sidewalk at approximately same elevation. Modify detail if site conditions are different
7. Proposed utility lines to be located out of facility, or per details P-331, P-332, and P-333.
8. Depress gutter pan Flow Line (FL) 2-in to Bottom of Inlet (BI).

RELATED DETAILS AND RESOURCES:

9. City of Portland Standard Drawings:
   - 9.1. P-304: Concrete Inlet, Type Metal with Channel and Grate (1FT Step-out).
   - 9.2. P-551: Sidewalks, Typical Monolithic Curb and Sidewalk.
   - 9.3. P-540: Curbs, 18" Modified Curb and Gutter typ. When adjacent to a bike lane use 12" gutter pan.
   - 9.4. P-332: Utility Coordination Water Service Line Sleeving.
   - 9.5. P-333: Utility Coordination Water Asset Clearances.
10. Stormwater Management Manual Details:
    - 10.1. SW-312: Check Dam - Infiltration Facility.
    - 10.2. SW-313: Check Dam - Infiltration Facility with Rock.
    - 10.3. SW-314: Check Dam - Partial Infiltration Facility with Weep Holes.
    - 10.4. SW-315: Check Dam Lined Facility with Weep Holes.

CONSTRUCTION NOTES:

11. In facilities that are unlined, fracture and loosen soil - DO NOT TILL - to a depth of 12-in below stormwater facility blended soil excavation before installing aggregates or blended soil.

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.

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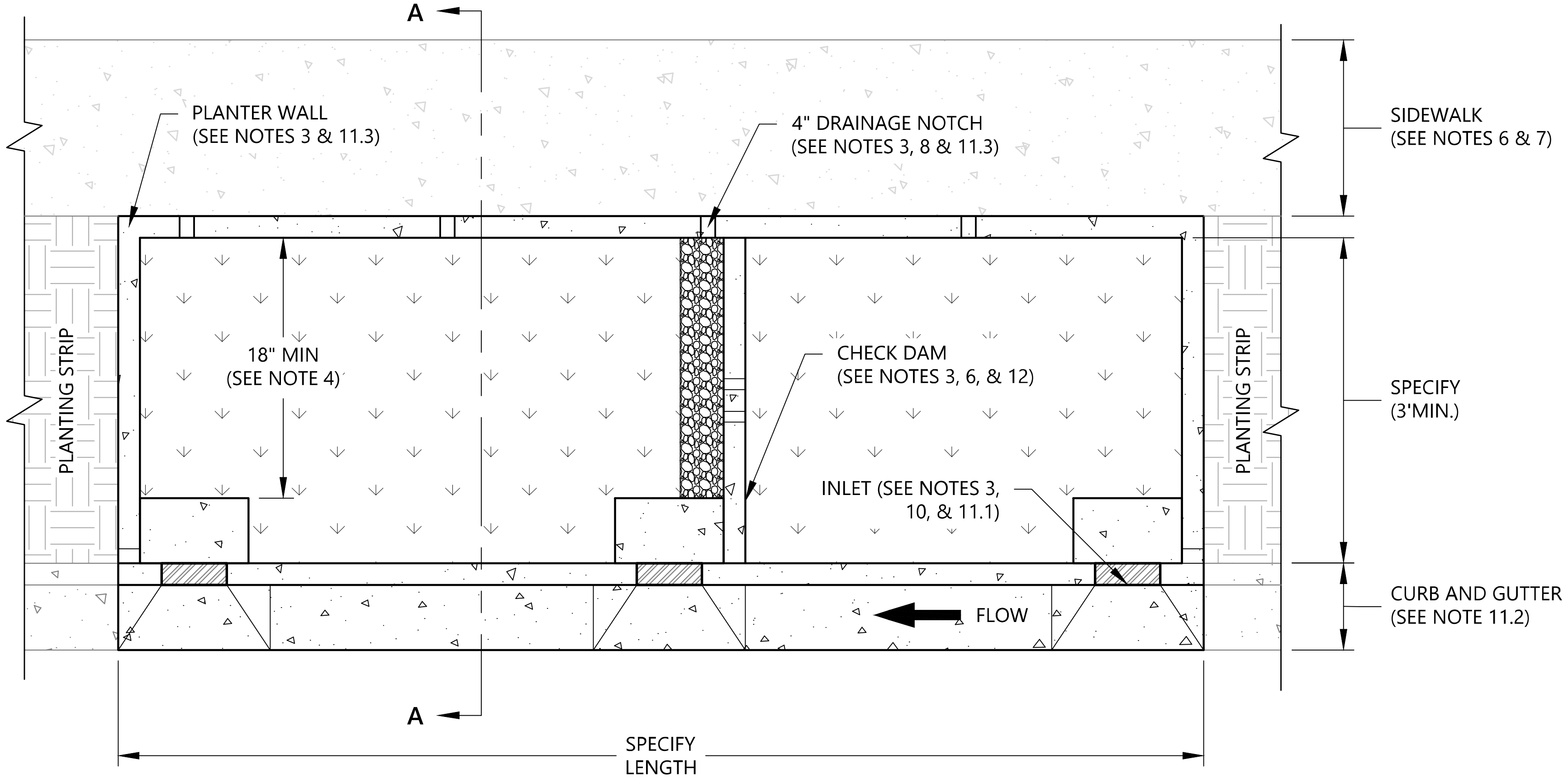
For more information contact:
PBOT (503) 823-7884
BES (503) 823-7761
PWB (503) 823-7368
Urban Forestry (503) 823-8733

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

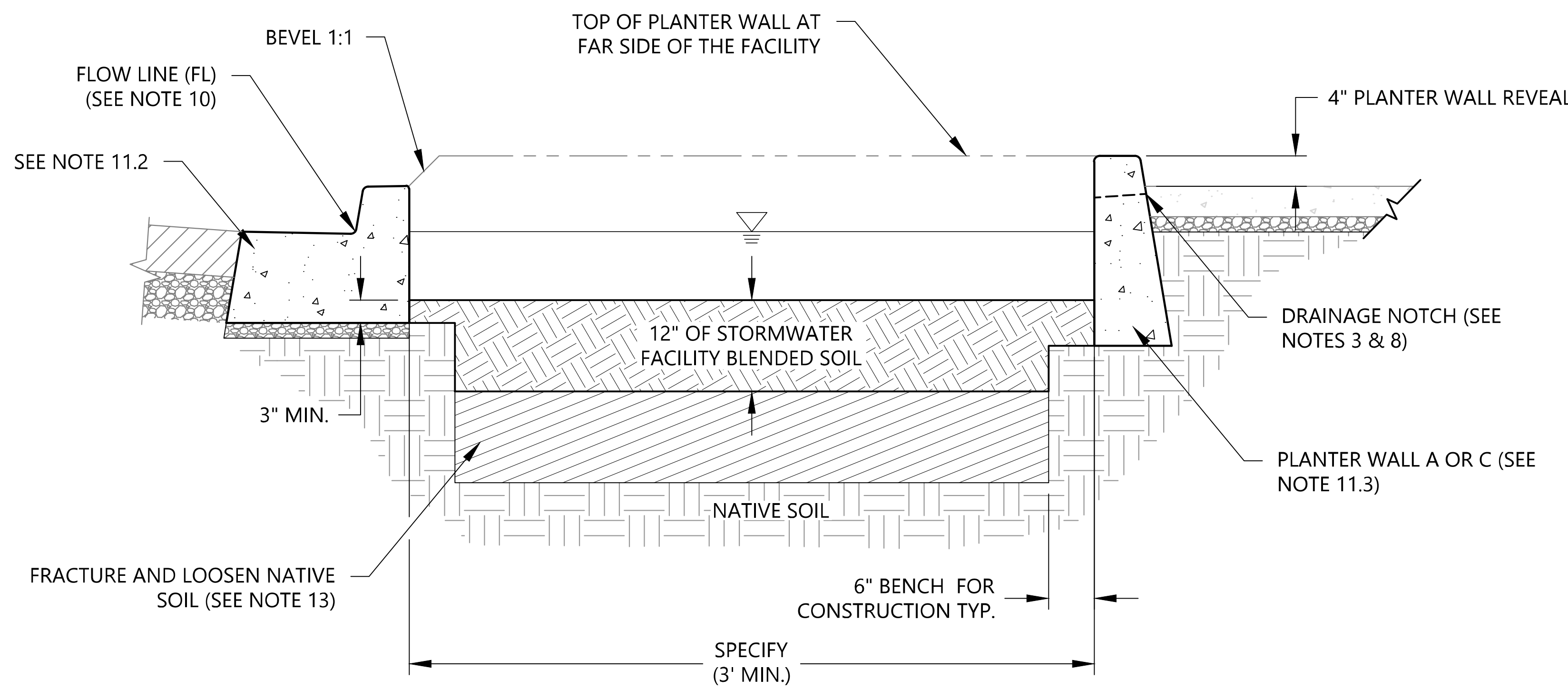
SLOPED BASIN - WITH PARKING
1 FT STEP-OUT
PLAN AND SECTION VIEWS

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-300
Baseline Report Date: N/A	



PLAN VIEW

(PLANTER WITHOUT PARKING)



SECTION A-A

(PLANTER WITHOUT PARKING)

DESIGNER INFORMATION:

1. Adapt this plan and section view example to your engineered design. Maximize surface storage.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints.
3. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, notch, and wall corner
4. If less than 18-in between splash pad and planter wall, then extend pad to wall.
5. Show liner, slotted pipe, 24" depth stormwater facility blended soil, and aggregate in section when used. Refer to SWMM detail SW-316: Stormwater Configuration Sections.
6. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
7. Detail assumes top-of-curb and top-of-sidewalk at approximately the same elevation. Modify detail if site conditions are different
8. Place drainage notch at low point in sidewalk. Space additional notches 6-ft apart.
9. Proposed utility lines to be located out of facility, or per details P-331, P-332, and P-333.
10. Depress gutter pan Flow Line (FL) 2-in to Bottom of Inlet (BI).

RELATED DETAILS AND RESOURCES:

11. City of Portland Standard Drawings:
    - 11.1. P-300: Concrete Inlet, Type Metal.
    - 11.2. P-540: Curbs, 18" Thickened Curb and Gutter typ. When adjacent to a bike lane use 12" Thickened Curb and Gutter.
    - 11.3. P-307: Planter Walls.
    - 11.4. P-332: Utility Coordination Water Service Line Sleeving.
    - 11.5. P-333: Utility Coordination Water Asset Clearances.
12. Stormwater Management Details:
    - 12.1. SW-312: Check Dam - Infiltration Facility.
    - 12.2. SW-313: Check Dam - Infiltration Facility with Rock.
    - 12.3. SW-314: Check Dam - Partial Infiltration Facility with Weep Holes.
    - 12.4. SW-315: Check Dam - Lined Facility with Weep Holes.

CONSTRUCTION NOTES:

13. In facilities that are unlined, fracture and loosen soil - DO NOT TILL - to a depth of 12" below stormwater facility blended soil excavation before installing aggregates or blended soil.

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.

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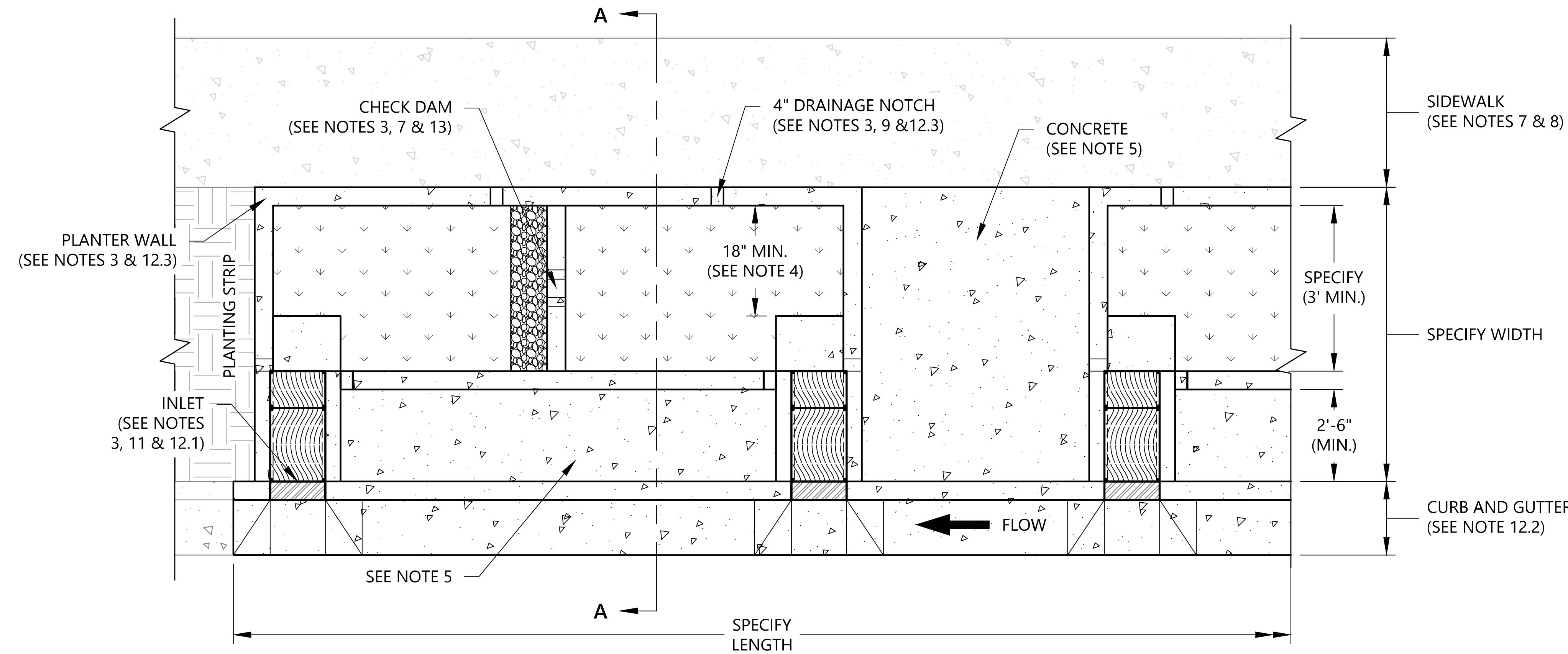
PWB (503) 823-7368
Urban Forestry (503) 823-8733

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER
MANAGEMENT MANUAL

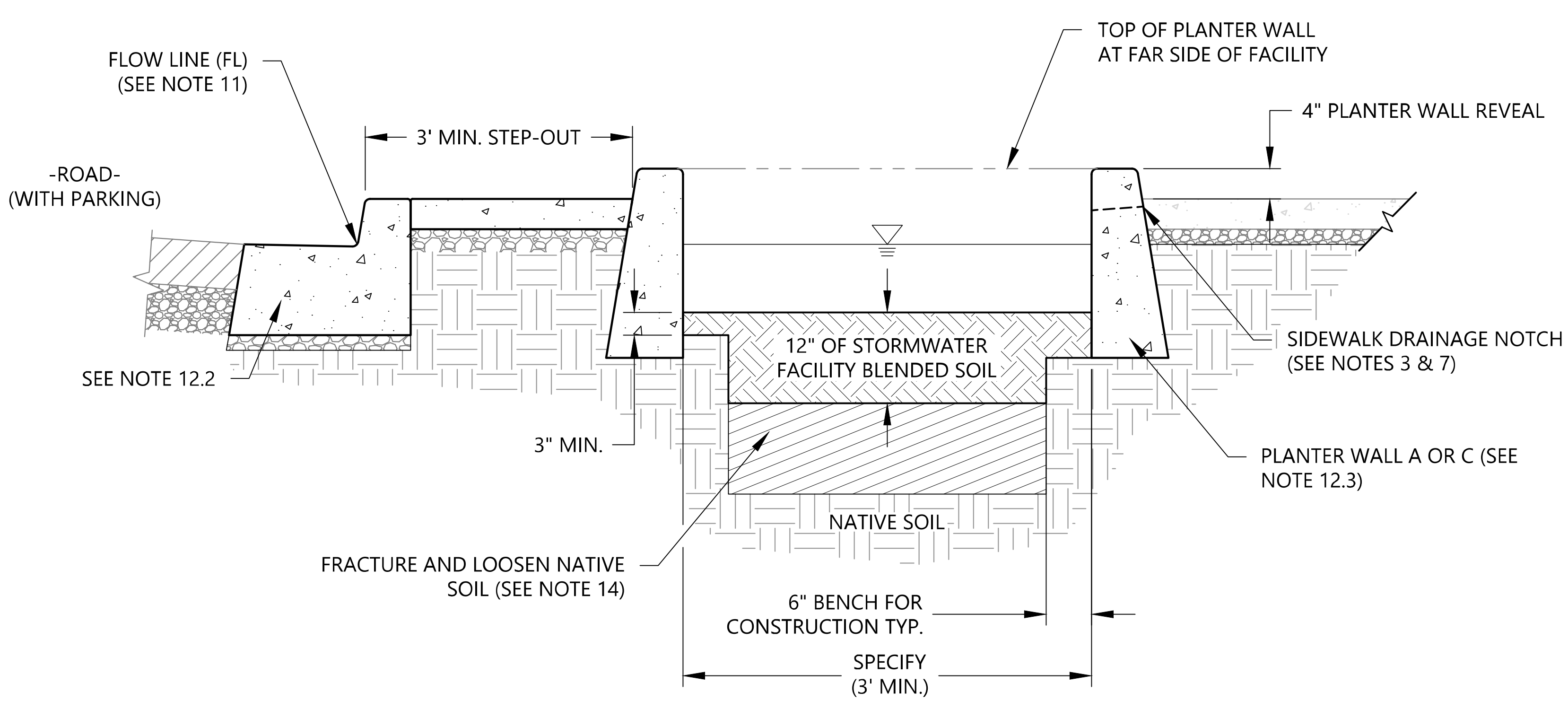
SWMM Detail Title

PLANTER - NO PARKING
PLAN AND SECTION VIEWS

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-301
Baseline Report Date: N/A	



PLAN VIEW
(PLANTER WITH PARKING)



SECTION A-A
(PLANTER WITH PARKING, 3-FT STEP-OUT)

DESIGNER INFORMATION:

1. Adapt this plan and section view example to your engineered design. Maximize surface storage.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints.
3. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions, and elevations at each inlet, outlet, check dam, notch and wall corner.
4. If less than 18-in between splash pad and planter wall, then extend pad to wall.
5. May use concrete per City Standards, or pavers as approved by PBOT.
6. Show liner, slotted pipe, 24" depth stormwater facility blended soil, and aggregate in section when used. Refer to SWMM detail SW-316: Facility Configuration Sections.
7. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
8. Detail assumes top-of-curb and top-of-sdiewalk at approximately the same elevation. Modify detail if site conditions are different.
9. Place drainage notch at low point in sidewalk. Space additional notches 6-ft apart.
10. Proposed utility lines to be located out of facility, or per details P-331, P-332, and P-333.
11. Depress gutter pan Flow Line (FL) 2-in to Bottom of Inlet (BI).

RELATED DETAILS AND RESOURCES:

12. City of Portland Standard Drawings:
    - 12.1. P-303: Concrete Inlet, Type Metal with Channel and Grate (2.5 FT Step-out).
    - 12.2. P-540: Curbs, 18" Thickened Curb and Gutter, 18" Curb and Gutter, typ. When adjacent to bike lane use 12" Thickened Curb and Gutter.
    - 12.3. P-307: Planter Walls.
    - 12.4. P-332: Utility Coordination Water Service Line Sleeving.
    - 12.5. P-333: Utility Coordination Water Asset Clearances.
13. Stormwater Management Manual Details:
    - 13.1. SW-312: Check Dam - Infiltration Facility.
    - 13.2. SW-313: Check Dam - Infiltration Facility with Rock.
    - 13.3. SW-314: Check Dam - Partial Infiltration Facility with Weep Holes.
    - 13.4. SW-315: Check Dam - Lined Facility with Weep Holes.

CONSTRUCTION NOTES:

14. In facilities that are unlined, fracture and loosen soil - DO NOT TILL - to a depth of 12" below stormwater facility blended soil excavation before installing aggregates or blended soil.

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.

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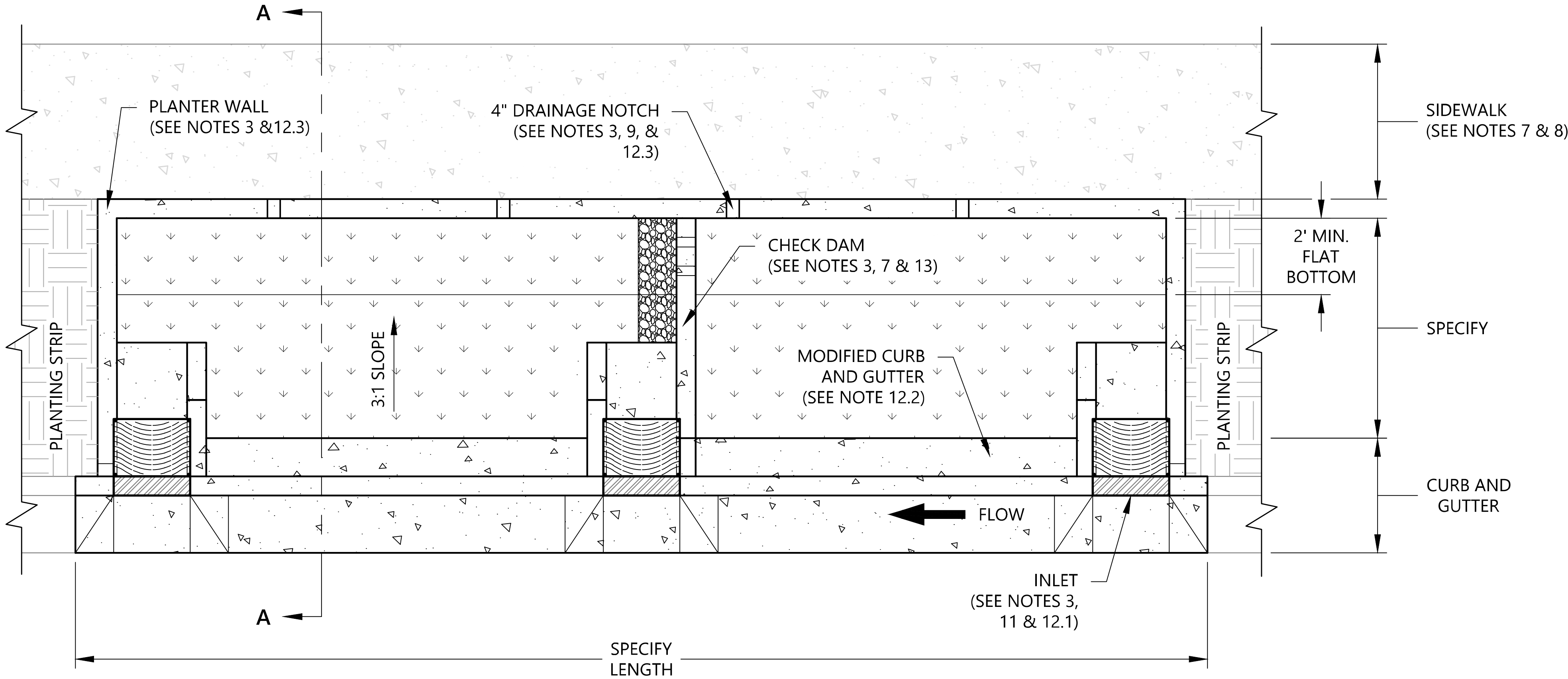
PWB (503) 823-7368
Urban Forestry (503) 823-8733

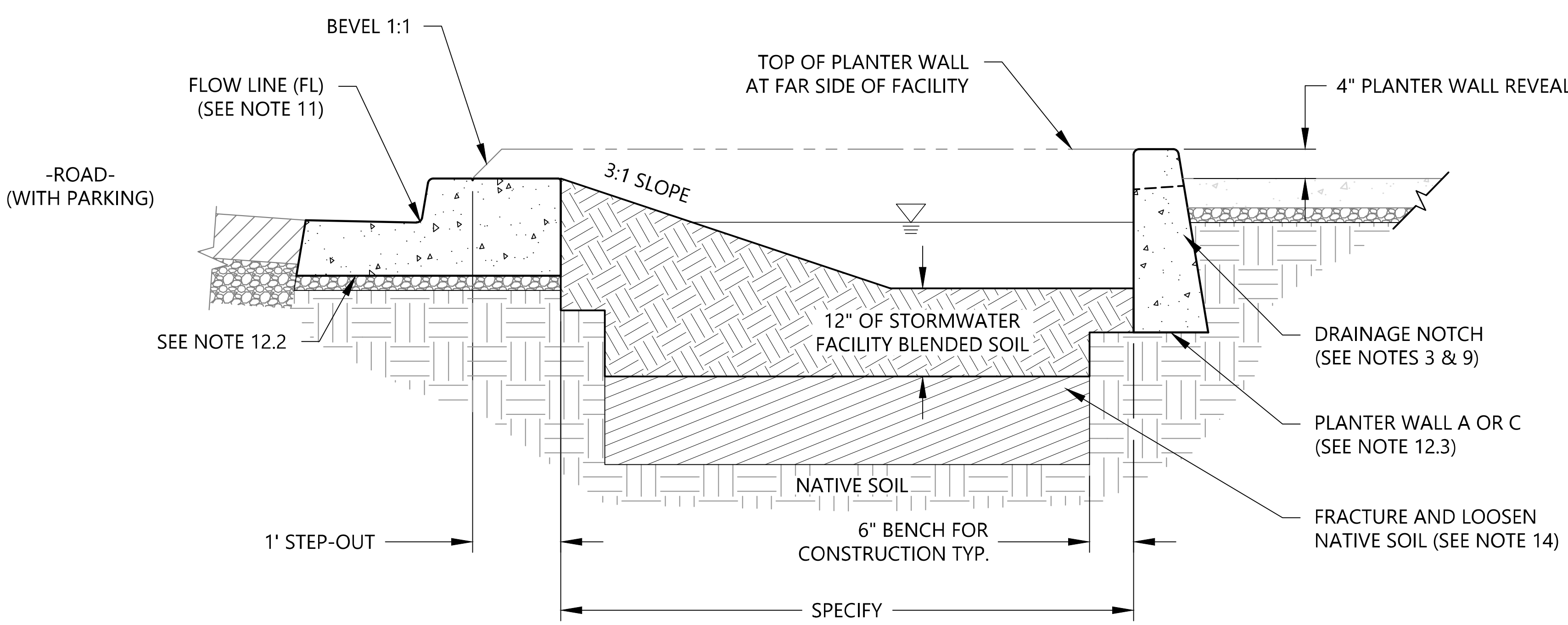
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER
MANAGEMENT MANUAL

SWMM Detail Title
PLANTER - WITH PARKING
2.5 FT STEP-OUT
PLAN AND SECTION VIEWS

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-302
Baseline Report Date: N/A	



PLAN VIEW
(PLANTER WITH PARKING)



SECTION A-A
(PLANTER WITH PARKING, 1 FT STEP-OUT)

DESIGNER INFORMATION:

1. Adapt this plan and section view example to your engineered design. Maximize surface storage.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints.
3. Provide beginning and ending stations for each facility. Provide stations and/or dimensions and elevations at each inlet, outlet, check dam, notch and wall corner.
4. If less than 18-in between splash pad and planter wall, then extend pad to wall.
5. Slope stormwater facility blended soil down to flat bottom area with 3:1 slope
6. Show liner, slotted pipe, 24" depth stormwater facility blended soil, and aggregate in section when used. Refer to SWMM detail SW-316: Stormwater Configuration Section.
7. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
8. Detail assumes top-of-curb and top-of-sidewalk at approximately the same elevation. Modify this detail if site conditions are different.
9. Place drainage notch at low point in sidewalk. Space additional notches 6-ft apart.
10. Proposed utility lines to be located out of facility, or per details P-331, P-332, and P-333.
11. Depress gutter pan Flow Fine (FL) 2-in to Bottom of Inlet (BI).

RELATED DETAILS AND RESOURCES:

12. City of Portland Standard Drawings:
    - 12.1. P-304: Concrete Inlet, Type Metal with Channel and Grate (1 FT Step-out).
    - 12.2. P-540: Curbs, Modified Curb and Gutter, typ. When adjacent to a bike lane use a 12" gutter pan.
    - 12.3. P-307: Planter Walls.
    - 12.4. P-332: Utility Coordination Water Service Line Sleeving.
    - 12.5. P-333: Utility Coordination Water Asset Clearances.
13. Stormwater Management Manual:
    - 13.1. SW-312: Check Dam - Infiltration Facility
    - 13.2. SW-313: Check Dam - Infiltration Faiclity with Rocks
    - 13.3. SW-314: Check Dam - Partial Infiltration Facility with Weep Holes
    - 13.4. SW-315: Check Dam - Lined Facility with Weep Holes.

CONSTRUCTION NOTES:

14. In facilities that are unlined, fracture and loosen soil - DO NOT TILL - to a depth of 12-in below stormwater facility blended soil excavation before installing aggregates or blended soil.

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.

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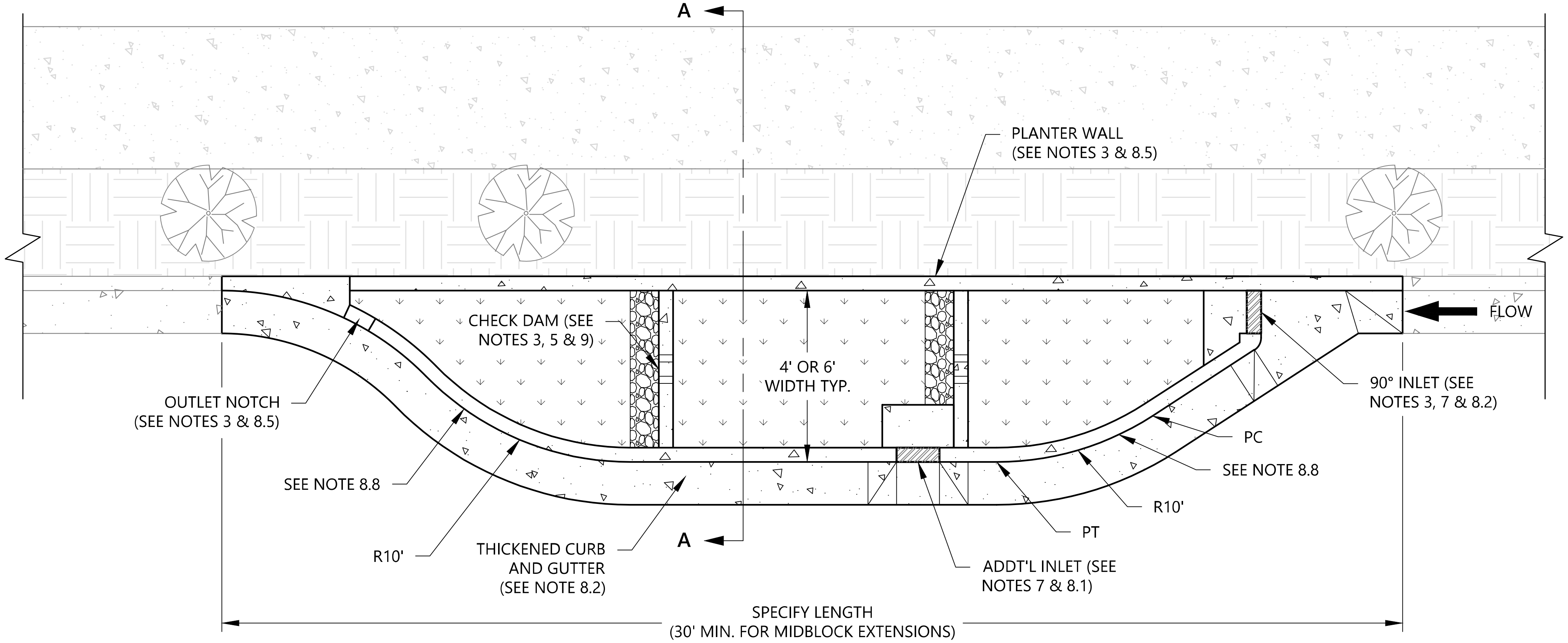
PWB (503) 823-7368
Urban Forestry (503) 823-8733

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER
MANAGEMENT MANUAL

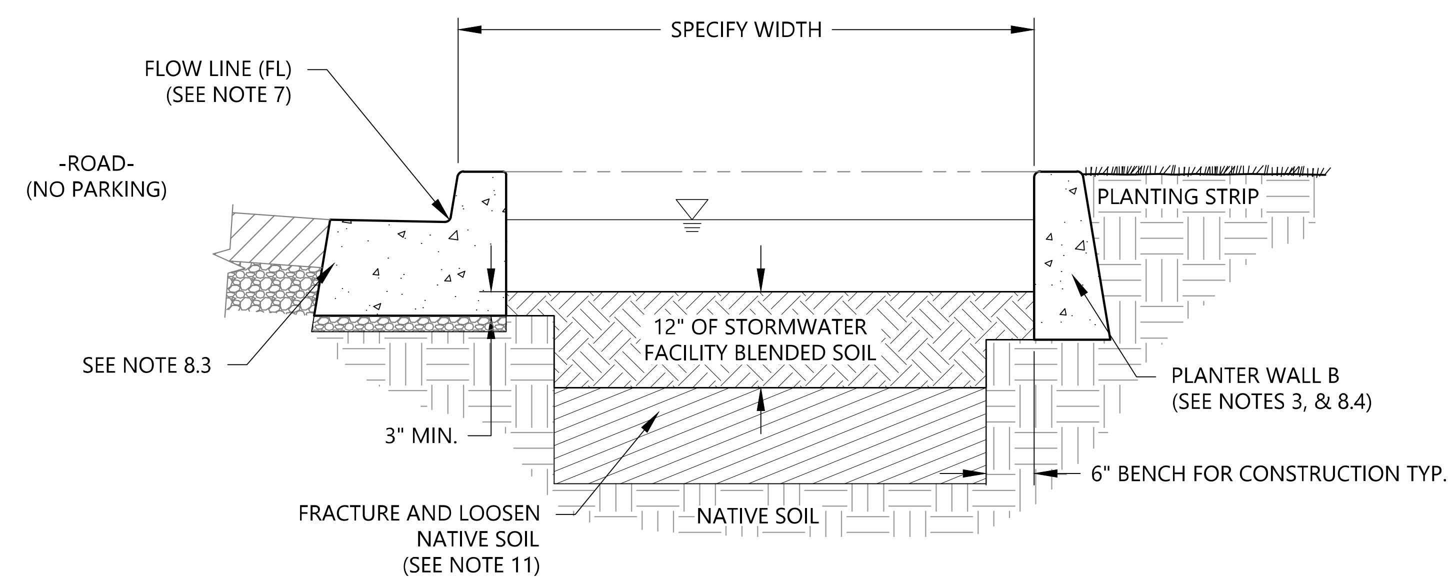
SWMM Detail Title

PLANTER - WITH PARKING
1 FT STEP-OUT
PLAN AND SECTION VIEWS

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-303
Baseline Report Date: N/A	



PLAN VIEW
(CURB EXTENSION NO PARKING)



SECTION A-A

DESIGNER INFORMATION:

1. Adapt this plan and section view example to your engineered design. Maximize surface storage.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints.
3. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, notches and wall corners.
4. Show liner, slotted pipe, 24" depth stormwater facility blended soil, and rock gallery in section when required. Refer to SWMM Detail SW-316: Facility Configuration Sections.
5. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
6. Proposed utility lines to be located out of facility or per details P-331, P-332 and P-333.
7. Depress gutter pan Flow Line (FL) 2-in to Bottom of Inlet (BI).

RELATED DETAILS AND RESOURCES:

8. City of Portland Standard Drawings:
   - 8.1. P-300: Concrete Inlet, Type Metal
   - 8.2. P-301: Concrete Inlet, Type Metal (Rotated)
   - 8.3. P-540: Curbs, 18" Thickened Curb and Gutter, typ. When adjacent to a bike lane use 12" Thickened Curb and Gutter.
   - 8.4. P-307: Planter Walls
   - 8.5. P-308: Curb Extension Outlet Notch
   - 8.6. P-332: Utility Coordination Water Service Line Sleeving
   - 8.7. P-333: Utility Coordination Water Asset Clearances
   - 8.8. P-434: Pavement Markings Standard Detail Blocks, Curb Extension Detail and Midblock Curb Extension Pavement Markings

9. Stormwater Management Manual:
   - 9.1. SW-312: Check Dam - Infiltration Facility
   - 9.2. SW-313: Check Dam - Infiltration Facility with Rock
   - 9.3. SW-314: Check Dam - Partial Infiltration Facility with Weep Holes
   - 9.4. SW-315: Check Dam - Lined Facility with Weep Holes

CONSTRUCTION NOTES:

10. In facilities that are unlined, fracture and loosen soil - DO NOT TILL - to a depth of 12-in below stormwater facility blended soil excavation before installing aggregates or blended soil.

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.

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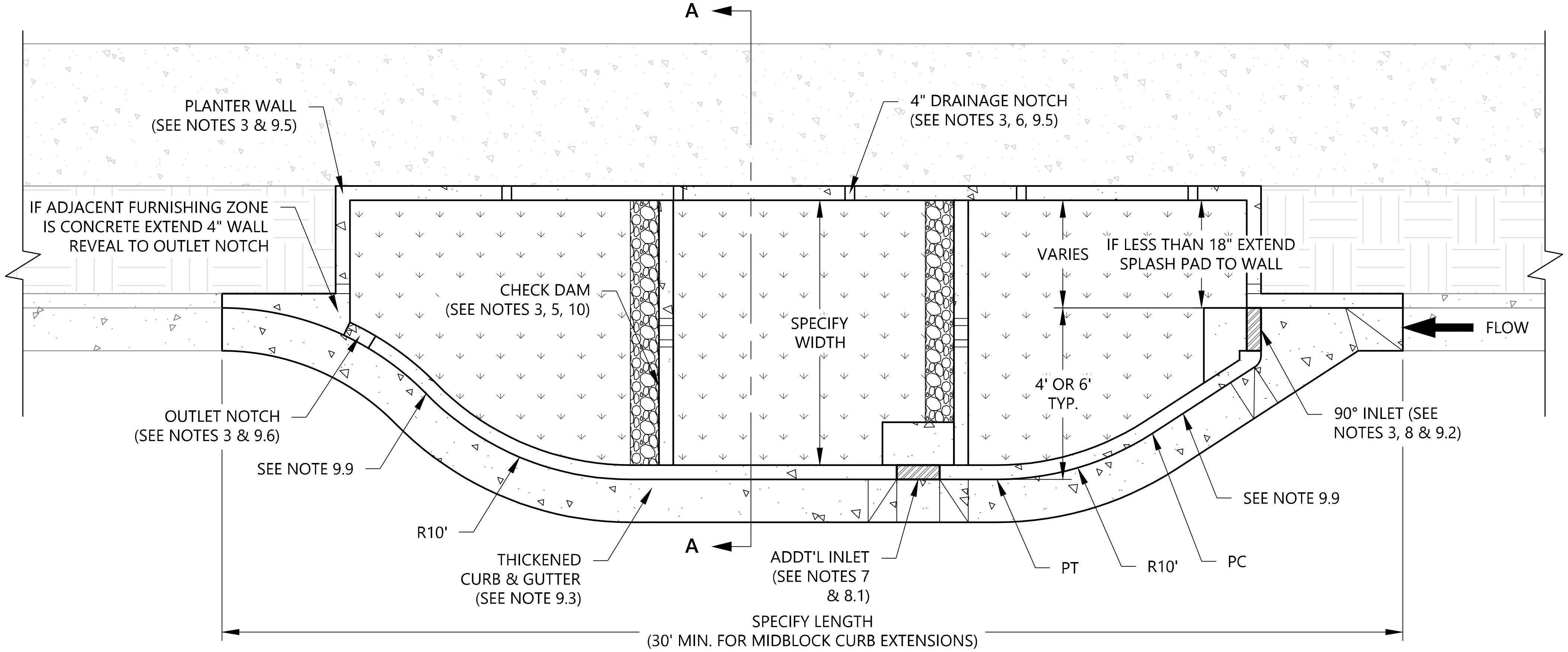
PWB (503) 823-7368
Urban Forestry (503) 823-8733

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

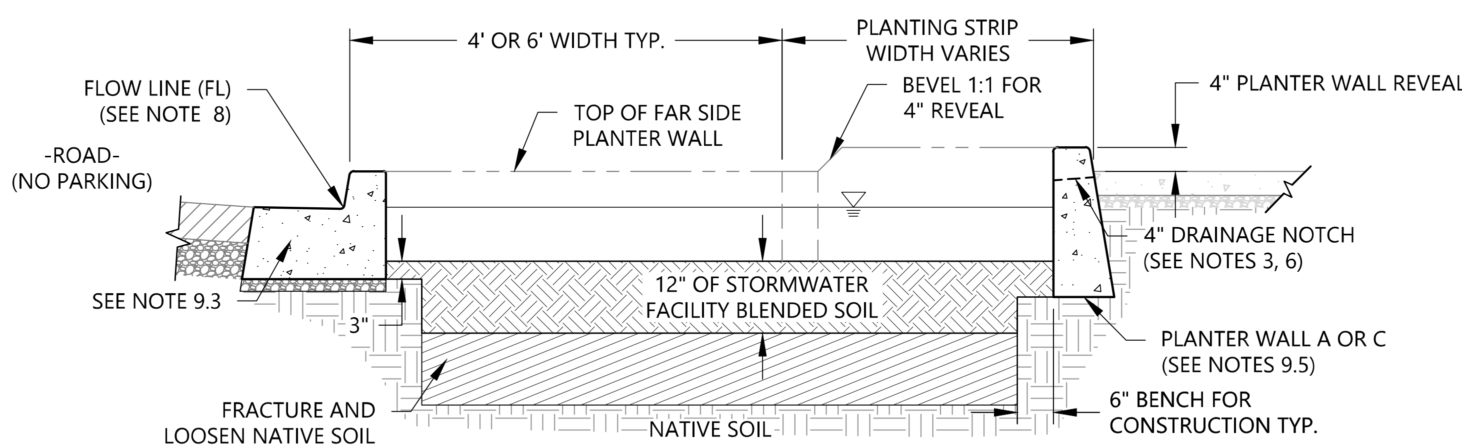
SWMM Detail Title

CURB EXTENSION
NO PLANTING STRIP
PLAN AND SECTION VIEWS

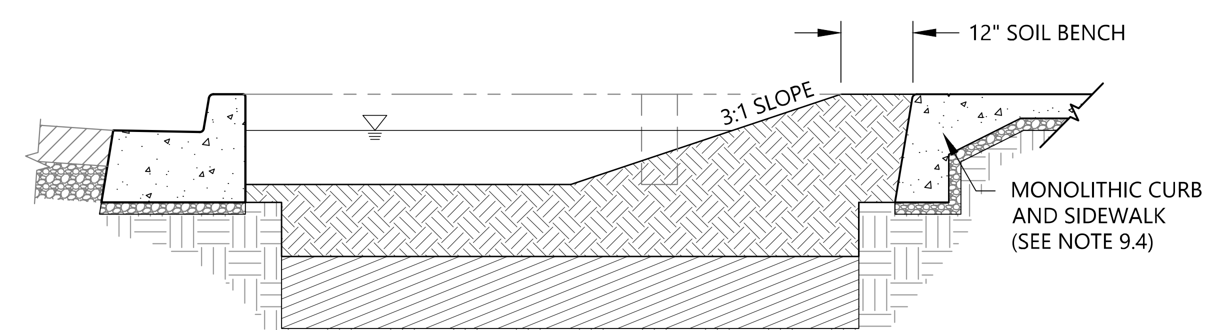
Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-304
Baseline Report Date: N/A	



PLAN VIEW
(CURB EXTENSION NO PARKING)



SECTION A-A



SECTION A-A
(ALTERNATIVE)

DESIGNER INFORMATION:

1. Adapt this plan and section view example to your engineered design. Maximize surface storage.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints.
3. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, notches and wall corners.
4. Show liner, slotted pipe, 24" depth stormwater facility blended soil, and rock gallery in section when required. Refer to SWMM Detail SW-316: Facility Configuration Sections.
5. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
6. Place 4-in wide drainage notch at low point in sidewalk. Space additional notches 6-ft apart.
7. Proposed utility lines to be located out of facility or per details P-331, P-332, and P-333.
8. Depress gutter pan Flow Line (FL) 2-in to Bottom of Inlet (BI).

RELATED DETAILS AND RESOURCES:

9. City of Portland Standard Drawings:
   - 9.1. P-300: Concrete Inlet, Type Metal
   - 9.2. P-301: Concrete Inlet, Type Metal (Rotated)
   - 9.3. P-540: Curbs, 18" Thickened Curb and Gutter, typ. When adjacent to a bike lane use 12" Thickened Curb and Gutter.
   - 9.4. P-551: Sidewalks, Monolithic Curb and Sidewalk
   - 9.5. P-307: Planter Walls
   - 9.6. P-308: Curb Extension Outlet Notch
   - 9.7. P-332: Utility Coordination Water Service Line Sleeving
   - 9.8. P-333: Utility Coordination Water Asset Clearances
   - 9.9. P-434: Pavement Marking Standard Detail Blocks, Curb Extension Detail and Midblock Curb Extension Pavement Markings

10. Stormwater Management Manual:
    - 10.1. SW-312: Check Dam - Infiltration Facility
    - 10.2. SW-313: Check Dam - Infiltration Facility with Rock
    - 10.3. SW-314: Check Dam - Partial Infiltration Facility with Weep Holes
    - 10.4. SW-315: Check Dam - Lined Facility with Weep Holes

CONSTRUCTION NOTES:

11. In facilities that are unlined, fracture and loosen soil - DO NOT TILL - to a depth of 12-in below stormwater facility blended soil excavation before installing aggregates or blended soil.

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BES (503) 823-7761
PWB (503) 823-7368
Urban Forestry (503) 823-8733

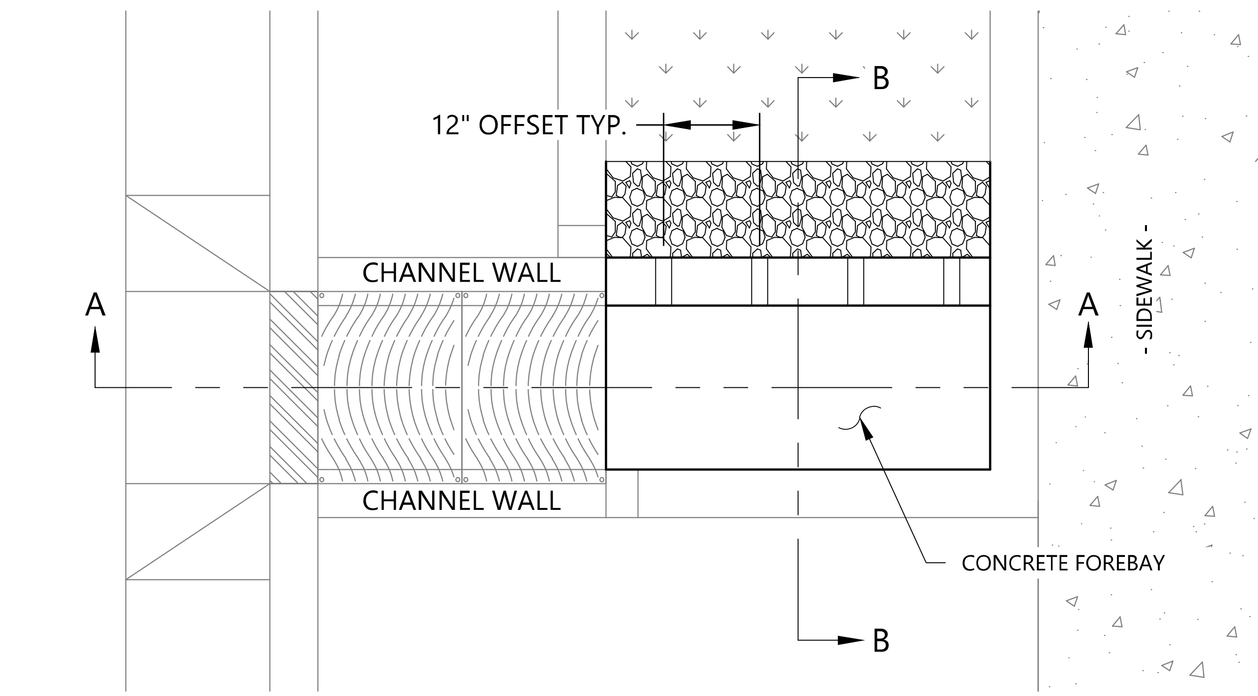
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER
MANAGEMENT MANUAL

SWMM Detail Title

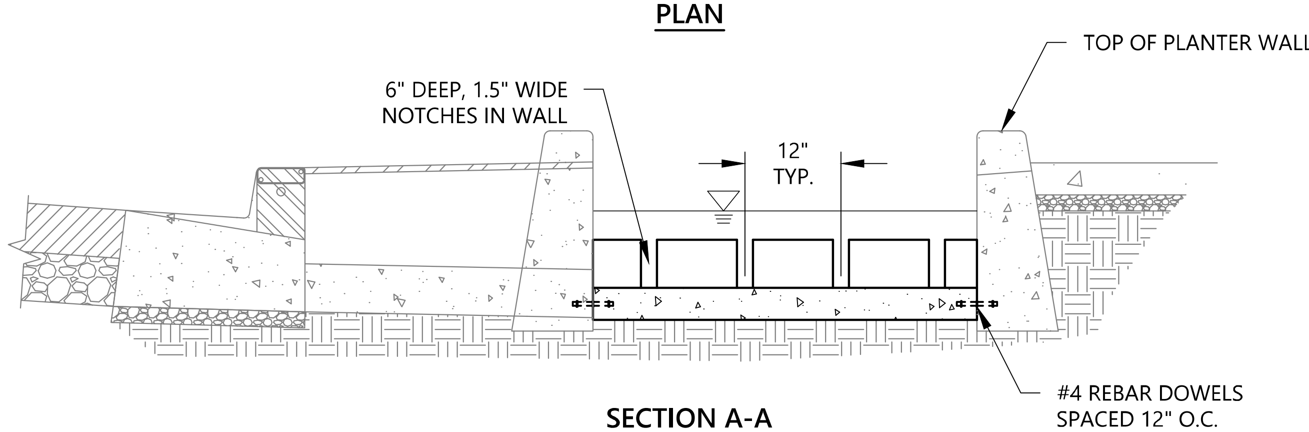
CURB EXTENSION
WITH PLANTING STRIP
PLAN AND SECTION VIEWS

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-305
Baseline Report Date: N/A	

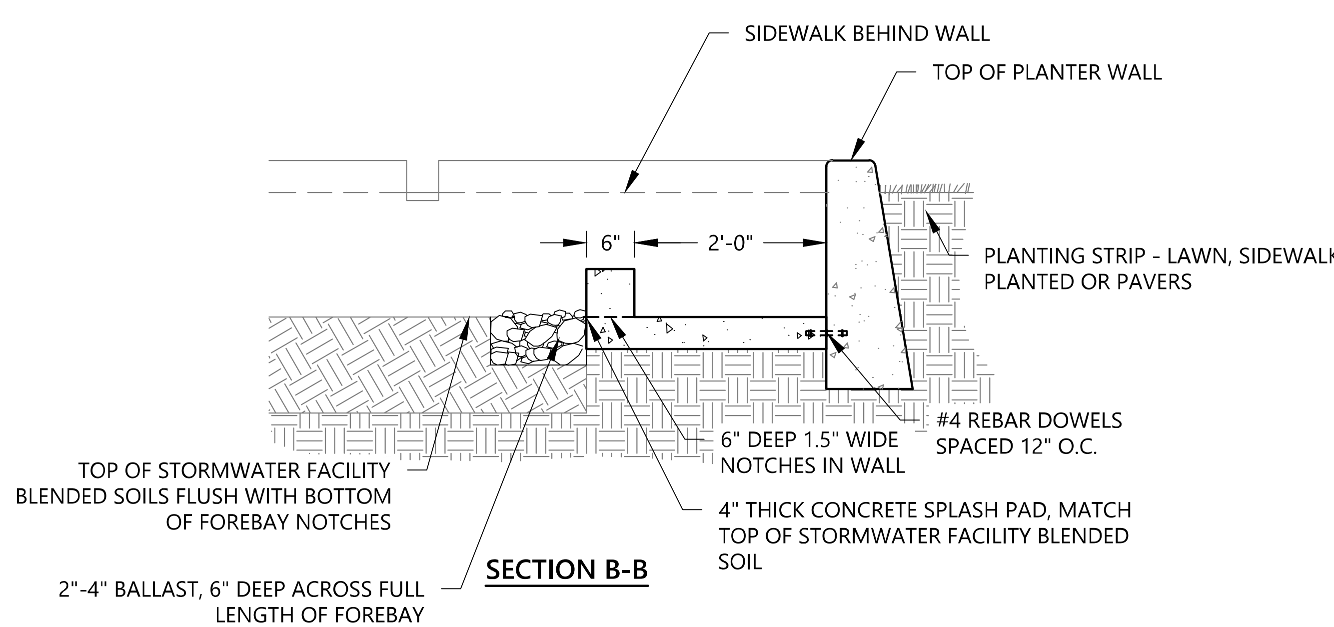
2020SWMM-DETAILS.DWG 12/9/20 11:20 AM SPEREZ



PLAN



SECTION A-A



SECTION B-B

DESIGNER INFORMATION:

1. INLET TYPE MAY VARY, 3-FT STEP-OUT SHOWN. ADAPT THESE PLAN AND SECTIONS TO YOUR DESIGN AS REQUIRED.
2. AN 18-IN GUTTER IS TYPICAL. FOR FACILITIES ADJACENT TO BIKE LANES, A 12-IN GUTTER IS REQUIRED.

RELATED DETAIL AND RESOURCES:

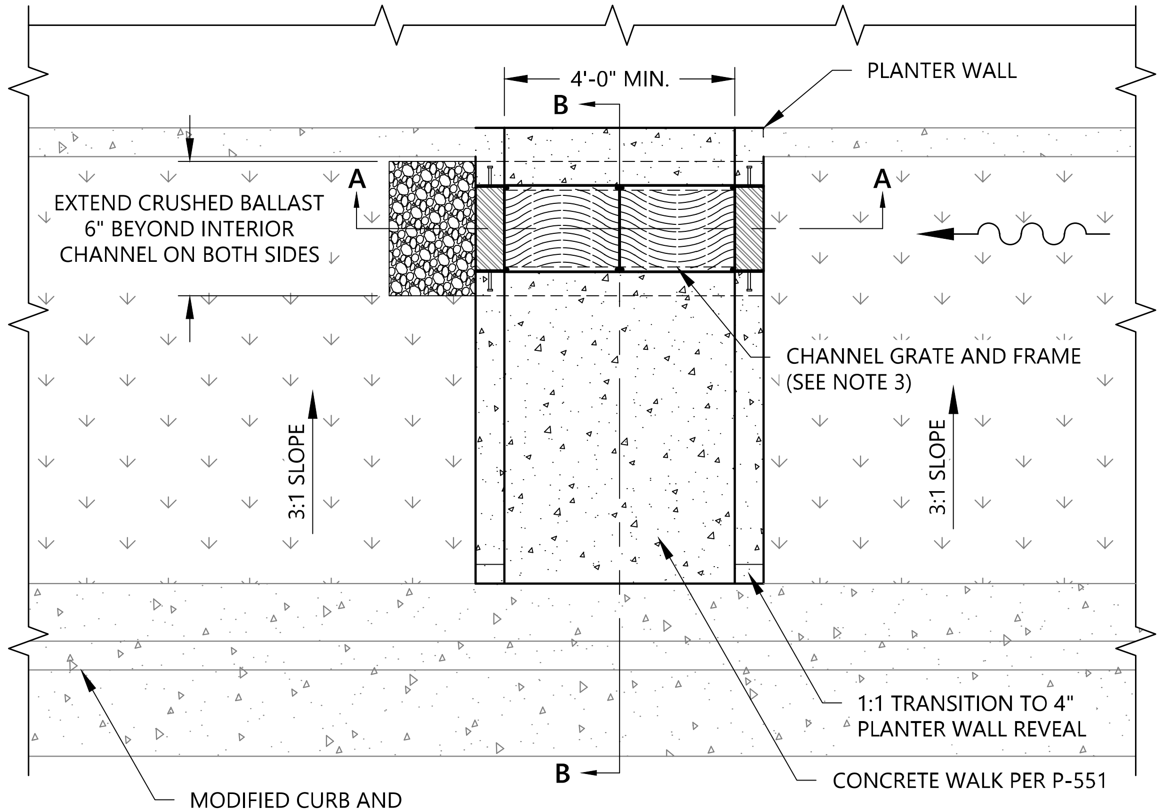
4. REFER TO CITY OF PORTLAND STANDARD DRAWING P-540: CURBS, 18" THICKENED CURB AND GUTTER.
5. REFER TO CITY OF PORTLAND STANDARD DRAWINGS P-300, P-303, P-304, AND P-305 FOR INLETS.
6. REFER TO CITY OF PORTLAND STANDARD DRAWING P-307 FOR PLANTER WALLS.

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

NOTCHED FOREBAY WALL FOR PLANTERS

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-310
Baseline Report Date: N/A	



PLAN

DESIGNER INFORMATION:

1. AVOID USING THIS DETAIL IF STOPPING AND STARTING THE FACILITY IS POSSIBLE.

2. DETAIL DEPICTED WITH COMBINATION SWALE/PANTER. MODIFY DETAIL TO USE WITH OTHER CROSS SECTIONS.

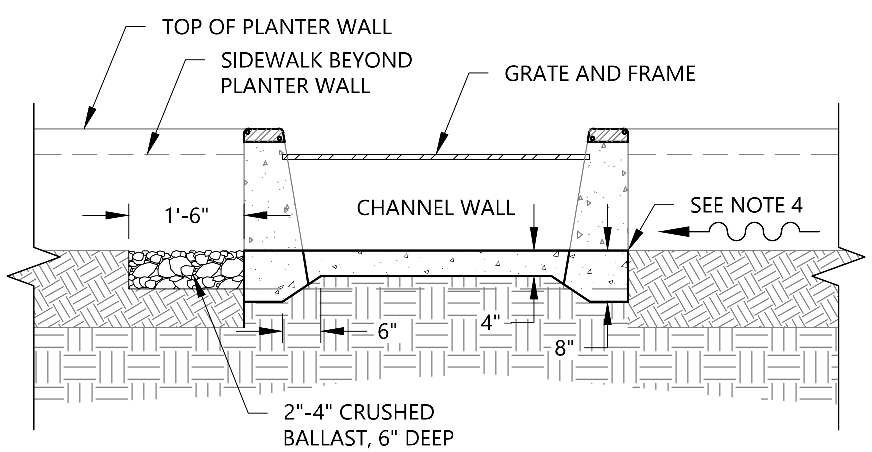
3. CHANNEL GRATE FRAME SHELF VARIES PER MANUFACTURER. REFER TO MANUFACTURER'S RECOMMENDATIONS, AND ADJUST CHANNEL OPENING AS REQUIRED. 2% MAXIMUM CROSS SLOPE ON GRATE**. GRATE AND FRAME SYSTEM TO MEET THE FOLLOWING REQUIREMENTS:

   3.1. OLYMPIC FOUNDRY INC. SM50 18"X24" "TWS" ADA GRATE AND FRAME, OR APPROVED EQUAL.
   3.2. CAST IRON, WITH NATURAL FINISH
   3.3. GRATE SHALL BE ADA COMPLIANT.
   3.4. IN TWO OPPOSITE CORNERS, BOLT GRATE TO FRAME. COUNTERSINK, DRILL, AND TAP FOR SS 6-SIDED HEX HEAD BOLT.
   3.5. BOLTS TO HAVE ANTI-SEIZE THREAD LUBRICANT APPLIED AT INSTALLATION.

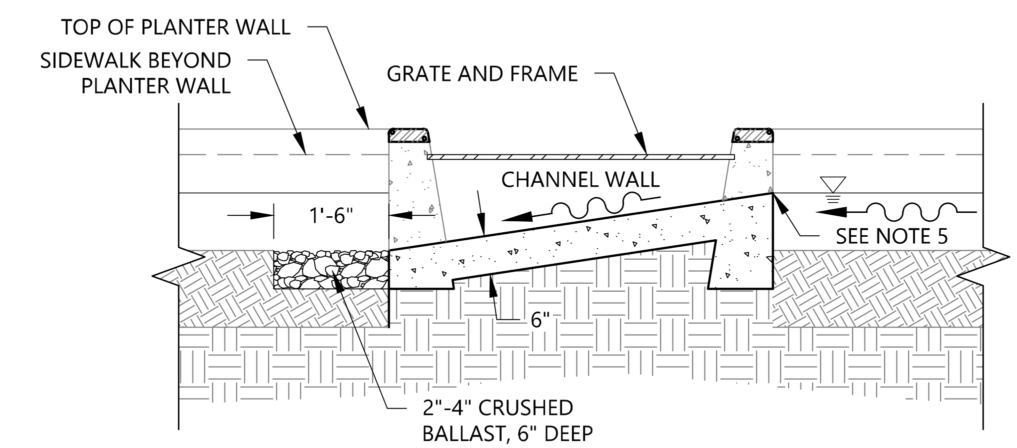
4. SEE SECTION A-A. MATCH CONCRETE CHANNEL TO TOP OF STORMWATER FACILITY BLENDED SOILS, TYP. BOTH SIDES. CHANNEL SLOPE TO MATCH FACILITY SLOPE.

5. SEE SECTION B-B (CHANNEL AS CHECK DAM). SET TOP OF CHANNEL ELEVATION PER DESIGNED PONDING DEPTH. SLOPE CHANNEL TO BE FLUSH WITH FACILITY GRADE AT DOWNSTREAM CELL.

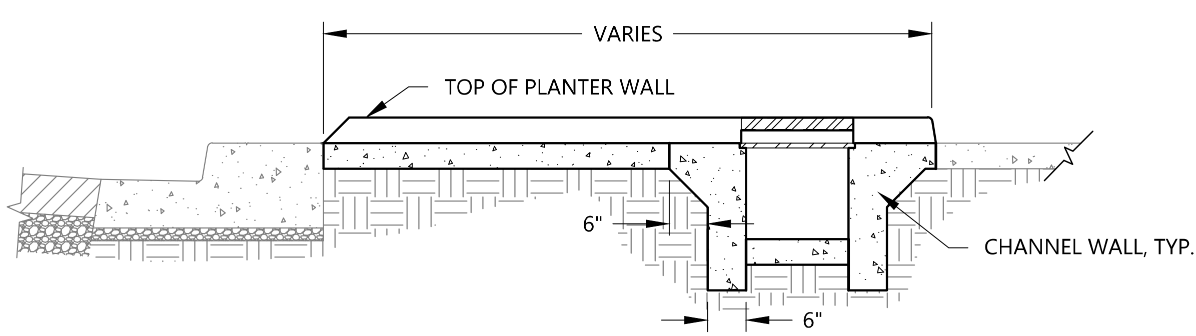
** USE 1.5% SLOPE MAXIMUM DESIGN SLOPE FOR CONSTRUCTION TOLERANCE.



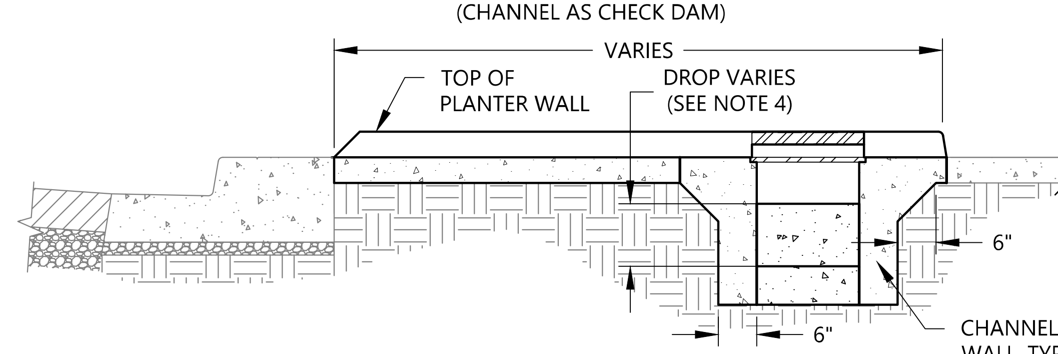
SECTION A-A



SECTION A-A
(CHANNEL AS CHECK DAM)



SECTION B-B



SECTION B-B
(CHANNEL AS CHECK DAM)

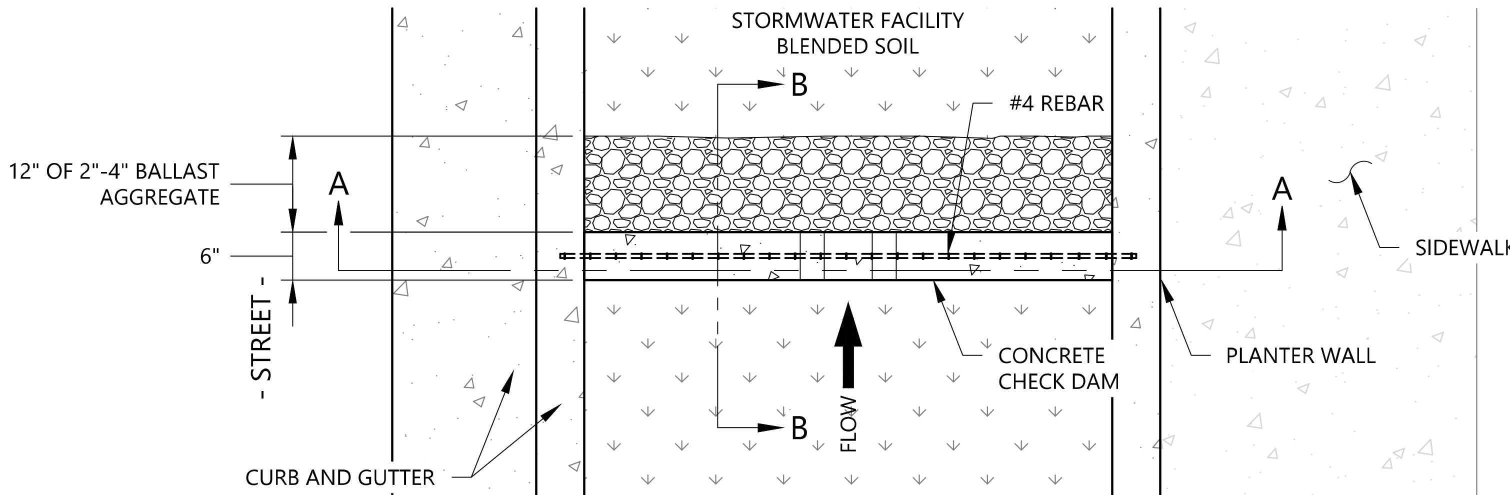
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER
MANAGEMENT MANUAL

SWMM Detail Title

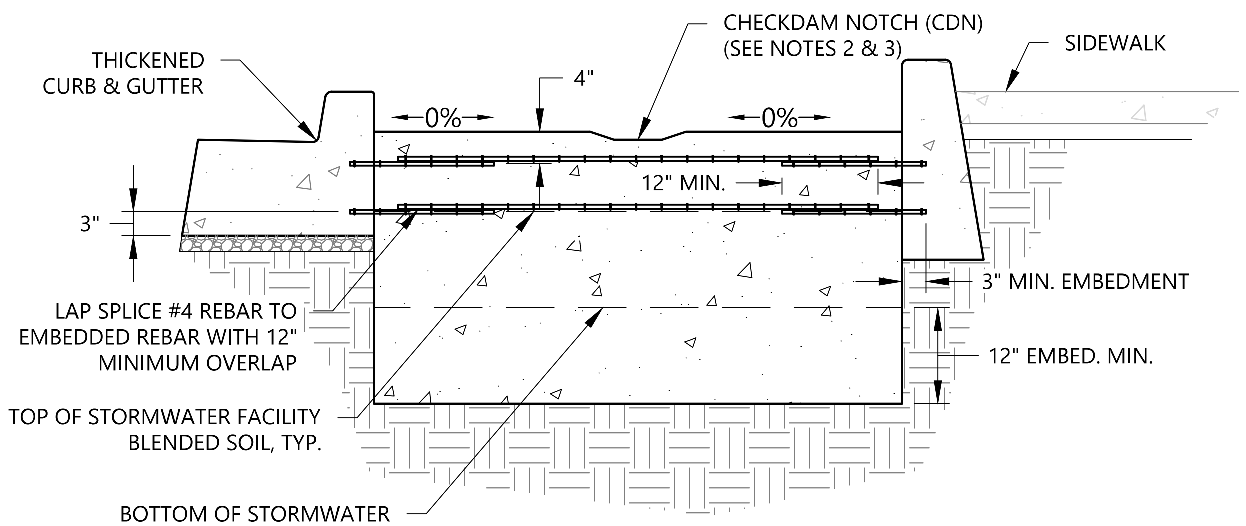
CARRIAGE WALK
WITH TRENCH GRATE

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-311
Baseline Report Date: N/A	

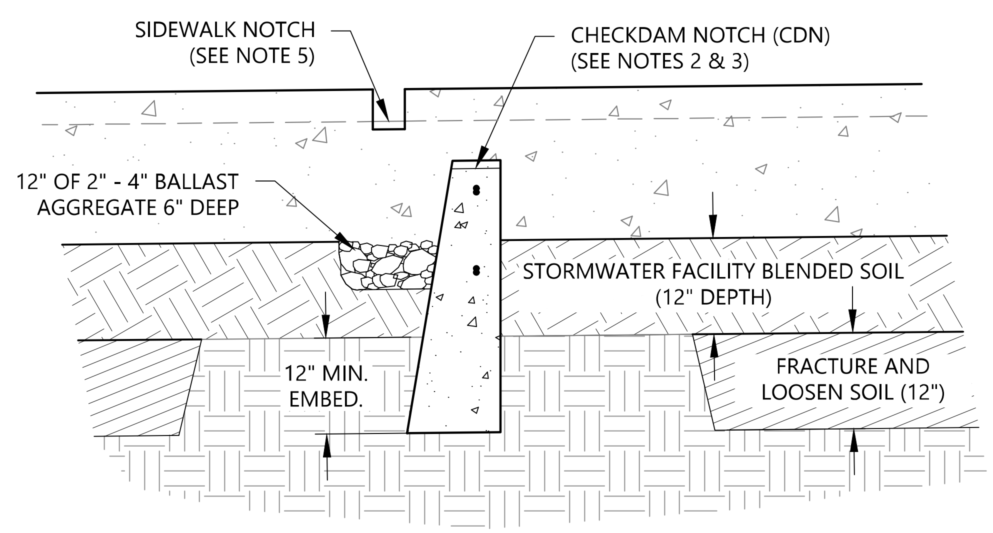
2020SWMM–DETAILS.DWG 12/9/20 11:20 AM SPEREZ



PLAN



SECTION A-A



SECTION B-B
(SEE NOTE 1)

DESIGNER INFORMATION:

1. USE THIS DETAIL FOR FACILITIES WITH >2" PER HOUR NATIVE INFILTRATION RATE, OR FOR FACILITIES DESIGNED FOR COMPLETE INFILTRATION OF THE 10-YEAR EVENT
2. CHECK DAM NOTCH (CDN) ELEVATION TO BE WHICHEVER IS LOWEST: EQUAL TO THE FLOW LINE ELEVATION AT THE UPSTREAM INLET OF THE FACILITY; 2" BELOW THE ELEVATION OF THE SIDEWALK ADJACENT TO THE CHECK DAM; OR 2" BELOW THE ELEVATION OF THE TOP-OF-CURB (TOC) ADJACENT TO THE. IF IT IS NOT THEN CONTACT INSPECTOR FOR DIRECTION.
3. ENSURE THAT THE CHECK DAM ELEVATIONS DO NOT CAUSE STORMWATER TO OVERFLOW TO SIDEWALK, OR BACKWATER INTO THE STREET.
4. A PARTIAL LINER MAY BE REQUIRED ON THE STREET SIDE OR SIDEWALK SIDE DEPENDING ON EXISTING CONDITIONS, REFER TO CONSTRUCTION DRAWINGS. ATTACH LINER PER CITY OF PORTLAND STANDARD DRAWING P-340.
5. WHERE FEASIBLE, LOCATE SIDEWALK DRAINAGE NOTCHES IMMEDIATELY DOWNSTREAM OF CONCRETE CHECK DAMS TO MINIMIZE DROP FROM SIDEWALK TO FACILITY SOIL.

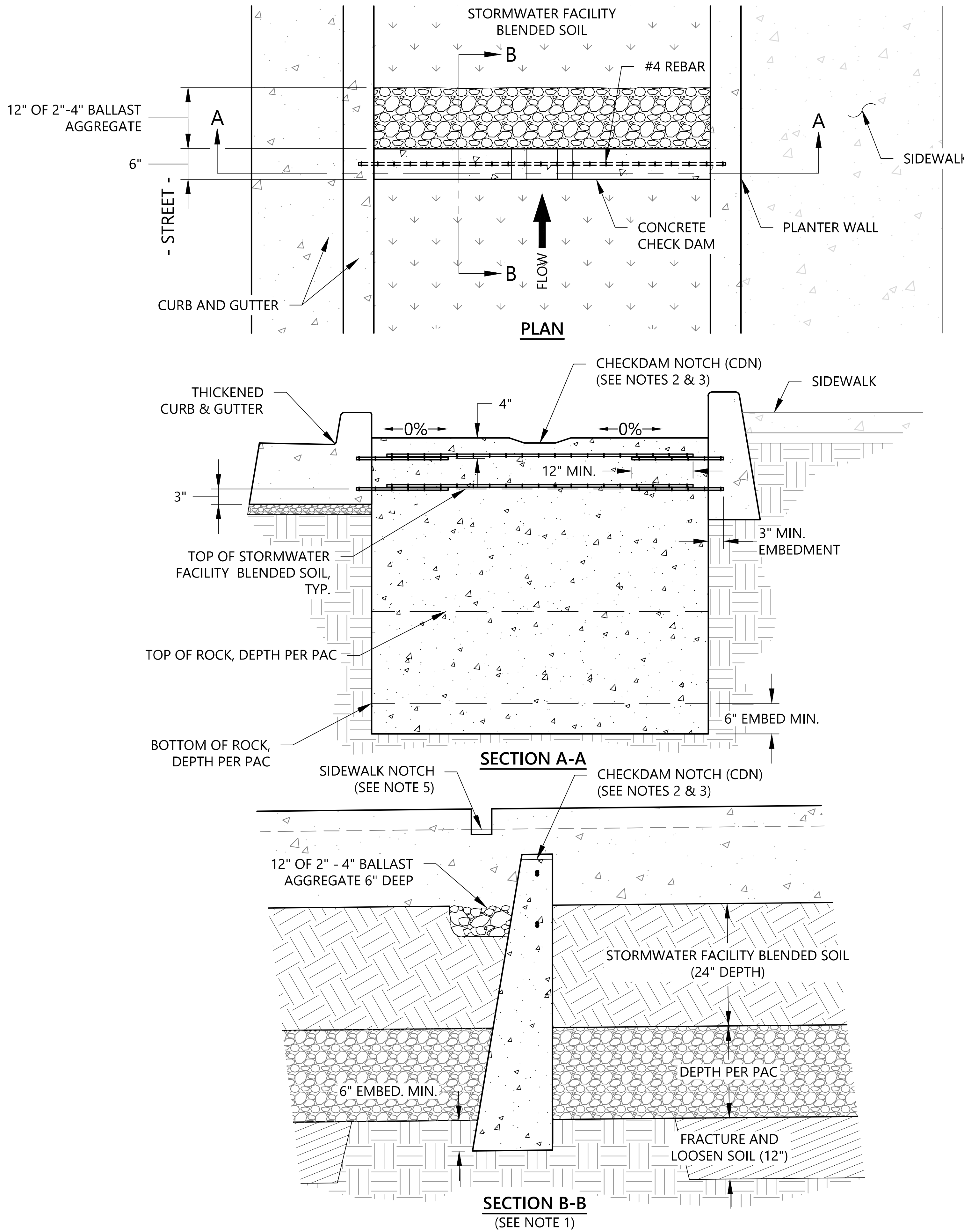
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

CHECK DAM - INFILTRATION FACILITY

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-312
Baseline Report Date: N/A	

2020SWMM-DETAILS.DWG 12/9/20 11:20 AM SPEREZ



DESIGNER INFORMATION:

1. USE THIS DETAIL FOR FACILITIES WITH >2" PER HOUR NATIVE INFILTRATION RATE WHEN THE PAC REQUIRES ROCK.
2. CHECK DAM NOTCH (CDN) ELEVATION TO BE WHICHEVER IS LOWEST: EQUAL TO THE FLOW LINE ELEVATION AT THE UPSTREAM INLET OF THE FACILITY; 2" BELOW THE ELEVATION OF THE SIDEWALK ADJACENT TO THE CHECK DAM; OR 2" BELOW THE ELEVATION OF THE TOP-OF-CURB (TOC) ADJACENT TO THE. IF IT IS NOT THEN CONTACT INSPECTOR FOR DIRECTION.
3. ENSURE THAT THE CHECK DAM ELEVATIONS DO NOT CAUSE STORMWATER TO OVERFLOW TO SIDEWALK, OR BACKWATER INTO THE STREET.
4. A PARTIAL LINER MAY BE REQUIRED ON THE STREET SIDE OR SIDEWALK SIDE DEPENDING ON EXISTING CONDITIONS, REFER TO CONSTRUCTION DRAWINGS. ATTACH LINER PER CITY OF PORTLAND STANDARD DRAWING P-340.
5. WHERE FEASIBLE, LOCATE SIDEWALK DRAINAGE NOTCHES IMMEDIATELY DOWNSTREAM OF CONCRETE CHECK DAMS TO MINIMIZE DROP FROM SIDEWALK TO FACILITY SOIL.

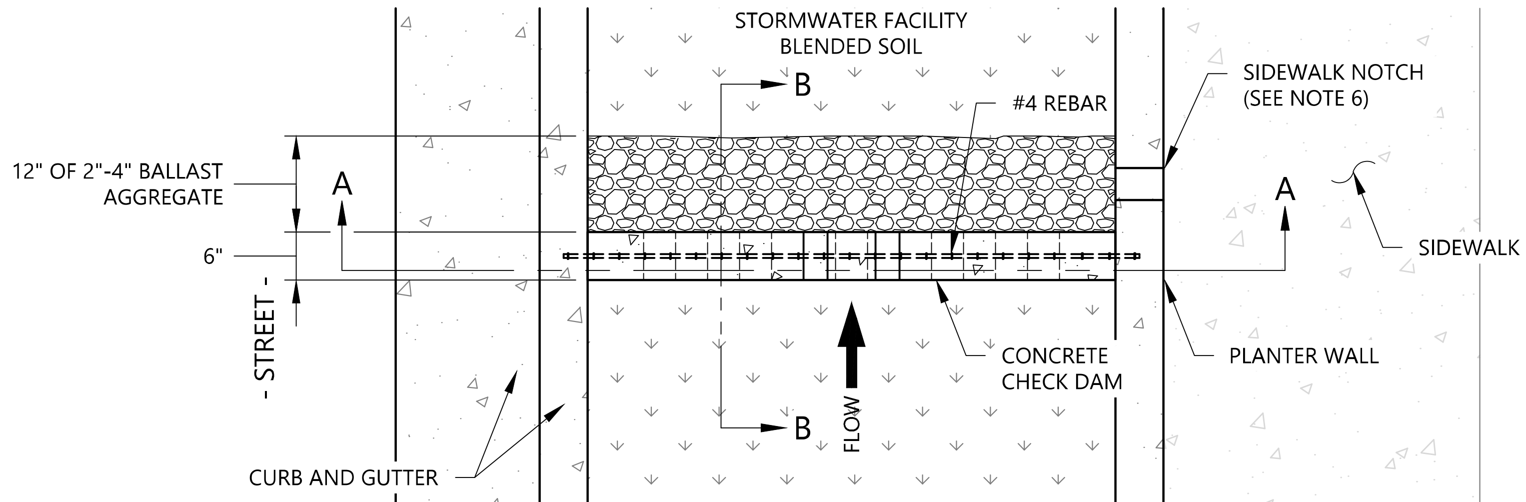
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

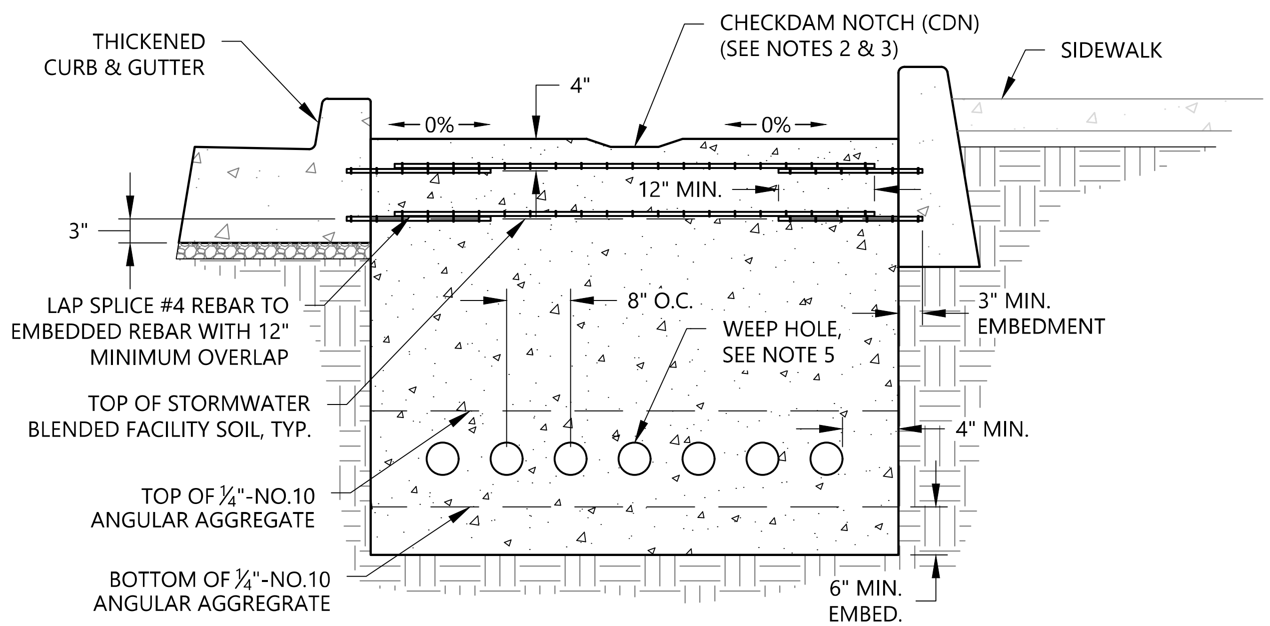
CHECK DAM
INFILTRATION FACILITY WITH ROCK

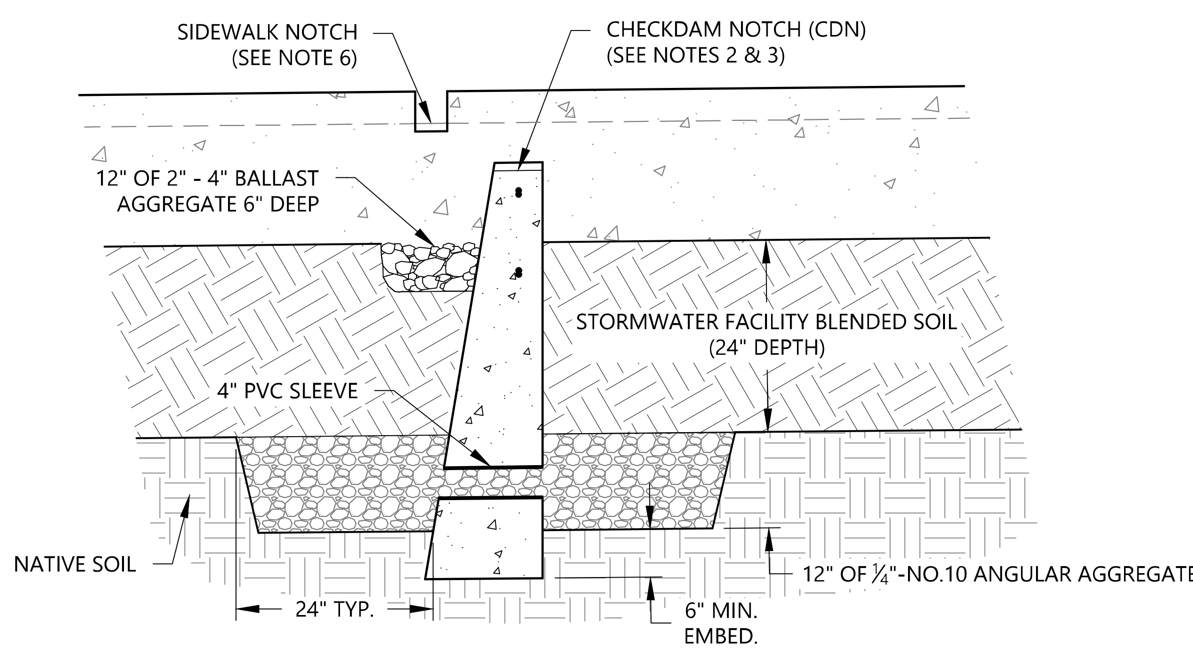
Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-313
Baseline Report Date: N/A	

2020SWMM–DETAILS.DWG 12/9/20 11:20 AM SPEREZ



PLAN





SECTION B-B
(SEE NOTE 1)

DESIGNER INFORMATION:

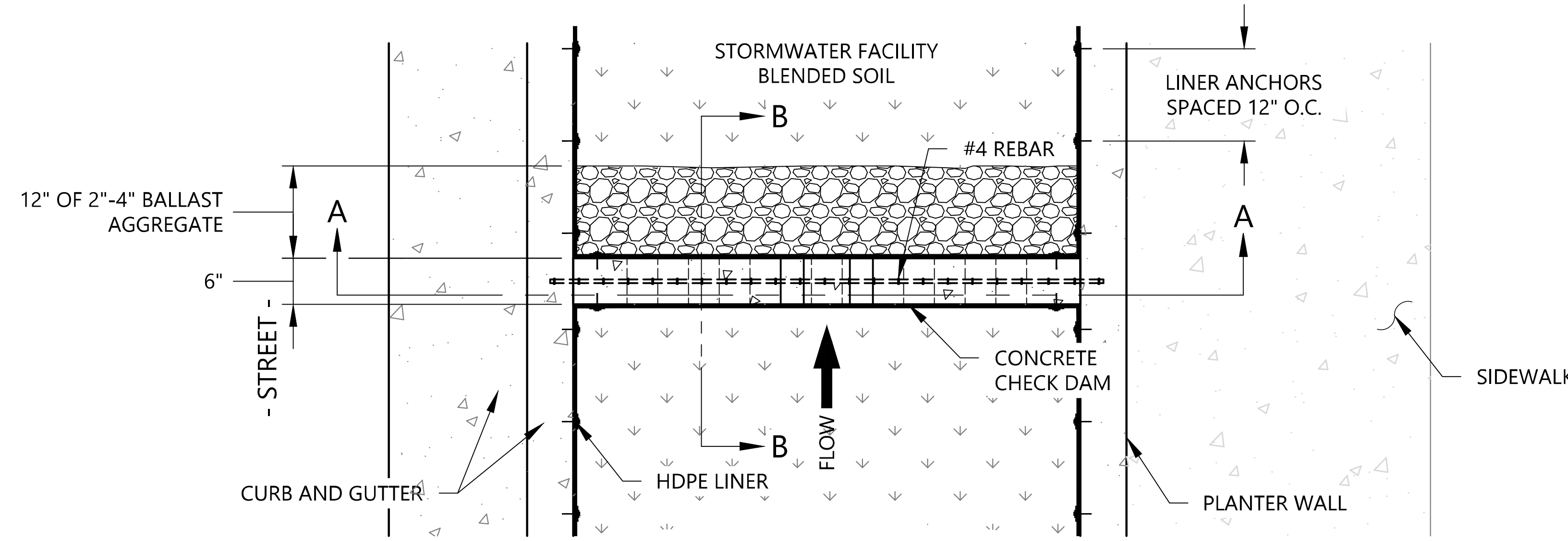
1. USE THIS DETAIL FOR FACILITIES WITH <2" PER HOUR NATIVE SOIL INFILTRATION RATES WITH AN UNDERDRAIN AT THE DOWNSTREAM END OF THE FACILITY.
2. CHECK DAM NOTCH (CDN) ELEVATION TO BE WHICHEVER IS LOWEST: EQUAL TO THE FLOW LINE ELEVATION AT THE UPSTREAM INLET OF THE FACILITY; 2" BELOW THE ELEVATION OF THE SIDEWALK ADJACENT TO THE CHECK DAM; OR 2" BELOW THE ELEVATION OF THE TOP-OF-CURB (TOC) ADJACENT TO THE. IF IT IS NOT THEN CONTACT INSPECTOR FOR DIRECTION.
3. ENSURE THAT THE CHECK DAM ELEVATIONS DO NOT CAUSE STORMWATER TO OVERFLOW TO SIDEWALK, OR BACKWATER INTO THE STREET.
4. A PARTIAL LINER MAY BE REQUIRED ON THE STREET SIDE OR SIDEWALK SIDE DEPENDING ON EXISTING CONDITIONS, REFER TO CONSTRUCTION DRAWINGS. ATTACH THE LINER PER CITY OF PORTLAND STANDARD DRAWING P-340.
5. CONSTRUCT 4" WEEP HOLES 8" ON CENTER WITH AT LEAST 4" BETWEEN OUTSIDE EDGE OF WEEP HOLES AND EDGE OF CHECKDAMS
6. WHERE FEASIBLE, LOCATE SIDEWALK DRAINAGE NOTCHES IMMEDIATELY DOWNSTREAM OF CONCRETE CHECK DAMS TO MINIMIZE DROP FROM SIDEWALK TO FACILITY SOIL.

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

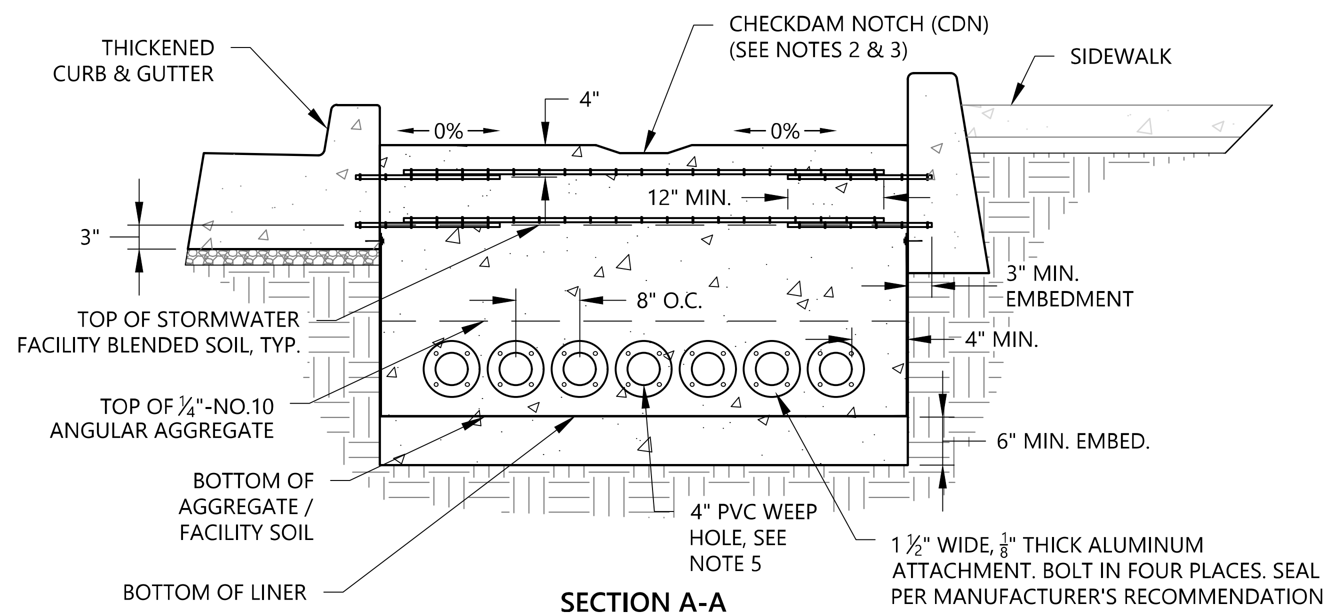
SWMM Detail Title

CHECK DAM
PARTIAL INFILTRATION FACILITY
WITH WEEP HOLES

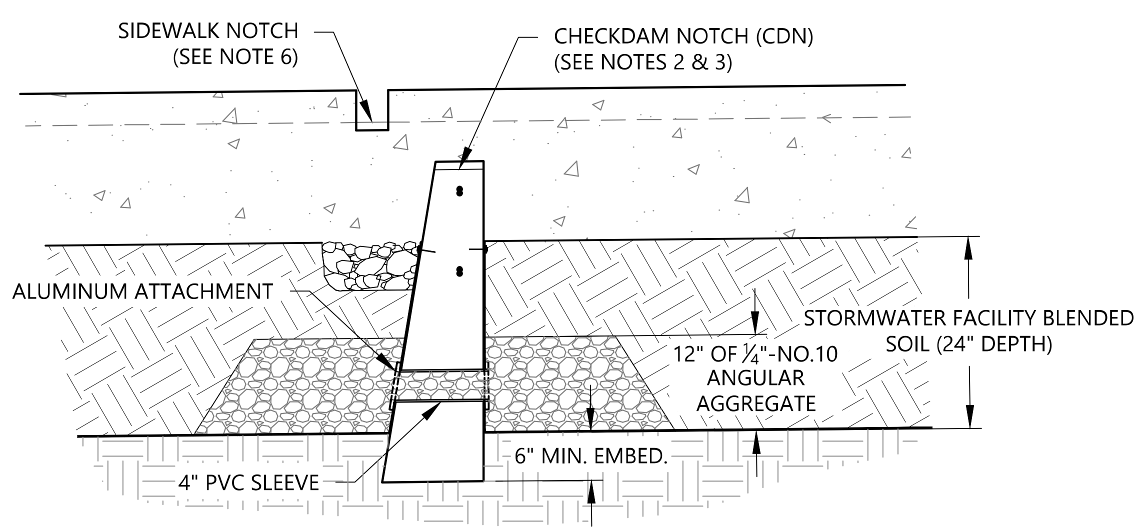
Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-314
Baseline Report Date: N/A	



PLAN



SECTION A-A



SECTION B-B
(SEE NOTE 1)

DESIGNER INFORMATION:

1. USE THIS DETAIL FOR FULLY LINED NON-INFILTRATING FACILITIES.
2. CHECK DAM NOTCH (CDN) ELEVATION TO BE WHICHEVER IS LOWEST: EQUAL TO THE FLOW LINE ELEVATION AT THE UPSTREAM INLET OF THE FACILITY; 2" BELOW THE ELEVATION OF THE SIDEWALK ADJACENT TO THE CHECK DAM; OR 2" BELOW THE ELEVATION OF THE TOP-OF-CURB (TOC) ADJACENT TO THE. IF IT IS NOT THEN CONTACT INSPECTOR FOR DIRECTION.
3. ENSURE THAT THE CHECK DAM ELEVATIONS DO NOT CAUSE STORMWATER TO OVERFLOW TO SIDEWALK, OR BACKWATER INTO THE STREET.
4. REFER TO CITY OF PORTLAND STANDARD DRAWING P-340 FOR LINER ATTACHMENT DETAILS.
5. CONSTRUCT 4" WEEP HOLES 8" ON CENTER WITH AT LEAST 4" BETWEEN OUTSIDE EDGE OF WEEP HOLES AND EDGE OF CHECK DAM.
6. WHERE FEASIBLE, LOCATE SIDEWALK DRAINAGE NOTCHES IMMEDIATELY DOWNSTREAM OF CONCRETE CHECK DAMS TO MINIMIZE DROP FROM SIDEWALK TO FACILITY SOIL.

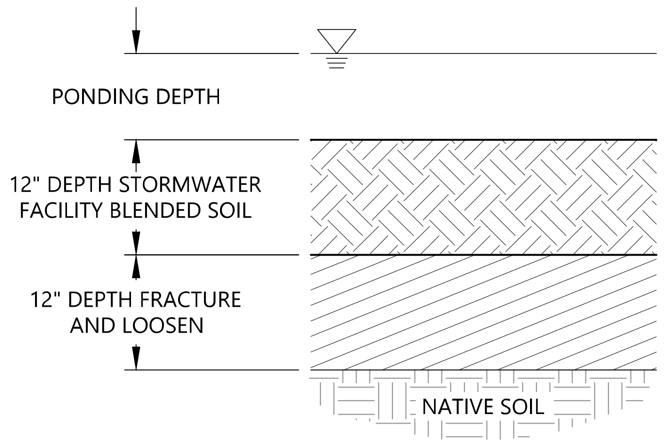
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

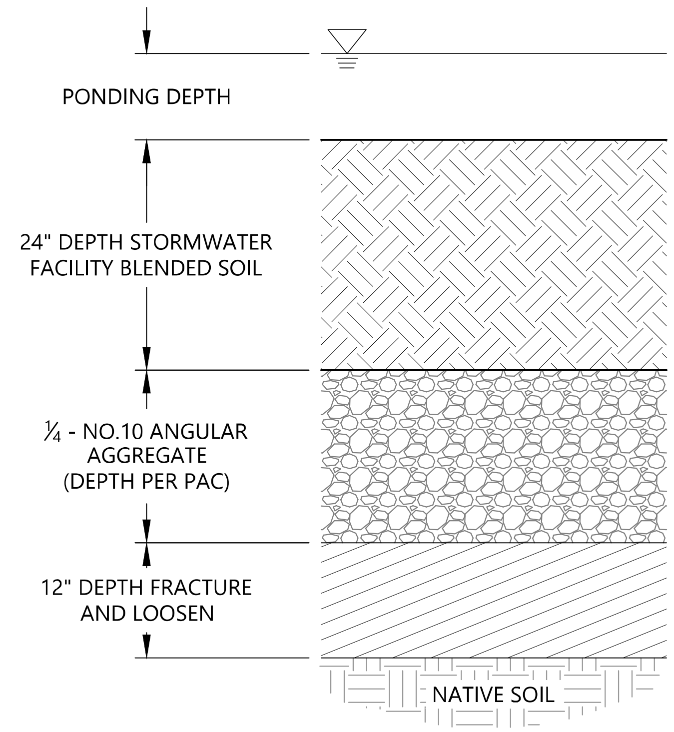
CHECK DAM
LINED FACILITY
WITH WEEP HOLES

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-315
Baseline Report Date: N/A	

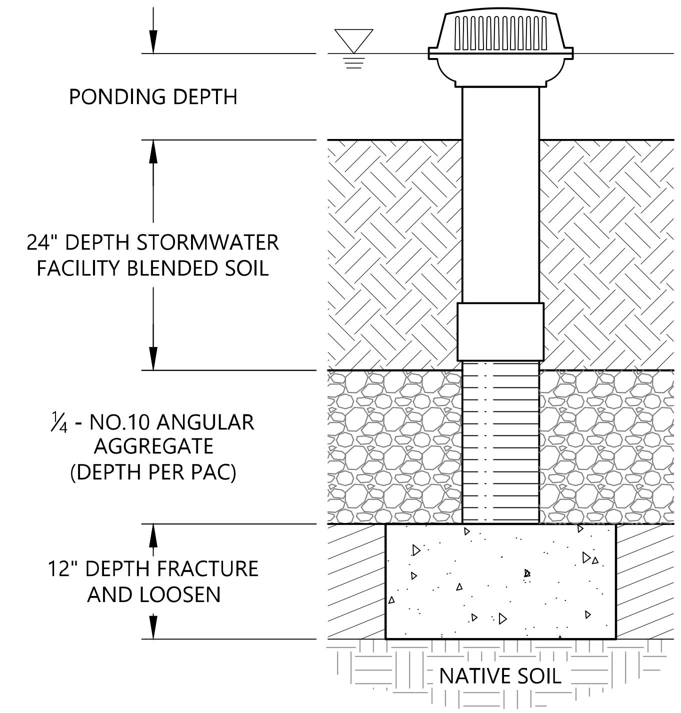
2020SWMM-DETAILS.DWG 12/9/20 11:20 AM SPEREZ



INFILTRATION



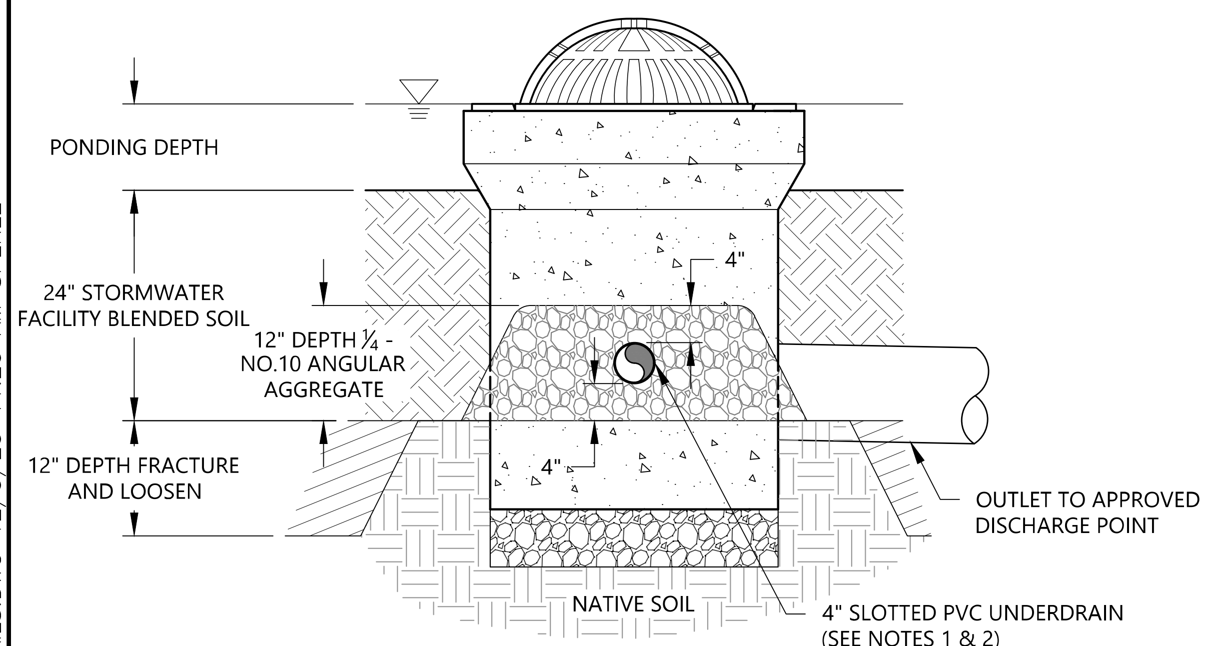
INFILTRATION WITH ROCK



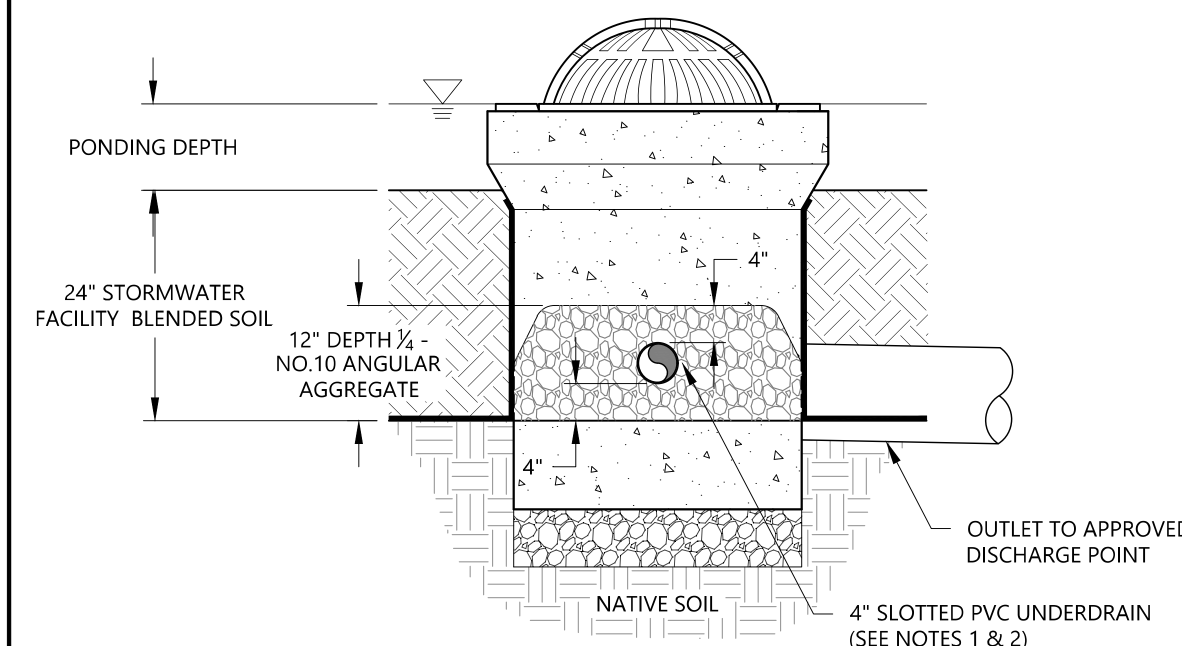
HYBRID
(OVERFLOW DIRECTED TO DRAIN ROCK)

DESIGNER INFORMATION:

1. SET THE 4-IN SLOTTED PVC UNDERDRAIN PIPE 4" ABOVE THE LINER OR THE BOTTOM OF EXCAVATION, AND COVER WITH 4" OF AGGREGATE.
2. RUN UNDERDRAIN PIPE A MAXIMUM OF ¼ THE LENGTH OF THE FACILITY.
3. SEE DETAILS SW-317/318 BEEHIVE OVERFLOW CONFIGURATION AND UNDERDRAIN WITH CLEANOUT FOR ADDITIONAL DESIGN GUIDANCE.
4. HYBRID FACILITIES MUST BE REGISTERED AS A UIC.



PARTIAL INFILTRATION
(OVERFLOW AND UNDER DRAIN REQUIRED)



LINED
(OVERFLOW AND UNDER DRAIN REQUIRED)

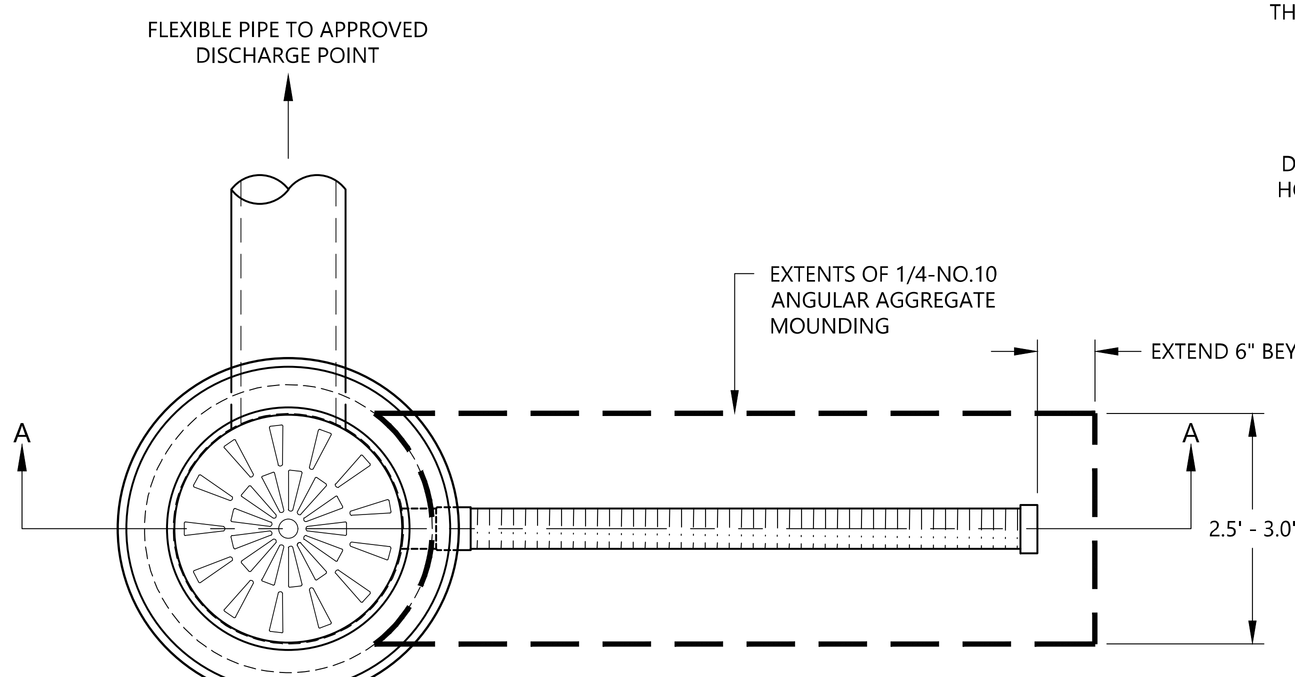
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

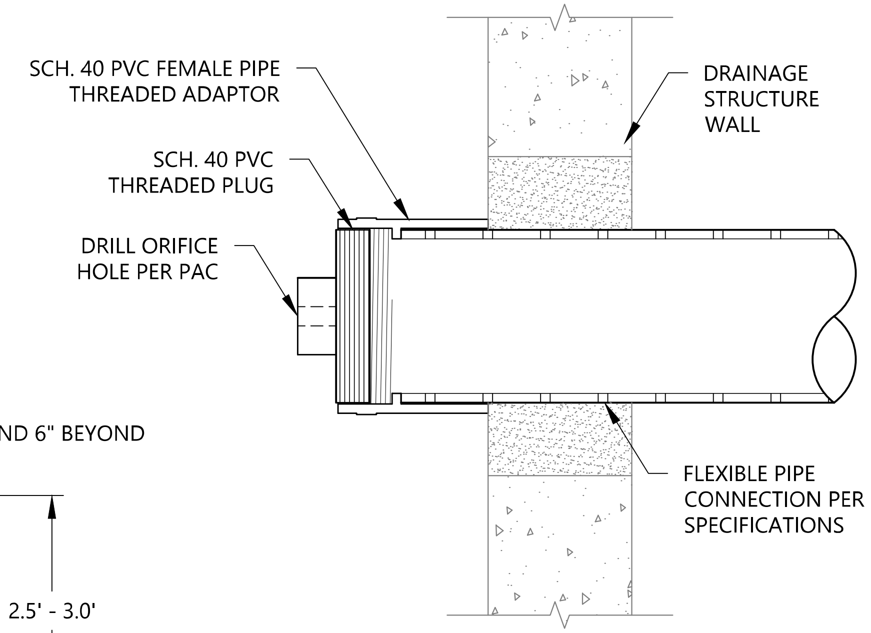
FACILITY CONFIGURATION SECTIONS

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-316
Baseline Report Date: N/A	

2020SWMM-DETAILS.DWG 12/9/20 11:20 AM SPEREZ



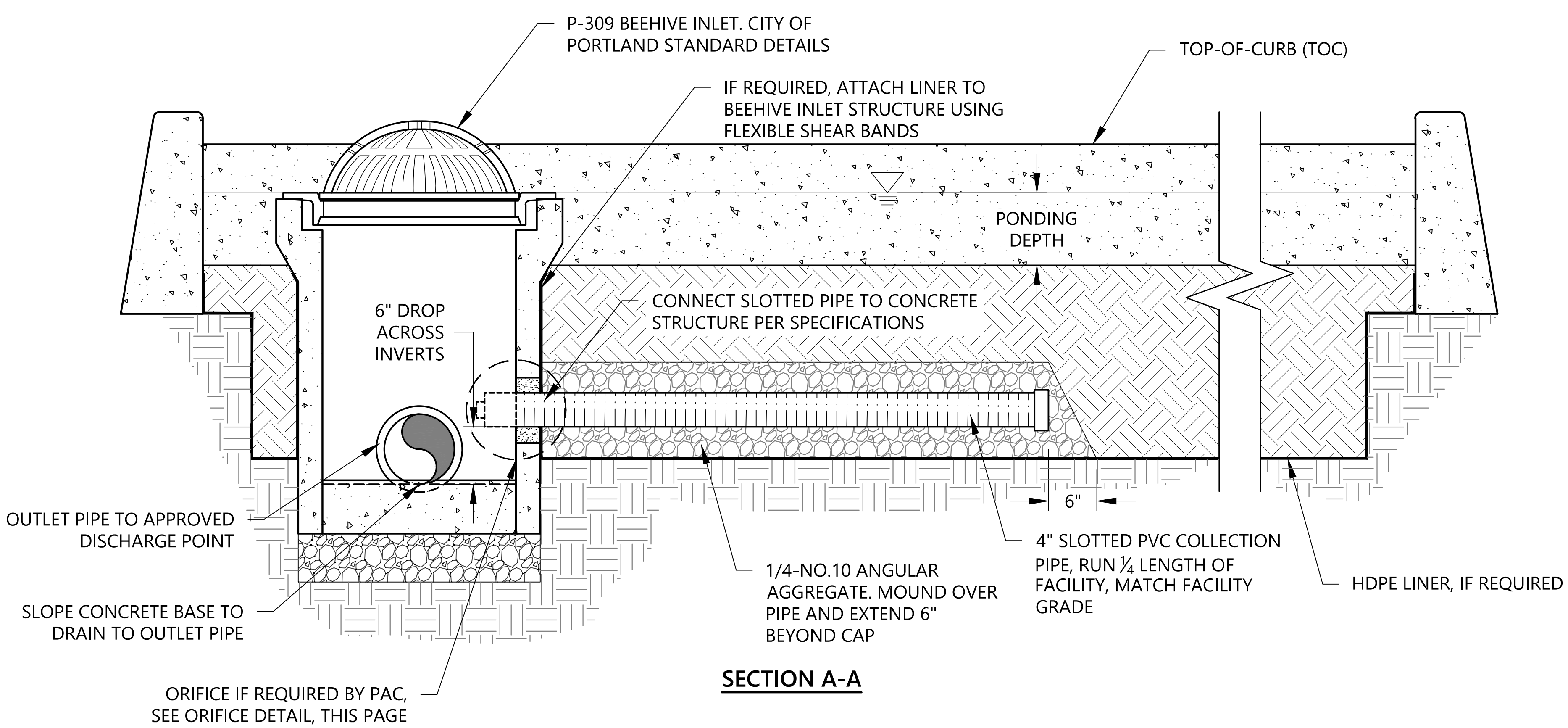
PLAN VIEW



ORIFICE DETAIL

DESIGNER INFORMATION:

1. EXAMPLE SHOWN IS FOR A LINED FACILITY. MODIFY DETAIL FOR UNLINED FACILITY.
2. IF CONNECTING TO A COMBINATION SEWER MAINTENANCE HOLE INSTALLTION OF A SWING-CHECK BACKWATER VALVE OR APPROVED EQUAL IS REQUIRED TO PREVENT ODOR EMISSIONS.
3. PRE-DRILL ORIFICE BEFORE INSTALLATION. SMOOTH AND/OR SAND ORIFICE REMOVING ROUGH EDGES. CLEAR PIPE OF ALL DEBRIS BEFORE INSTALLING ORIFICE CAP.



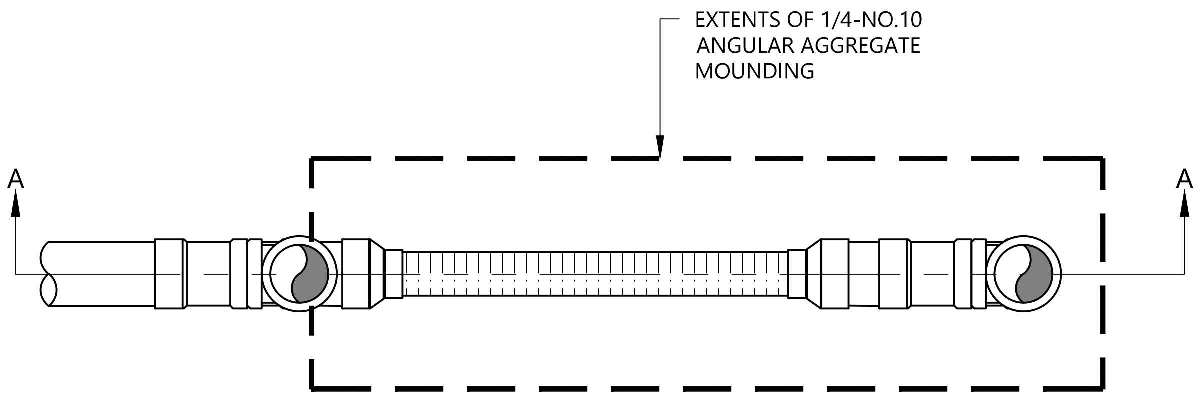
SECTION A-A

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

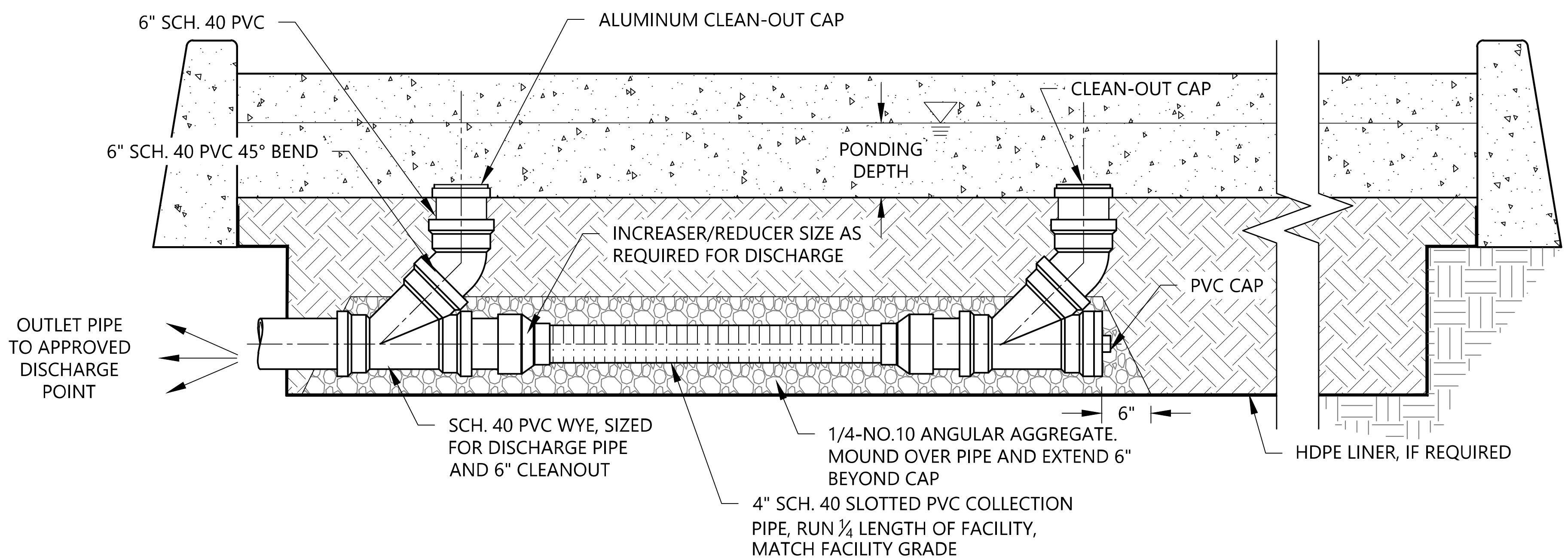
SWMM Detail Title

OVERFLOW CONFIGURATION
BEEHIVE OVERFLOW STRUCTURE

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-317
Baseline Report Date: N/A	



PLAN



SECTION A-A

DESIGNER INFORMATION:

1. EXAMPLE SHOWN IS FOR A LINED FACILITY. MODIFY DETAIL FOR UNLINED FACILITIES.

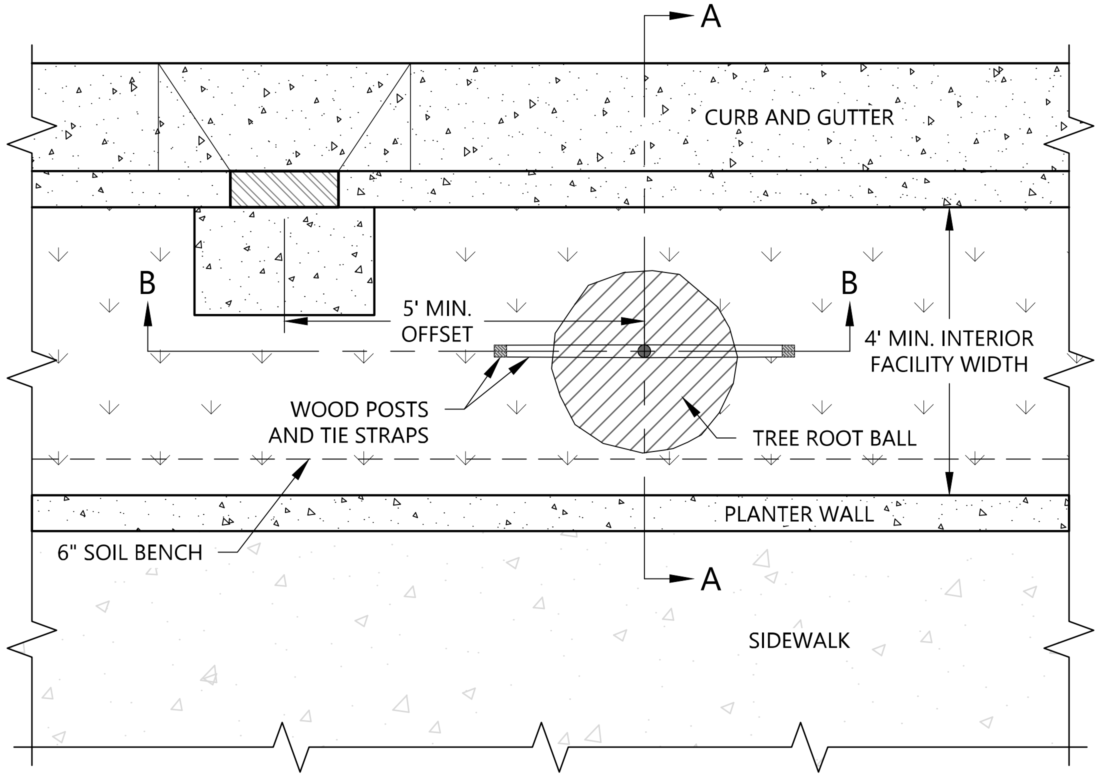
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER
MANAGEMENT MANUAL

SWMM Detail Title

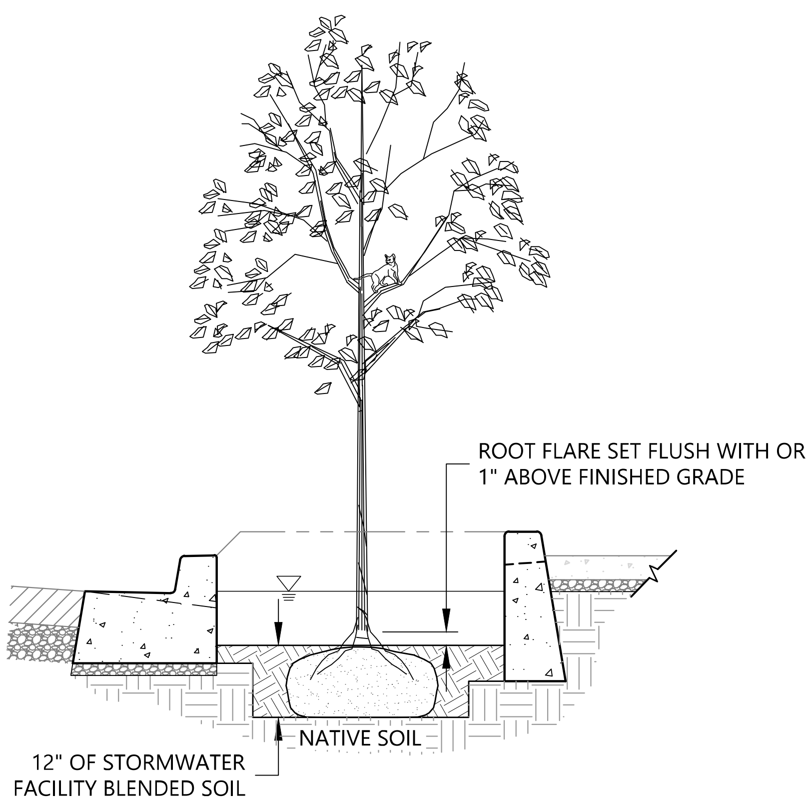
UNDERDRAIN WITH CLEANOUT

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-318
Baseline Report Date: N/A	

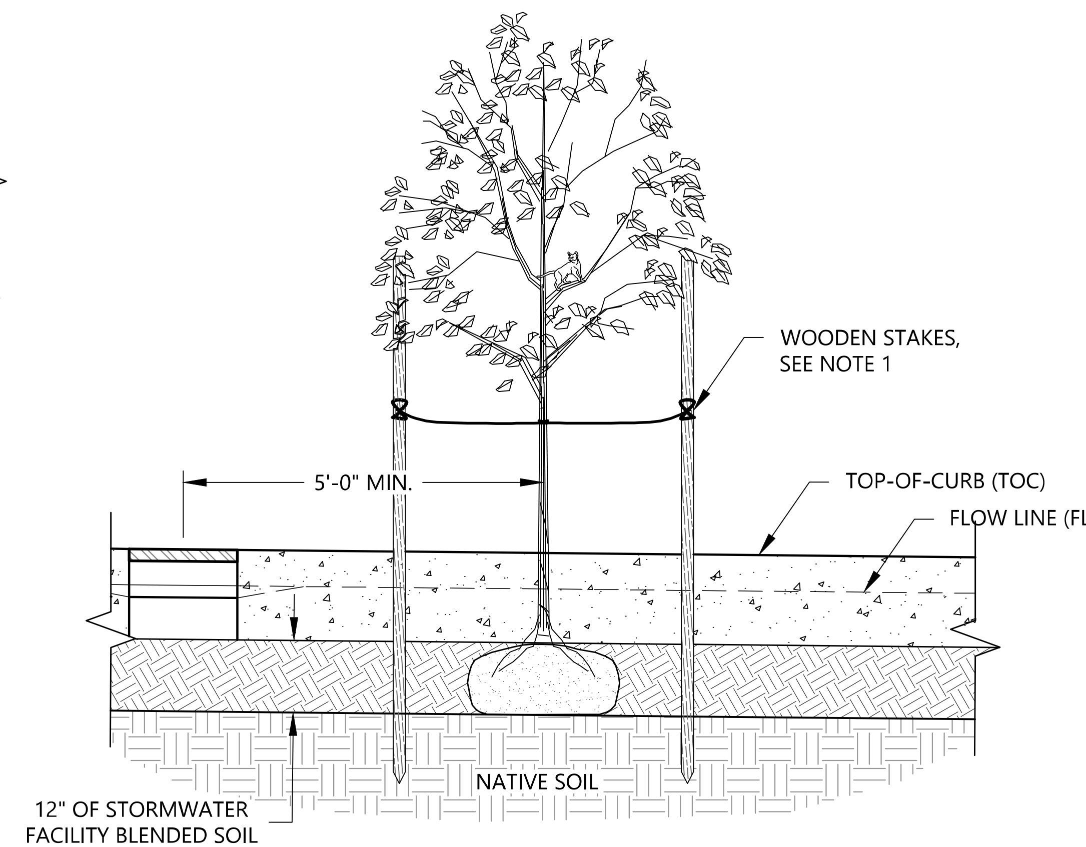
2020SWMM–DETAILS.DWG 12/9/20 11:20 AM SPEREZ



PLAN VIEW



SECTION A-A
(STREET TREE IN FACILITY WITHOUT ROCK GALLERY)



LONGITUDINAL SECTION B-B
(STREET TREE IN FACILITY WITHOUT ROCK GALLERY)

DESIGNER INFORMATION:

1. REFER TO CITY OF PORTLAND STANDARD DRAWING P-581: TYPICAL STREET TREE INSTALLATION, FOR TREE INSTALLATION GUIDANCE.
2. STORMWATER FACILITY CONSTRUCTION AND BLENDED SOIL REQUIREMENTS, SEE CITY OF PORTLAND STANDARD CONSTRUCTION SPECIFICATIONS SECTIONS 00415 AND 01040.14(D).
3. ALL PROPOSED TREE SPECIES AND LOCATION MUST BE APPROVED BY URBAN FORESTRY TITLE 11 PERMIT (503-823-8733) AND BES.
4. INCLUDE STREET TREES ON PLANS.
5. SHOW LINER IF USED.
6. OFFSET TREE TRUNK A MINIMUM OF 5' FROM INLETS.
7. IT IS PROHIBITED TO INCLUDE AN EXISTING TREE WITHIN THE BOUNDARY OF A NEW STORMWATER FACILITY.
8. STREET TREE PLANTING MUST ADHERE TO THE CITY OF PORTLAND STREET TREE PLANTING STANDARDS.
9. A 6' LONG 12" DEEP 80 MIL HDPE ROOT BARRIER MAY BE REQUIRED IN THE ABSENCE OF A PLANTER WALL, AS DIRECTED BY URBAN FORESTRY

CONSTRUCTION NOTES:

1. CONTACT URBAN FORESTRY FOR TREE PERMITTING AT (503) 823-8733.
2. CONTACT BES FOR TREE INSTALLATION ASSISTANCE.
3. SET ROOT FLARE FLUSH WITH OR 1" ABOVE FINISHED GRADE.
4. REMOVE ALL TWINE, WIRE, ROOT BAGS, BURLAP, AND ALL OTHER NURSERY MATERIALS FROM TREE PRIOR TO BACKFILLING.
5. DEPTH OF EXCAVATION FOR TREE WILL DEPEND ON SIZE OF ROOT BALL.
6. IN FACILITIES THAT ARE UNLINED, FRACTURE AND LOOSEN SOIL BEFORE INSTALLING BLENDED SOIL

IMPORTANT: Location of trees must meet clearance requirements established by the City of Portland. Utility conflicts and existing conditions can affect 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) 823-8733

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

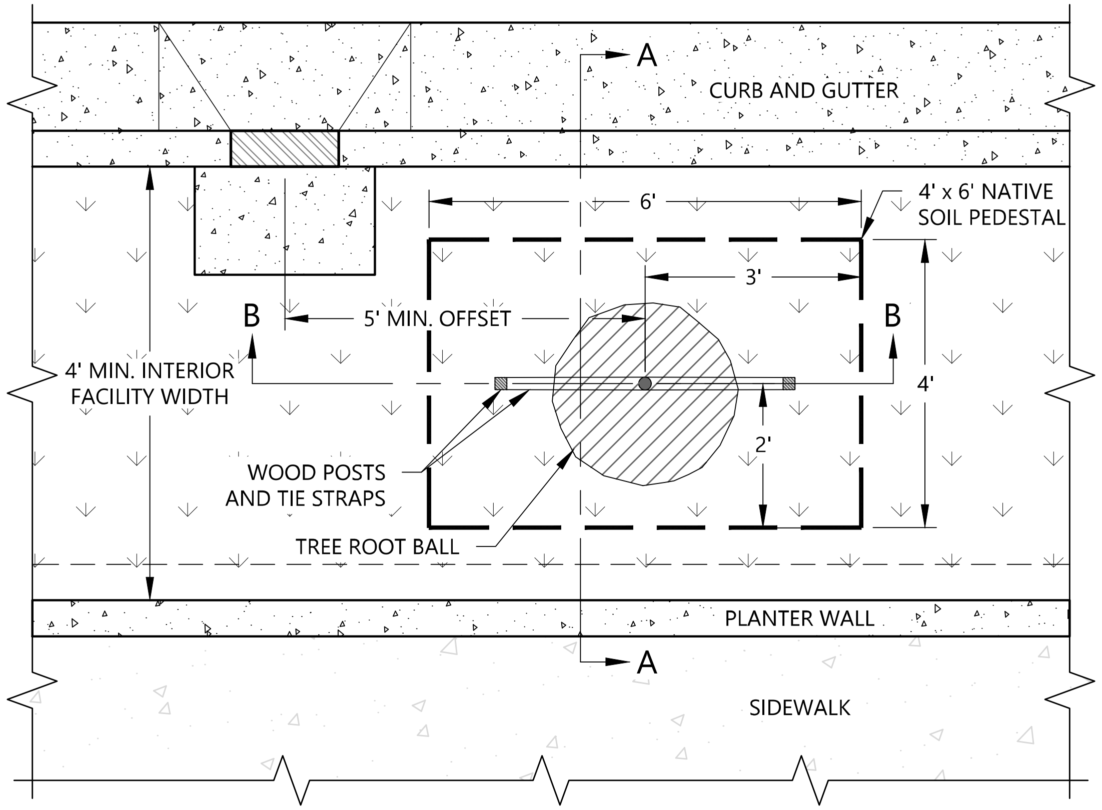
SWMM Detail Title

STREET TREES IN FACILITY
NO ROCK GALLERY

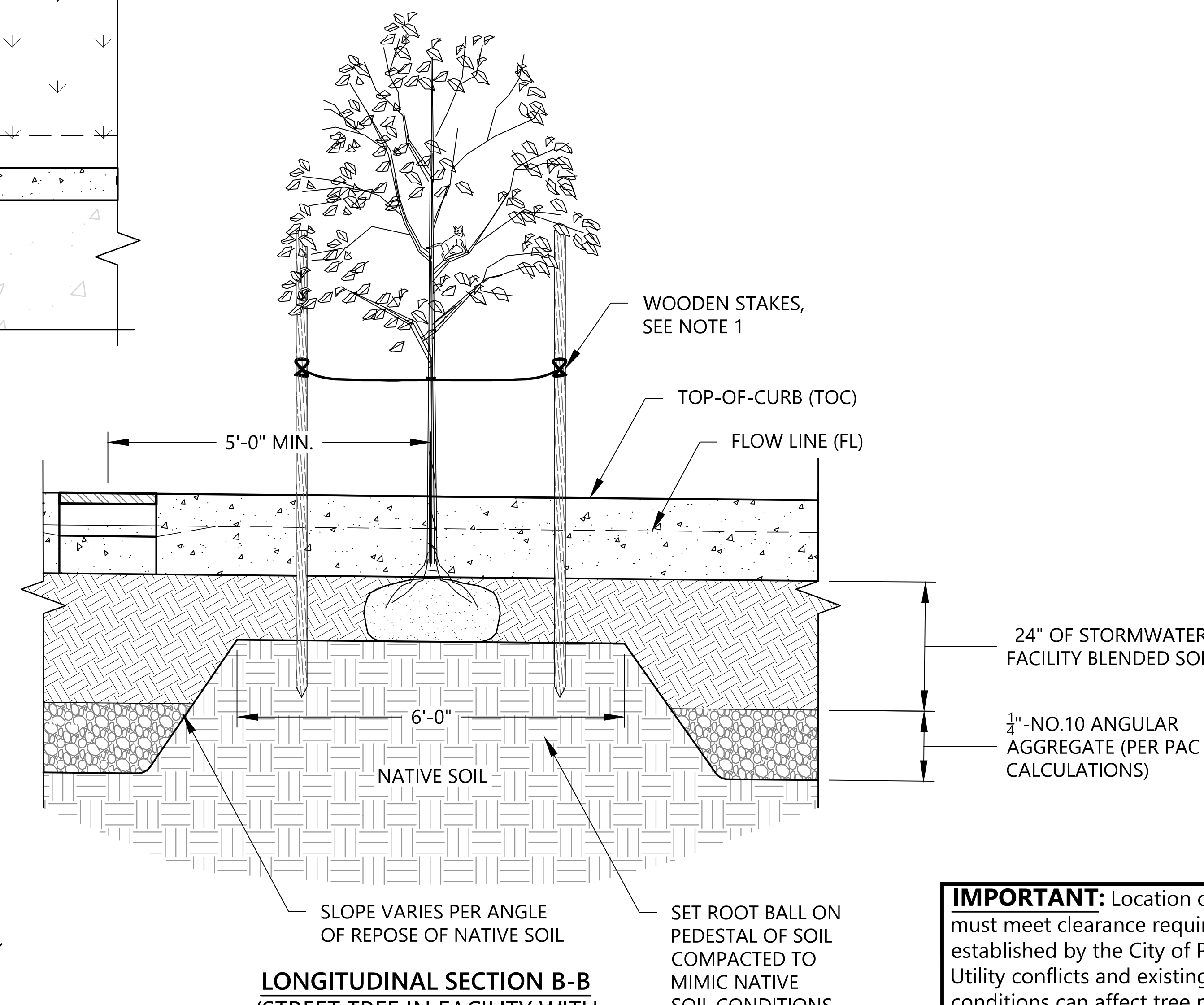
Effective Date: 12-14-2020
Calc. Book No.: N/A
Baseline Report Date: N/A

SWMM Detail No.
SW-320

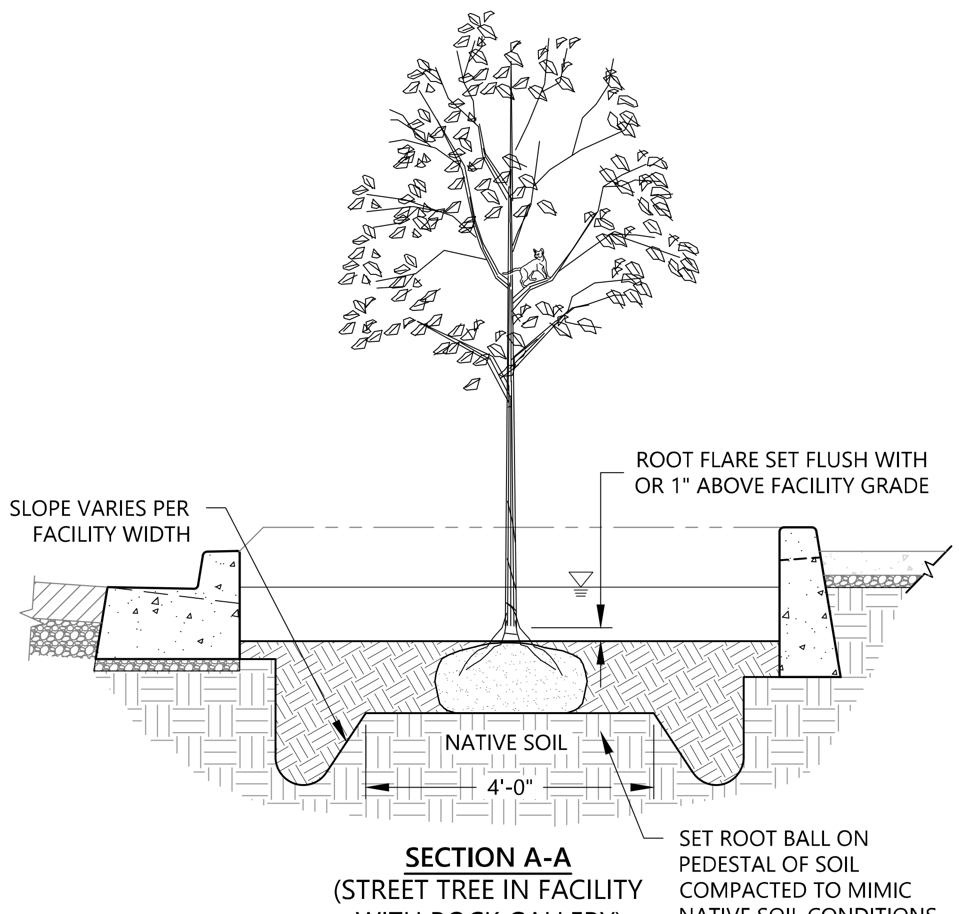
2020SWMM–DETAILS.DWG 12/9/20 11:20 AM SPEREZ



PLAN VIEW



LONGITUDINAL SECTION B-B
(STREET TREE IN FACILITY WITH
ROCK GALLERY)



SECTION A-A
(STREET TREE IN FACILITY
WITH ROCK GALLERY)

DESIGNER INFORMATION:

1. REFER TO CITY OF PORTLAND STANDARD DRAWING P-581: TYPICAL STREET TREE INSTALLATION, FOR TREE INSTALLATION GUIDANCE.
2. STORMWATER FACILITY CONSTRUCTION AND BLENDED SOIL REQUIREMENTS, SEE CITY OF PORTLAND STANDARD CONSTRUCTION SPECIFICATIONS SECTIONS 00415 AND 01040.14(D).
3. ALL PROPOSED TREE SPECIES AND LOCATIONS MUST BE APPROVED BY URBAN FORESTRY TITLE 11 PERMIT (503-823-8733), AND BES.
4. INCLUDE TREE PEDESTAL AND STREET TREE VIEWS ON PLANS.
5. SHOW LINER IF USED.
6. OFFSET TREE TRUNK A MINIMUM OF 5' FROM INLETS.
7. IT IS PROHIBITED TO INCLUDE AN EXISTING TREE WITHIN THE BOUNDARY OF A NEW STORMWATER FACILITY.
8. STREET TREE PLANTING MUST ADHERE TO CITY OF PORTLAND STREET TREE PLANTING STANDARDS.
9. A 6' LONG 12" DEEP 80 MIL HDPE ROOT BARRIER MAY BE REQUIRED IN THE ABSENCE OF A PLANTER WALL, AS DIRECTED BY URBAN FORESTRY.

CONSTRUCTION NOTES:

1. CONTACT URBAN FORESTRY FOR TREE PERMITTING AT (503) 823-8733.
2. CONTACT BES FOR TREE INSTALLATION ASSISTANCE.
3. STAKE, OR MARK CENTER OF PEDESTAL FOR FUTURE PLANTING.
4. SET ROOT BALL ON "PEDESTAL " OF MOUNDED COMPACTED NATIVE SOIL AS NEEDED TO ACCOMMODATE ROOT BALL AND PER STANDARD DRAWING P-581.
5. SET ROOT FLARE FLUSH WITH OR 1" ABOVE FINISHED GRADE.
6. REMOVE ALL TWINE, WIRE, ROOT BAGS, BURLAP, AND ALL OTHER NURSERY MATERIALS FROM TREE PRIOR TO BACKFILLING.
7. DEPTH OF EXCAVATION FOR TREE WILL DEPEND ON SIZE OF ROOT BALL.
8. IN FACILITIES THAT ARE UNLINED, FRACTURE AND LOOSEN SOIL BEFORE INSTALLING AGGREGATES OR BLENDED SOIL.

IMPORTANT: Location of trees must meet clearance requirements established by the City of Portland. Utility conflicts and existing conditions can affect 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) 823-8733

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER
MANAGEMENT MANUAL

SWMM Detail Title

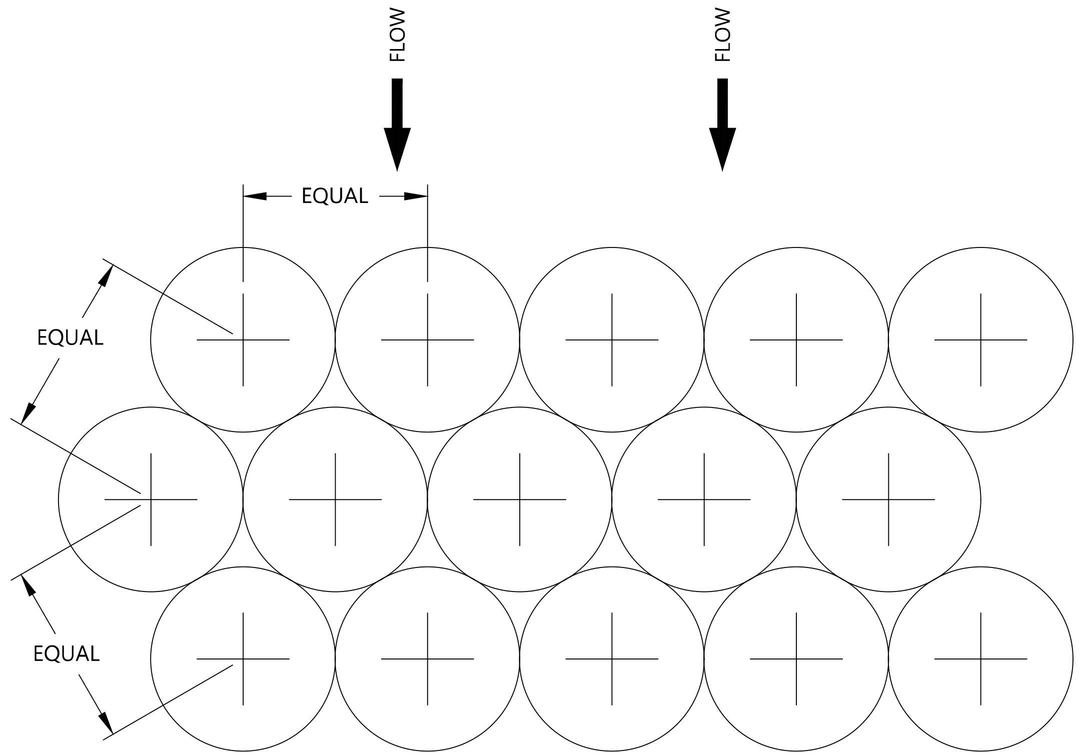
STREET TREES IN FACILITY
WITH ROCK GALLERY

Effective Date: 12-14-2020
Calc. Book No.: N/A
Baseline Report Date: N/A

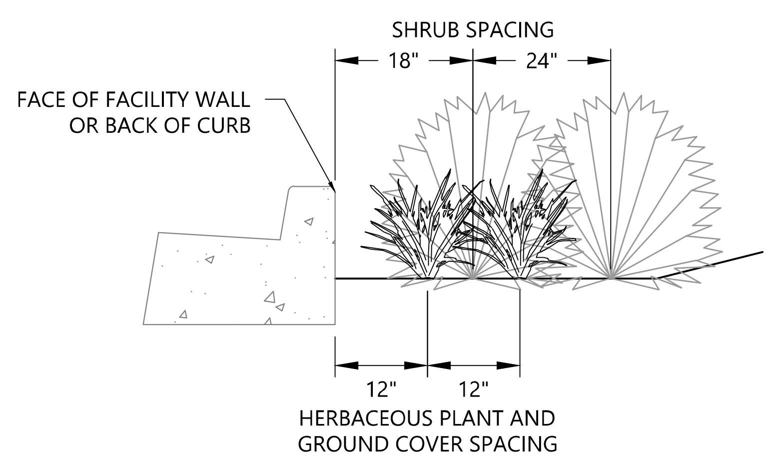
SWMM Detail No.
SW-321

DESIGNER INFORMATION:

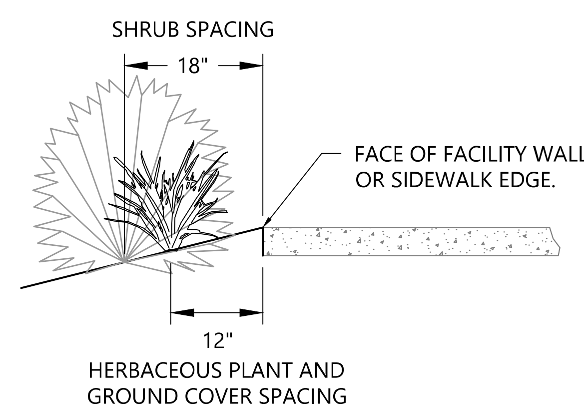
1. ALL PLANTS SHALL BE PLANTED AT EQUAL TRIANGULAR SPACING ON CENTER (O.C.) PER SPACING SPECIFIED ON THE PLANTING LEGEND.
2. PLANTS SHALL BE LOCATED SET BACK FROM FACILITY EDGES AS FOLLOWS:
   - 2.1. HERBACEOUS PLANTS AND GROUNDCOVERS: 12" FROM CENTER OF PLANT TO FACE OF FACILITY WALL, BACK OF CURB OR SIDEWALK EDGE.
   - 2.2. SHRUBS: 18" FROM CENTER OF PLANT TO FACE OF FACILITY WALL, BACK OF CURB OR SIDEWALK EDGE.
3. INTERIOR PLANT SPACING MAY BE SLIGHTLY ADJUSTED TO ACHIEVE DESIRED EDGE SETBACKS.



PLAN VIEW



STREET SIDE OF FACILITY ELEVATION VIEW



SIDEWALK SIDE OF FACILITY ELEVATION VIEW

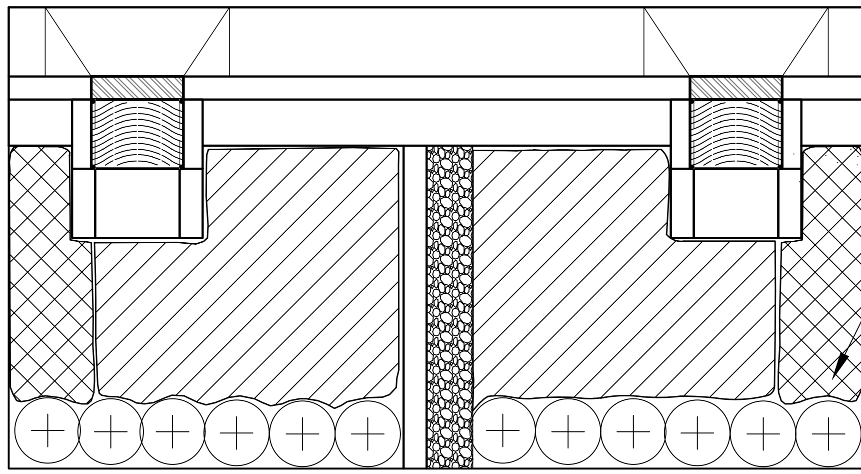
Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

PLANT SPACING FOR HERBACEOUS PLANTS GROUNDCOVERS AND SHRUBS

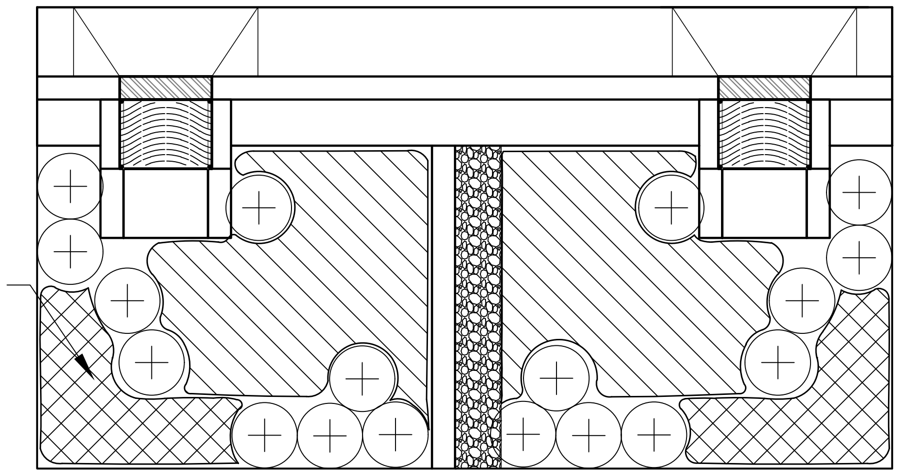
Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-322
Baseline Report Date: N/A	

TEMPLATE 1



QTY KEY

TEMPLATE 2



DESIGNER INFORMATION:

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 ON-CENTER SPACING REQUIREMENTS ARE FOUND IN SECTION 4.2.2
3. PLANTING LEGEND REQUIRED. STATE PLANT SPECIES, SPACING, AND QUANTITIES PER ZONE A AND ZONE B AND PER FACILITY. INCLUDE THE SQUARE FOOTAGE OF ZONE A AND B.
4. PLANTING PLANS SHALL INCLUDE LABELS FOR EACH PLANT GROUP IDENTIFYING THE PLANT SPECIES AND QUANTITY IN THE GROUP.
5. SEE DETAIL SW-322 FOR PLANT SPACING.
6. SEE SECTION 4.9.5, LANSCAPE PLAN REQUIREMENTS, FOR SUBMITTAL REQUIREMENTS.

KEY 1 Recommended Plants

Symbol	*Botanical Name* Common Name	Spacing
ZONE A		
	Carex obnupta Slough Sedge	12" O.C.
	Juncus patens Spreading rush	12" O.C.
ZONE B		
	Mahonia repens Creeping oregon grape	24" O.C.
	Spiraea x bumalda 'Goldflame' Goldflame spirea	24" O.C.
	Rubus calycinoides Creeping raspberry	12" O.C.

KEY 2 Recommended Plants

Symbol	*Botanical Name* Common Name	Spacing
ZONE A		
	Carex obnupta Slough Sedge	12" O.C.
	Juncus patens Spreading rush	12" O.C.
ZONE B		
	Cornus sericea 'Kelseyi' Dwarf Red-Twig Dogwood	24" O.C. OR AS SHOWN
	Spiraea x bumalda 'Goldmound' Goldmound spirea	24" O.C. OR AS SHOWN
	Fragaria chiloensis Coastal Strawberry	12" O.C.

SAMPLE PLANTING LEGEND

				SQ. FOOT AREA - ZONE A	X	
				SQ. FOOT AREA - ZONE B	X	
SYMBOL	BOTANIC NAME	COMMON NAME	SIZE (IN)	SPACING (IN)	QTY. ZONE A	QTY. ZONE B
	Xxxxx xxxxx	xxxxx	X	X	X	X
	Xxxxx xxxxx	xxxxx	X	X	X	X

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

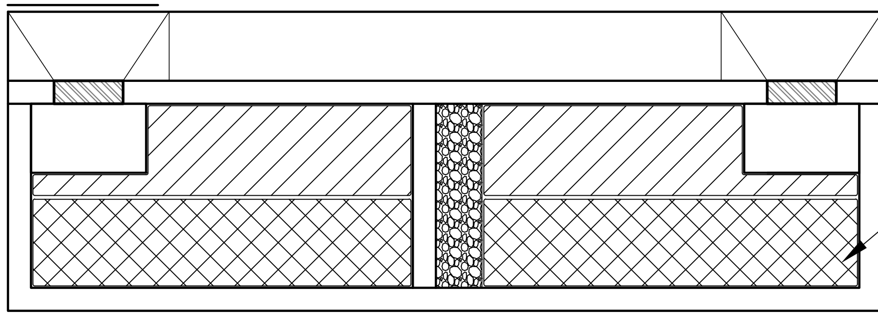
SWMM Detail Title

PLANTING TEMPLATE - SWALE

Effective Date: 12-14-2020	SWMM Detail No.
Calc. Book No.: N/A	SW-323
Baseline Report Date: N/A	

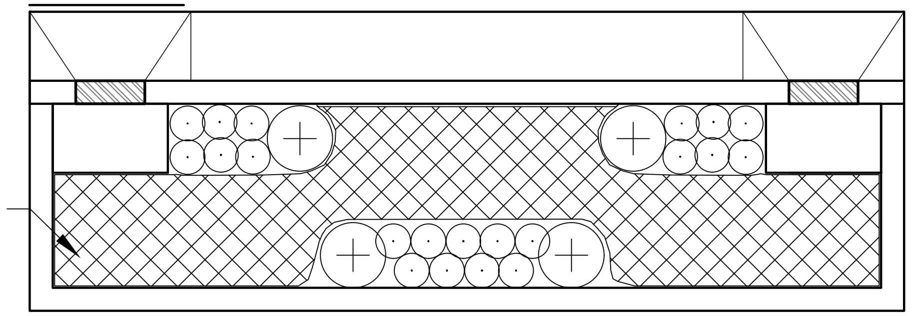
2020SWMM-DETAILS.DWG 12/9/20 11:20 AM SPEREZ

TEMPLATE 1



QTY KEY

TEMPLATE 2



DESIGNER INFORMATION:

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4. PLANTING PLANS SHALL INCLUDE LABELS FOR EACH PLANT GROUP IDENTIFYING THE PLANT SPECIES AND QUANTITY IN THE GROUP.
5. SEE DETAIL SW-322 FOR PLANT SPACING.
6. SEE SECTION 4.9.5, LANSCAPE PLAN REQUIREMENTS, FOR SUBMITTAL REQUIREMENTS.

KEY 1 Recommended Plants

Symbol	*Botanical Name* Common Name	Spacing
ZONE A		
	Juncus patens Spreading rush	12" O.C.
	Carex obnupta Slough sedge	12" O.C.

KEY 2 Recommended Plants

Symbol	*Botanical Name* Common Name	Spacing
ZONE A		
	Carex obnupta Slough sedge	12" O.C.
	Liriope muscari "Big Blue" Big blue lily turf	12" O.C.
	Cornus sericea 'Kelseyi' Kelsey dogwood	24" O.C. OR AS SHOWN

SAMPLE PLANTING LEGEND

				SQ. FOOT AREA - ZONE A	X
SYMBOL	BOTANIC NAME	COMMON NAME	SIZE (IN)	SPACING (IN)	QTY. ZONE A
	Xxxxx xxxxx	xxxxx	X	X	X
	Xxxxx xxxxx	xxxxx	X	X	X

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

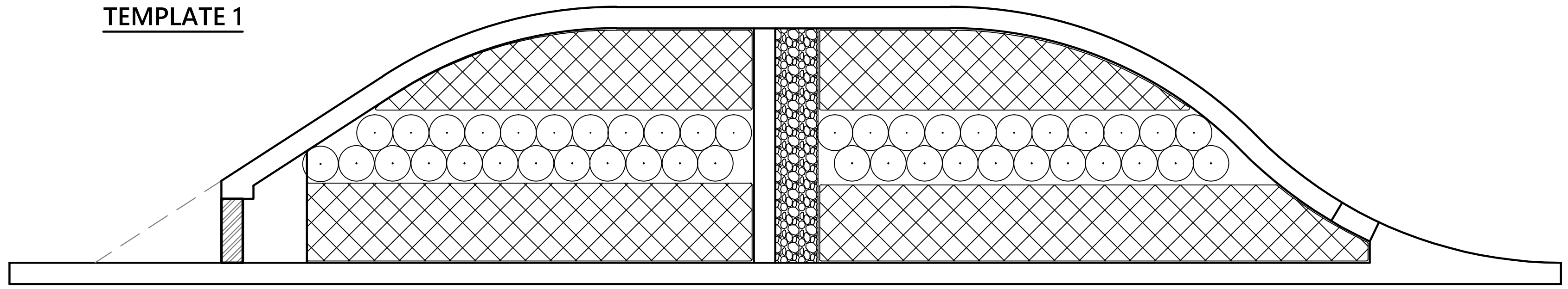
PLANTING TEMPLATE - PLANTER

Effective Date: 12-14-2020
Calc. Book No.: N/A
Baseline Report Date: N/A

SWMM Detail No.
SW-324

2020SWMM-DETAILS.DWG 12/9/20 11:20 AM SPEREZ

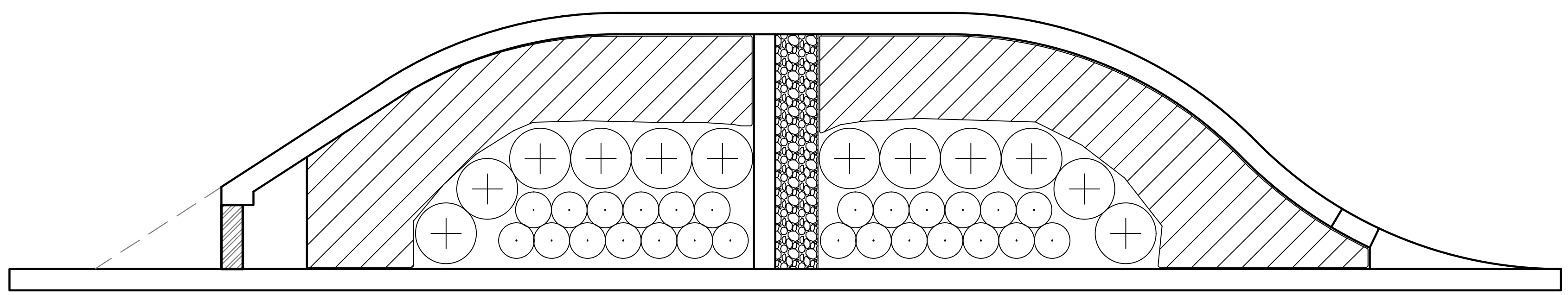
TEMPLATE 1



KEY 1 Recommended Plants

Symbol	*Botanical Name* Common Name	Spacing
ZONE A		
	Carex obnupta Slough sedge	12" O.C.
	Juncus patens Spreading rush	12" O.C.

TEMPLATE 2



KEY 2 Recommended Plants

Symbol	*Botanical Name* *Common Name*	Spacing
ZONE A		
	Juncus patens Spreading Rush	12" O.C.
	Carex morrowii 'Ice Dance' Ice Dance Sedge	12" O.C.
	Spiraea x bumalda 'Goldflame' Goldflame spirea	24" O.C.

SAMPLE PLANTING LEGEND

				SQ. FOOT AREA - ZONE A	X
SYMBOL	BOTANIC NAME	COMMON NAME	SIZE (IN)	SPACING (IN)	QTY. ZONE A
	Xxxxx xxxxx	xxxxx	X	X	X
	Xxxxx xxxxx	xxxxx	X	X	X

DESIGNER INFORMATION:

1. CHOOSE A TEMPLATE AND ALTER IT TO DESIGN. THESE ARE EXAMPLES OF APPROVED PLANTING TEMPLATES. OTHER PLANTING PLANS MAY BE APPROVED.
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4. PLANTING PLANS SHALL INCLUDE LABELS FOR EACH PLANT GROUP IDENTIFYING THE PLANT SPECIES AND QUANTITY IN THE GROUP.
5. SEE DETAIL SW-322 FOR PLANT SPACING.
6. SEE SECTION 4.9.5, LANSCAPE PLAN REQUIREMENTS, FOR SUBMITTALL REQUIREMENTS.

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

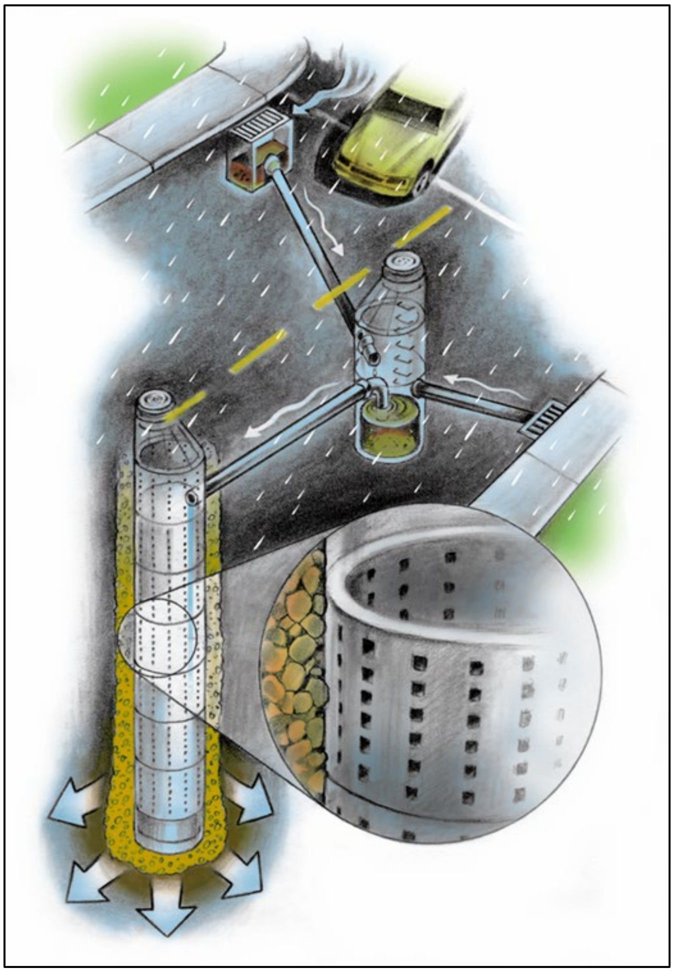
PLANTING TEMPLATE
CURB EXTENSION

Effective Date: 12-14-2020
Calc. Book No.: N/A
Baseline Report Date: N/A

SWMM Detail No.
SW-325

2020SWMM-DETAILS.DWG 12/9/20 11:20 AM SPEREZ

4.2.2. **Sumps**



A sump allows stormwater runoff to infiltrate into the ground through underground rings.

Public sump systems can be used to manage drainage from public streets by collecting stormwater runoff and infiltrating it into the ground. A sump system is the total of all sump components at a single location and consists of inlets, piping, a sedimentation maintenance hole, and a sump.

Sumps are Class V Injection Wells under the federal Underground Injection Control (UIC) Program regulated by DEQ to protect groundwater. DEQ has issued a Water Pollution Control Facility (WPCF) permit to the City to construct and operate public UICs. 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. The registration and permitting process for proposed City-owned UICs is managed by BES under the City's WPCF permit, which is different from rule authorization or permitting of private UICs. See Chapter 1 for more information.

ROW: The City of Portland manages the registration and permitting of City-owned UICs proposed for construction, redevelopment, or decommissioning. To ensure a timely review, public works permit applicants should notify the City immediately if UICs are being considered for infiltration of runoff from the public ROW. The City will complete the review in accordance with WPCF permit requirements. The City will provide a notice to proceed when it determines the proposed UIC meets permit requirements.

City-owned Property Outside of the ROW: Any UIC managing stormwater runoff from a City-owned or managed property outside of the public ROW (e.g., roofs, parking lots) must be registered and permitted by the City and processed in accordance with the City's WPCF permit. The design requirements for these facilities are in Section 3.2.4.

Private Street: A UIC on a private street is not registered and permitted by the City. Applicants must apply directly to DEQ for rule authorization or a permit. The design requirements for these facilities are in Chapter 3.

4.2.2.1. Design Requirements

Sumps must be designed using the Performance Approach.

Site Suitability

The City evaluates potential sump locations using a broad range of criteria including depth to groundwater, proximity to contamination, and protection of water supplies. Additional requirements may apply within the Columbia South Shore Wellhead Protection Area (see Section 1.11.6). A sump location may be rejected due to site-specific conditions.

Soil Suitability

The use of sumps depends on soil type and depth to seasonal groundwater. BES will not approve sumps without supporting geotechnical documentation concerning local soil conditions, the infiltration capacity of surrounding soils, and performance data from any nearby test sumps. The bottom of the sump must be at least 5 ft above the seasonal high-water table.

Setbacks

See Section 2.2.4 for more information about setbacks.

Pretreatment
When constructed according to standard design procedures, the sump system achieves pollution reduction benefits needed for the UIC. Sedimentation maintenance holes reduce pollution by settling out most large particulate material (e.g., sediment) that can clog sump drainage holes and by holding floatables at the surface with a downturned elbow. This pretreatment decreases maintenance needs and increases long-term effectiveness.

Sizing
Public sump systems must be designed to handle twice the peak flow of the 10-year design storm (i.e., twice 2.86 inches/hour for a 5-minute time of concentration). See Sewer and Drainage and Facility Design Manual for rainfall intensity charts.

- Hydraulic calculations for public sumps must be performed using the Rational Method. Information on the Rational Method is located in the City's Sewer and Drainage Facilities Design Manual. Use a 5-minute time of concentration.
- Design sumps to manage the full contributing area, not just the new impervious surface area.
- A maximum of two sumps can be used in series, unless approved by BES.

Stormwater runoff from new impervious surfaces can be added to an existing sump if it has capacity and it complies with the City's WPCF permit. BES may require a project to bring an existing sump up to current designs standards if new area is added.

Dimensions
- The minimum distance between sumps is 25 ft.
- The recommended distance between the sump and sedimentation maintenance hole is 25 ft. This distance is a guideline only and depends on site conditions.
- The maximum sump depth is 30 ft, unless otherwise approved by BES. BES will consider shallower sumps on a case-by-case basis
- The minimum sedimentation maintenance hole depth is 10 ft.

Other configurations, including horizontal infiltration pipes, may be used with BES approval.

Piping
The diameter of pipe between the sump and sedimentation maintenance hole must be 12 inches. See the City of Portland Sewer and Drainage Facilities Design Manual for acceptable pipe materials.

Public Sump System Testing

Unless exempted by the City, all public sumps must be tested after construction to ensure they meet or exceed the design capacity. The City will require the professional engineer, registered geologist or certified engineering geologist to supply a Sump Data Table (Table 4-6) to document whether the sump is performing as designed or if an additional sump may be required. BES Standard Notes are required on the plan set.

Table 4-6. Sump Data Table

Sump Number	Sheet No.	DEQ ID	UIC Registration ID	Minimum Percolation Rate Required (gpm)	Hydrant Location for Sump Testing	Hydrant Capacity	Testing Flow Rate (gpm)	ROW Drainage Area (sf)

4.2.2.2. Details:

See City of Portland Standard Drawings and Details

P-160: Precast Sump

P-161: Sedimentation Maintenance Hole with Hood

P-162: Sedimentation Maintenance Hole with Baffle

4.2.3. Manufactured Stormwater Treatment Technologies (MSTT)

Manufactured Stormwater Treatment Technologies (MSTTs) are manufactured devices designed to treat stormwater. BES has approved a number of MSTTs for use in the City of Portland based on their compliance with BES' pollution reduction requirements for discharging to stormwater-only systems. The list of approved MSTTs is posted on the BES website. The website includes links to the conditions of approval for each device. The unit sizings required to meet the City's pollution reduction requirements are part of the conditions of approval.

4.2.3.1. Design Requirements

Public MSTTs must be designed using the Performance Approach.

Selection

Designers must use MSTTs on the BES list of approved devices, unless otherwise approved. At its discretion, BES may approve an unlisted device if site-specific pollutant reduction goals require an alternative design (e.g., to comply with a 1200-Z NPDES Permit from DEQ).

Pretreatment

BES typically requires installation of a sedimentation maintenance hole to provide pretreatment upstream of a public MSTT.

Sizing

Design and construct MSTTs in accordance with the manufacturer's specifications. Design MSTTs to treat the full contributing area, not just new impervious surface. Size per the conditions of use on the BES list of approved MSTTs.

4.2.3.2. Details

See City of Portland Standard Drawings and Details

P-161: Sedimentation Maintenance Hole

4.2.4. Permeable Pavement

Two types of permeable pavement are shown: pervious concrete (foreground) and permeable pavers (background). Permeable pavements reduce impervious area and provide stormwater management.

Permeable pavement is a general term for a group of permeable, load-bearing paved surfaces that intercept and manage rainfall. Permeable pavement has a base system designed to manage stormwater while providing structure for the permeable pavement and design loads. See Section 3.2.1.2 for a description of permeable pavement types.

4.2.4.1. Design Requirements

See Section 3.2.1.2 for a description of permeable pavement requirements. BES and PBOT approve permeable pavement in the public ROW on a case-by-case basis and may have additional requirements.

The submittal requirements in this chapter (see Section 4.3) still apply.

4.2.5. Tree Credits

Trees intercept rainfall and reduce runoff.

Trees provide stormwater management benefits by intercepting precipitation (i.e., collecting rainfall on their leaves and branches), which provides some retention, facilitates evaporation, and delays runoff. The delay in runoff can facilitate stormwater infiltration, which helps groundwater recharge. These functions are most notable for storms with rainfall depths less than 0.5 inch over 24 hours, which are typical of most Portland storm events. Evergreen trees provide the most benefit year-round for stormwater management.

Trees can have significant benefits in addition to stormwater management. Trees provide shade (which reduces heat gain and can help conserve energy), provide habitat for urban wildlife, capture air pollutants, improve aesthetics, create visual screens, provide heritage value, create windbreaks, and improve human health.

4.2.5.1. Design Requirements

Site Suitability

A tree credit for new or existing trees can be used in the ROW to provide stormwater management for impervious surfaces, including sidewalks, driveways, and roads. BES may require a certified arborist's report to verify suitable tree preservation.

Design Requirements

New trees must meet Portland City Code Title 11 requirements, receive approval from Portland Urban Forestry, be selected from the most current Urban Forestry Approved Street Tree Planting Lists, or as approved by Urban Forestry, and comply with PP&R Urban Forestry Street Tree Planting Standards to be credited for stormwater management. See Table 4-7.

BES will also credit existing trees in the ROW if the trunk is at least 3 inches in diameter at breast height (DBH) or larger. DBH is the diameter of the tree measured 4 ft, 6 inches above the ground surface. See Table 4-7. Determine the credit allowed for your project using the Tree Credit Worksheet (Section 4.4)

Table 4-7. Stormwater Credit for Trees

Type of Tree	Stormwater Credit
Deciduous **New trees per Title 11** **Existing trees 3" DBH or larger**	100 ft^2
Evergreen **New trees per Title 11** **Existing trees 3" DBH or larger**	200 ft^2
Any new or existing tree in a planting strip 8.5' and wider without overhead wires, or an existing tree equal to or larger than 12" DBH	200 ft^2

Setbacks

Setbacks to underground and overhead utilities, streetlights and buildings, proximity to other trees, and planting strip width are considerations for tree locations. See PP&R Urban Forestry Street Tree Planting Standards for a complete list of setbacks.

4.2.5.2. Details

See City of Portland Standard Drawings and Details

P-581 Typical Street Tree Installation

4.2.6. Filter Strips

Filter strips are gently-sloped, vegetated areas designed to treat and manage sheet flow from narrow, adjacent impervious surfaces such as walkways. The vegetation slows and filters the runoff, allowing some or all of it to soak into the ground. Filter strips may occasionally be appropriate for use in the public right-of-way.

4.2.6.1. Design Requirements

See Section 3.2.3.1 for filter strip design requirements.

The submittal requirements in this chapter (see Section 4.3) still apply.

4.2.7. Structured Detention

Structured detention facilities such as tanks, vaults, and oversized pipes provide storage of stormwater as part of a flow control system. Tanks and vaults can be used in conjunction with other facilities as initial or supplemental storage. Structured detention facilities cannot be used to meet pollution reduction requirements; if pollution reduction is required, additional facilities are needed.

4.2.7.1. Design Requirements

Structured Detention must be designed using the Performance Approach.

Pretreatment

Tanks, vaults, and oversized pipes typically do not have a built-in design feature for containing sediment. Therefore, BES requires a sedimentation maintenance hole or other pre-treatment system upstream of detention facilities.

Access

Detention facilities must be accessible for maintenance and must meet the City of Portland Sewer and Drainage Facilities Design Manual requirements. All access openings must have round, solid lids and allow a person to enter the facility. The typical access entry cover size is 24 inches.

Sizing

Structured detention facilities must be designed using acceptable hydrologic and hydraulic modeling techniques to meet applicable flow control requirements. If storage is provided with collection system piping, the maximum water surface elevation must meet the requirements of the Sewer and Drainage Facilities Design Manual. Verify pipe capacity using an accepted methodology approved by the City (see the Sewer and Drainage Facilities Design Manual). The detention system must bypass the 100-year design storm.

Dimensions

The minimum internal height of a vault or tank is 3 ft and the minimum width is 3 ft.

Materials and Structural Stability

Design detention facilities to withstand periodic inundation, potentially corrosive chemicals, and electrochemical soil conditions. Detention facilities must be lined and watertight. Pipe materials and joints must conform to the Sewer and Drainage Facilities Design Manual.

All tanks, vaults, and pipes must meet structural requirements for overburden support and H-20 live load traffic loadings. Design end caps for structural stability at maximum hydrostatic loading conditions.

In soils where groundwater may induce flotation and buoyancy, take measures to counteract these forces. Ballasting with concrete or earthen backfill, providing concrete anchors, or other counteractive measures may be required. Provide calculations to demonstrate stability.

BES may require a geotechnical investigation. Tanks and vaults are prohibited in fill areas and near slopes without a geotechnical analysis of stability and construction practices that demonstrates the feasibility of the project. The design may require consolidated native soil with suitable bedding.

Weirs

For sizing weirs, see the Sewer and Drainage Facilities Design Manual. Enclose weir structures in a catch basin, maintenance hole, or vault that is accessible for maintenance. The structure must be designed to pass the 100-year design storm as overflow, without flooding the contributing drainage area. Protect flow control structures from debris and make them accessible for maintenance and inspection.

Orifices

For orifice sizing equations, see the Sewer and Drainage Facilities Design Manual. The minimum allowable diameter for an orifice in a public facility taking unfiltered flow is 2 inches in diameter. Protect flow control structures from debris and make them accessible for maintenance and inspection.

Multiple orifices may be necessary to meet the 2- through 25-year design storm requirements for a detention system. Large projects may require large orifices that are impractical to construct. In these cases, several orifices may be located at the same elevation to reduce their individual sizes.

Orifices managing unfiltered stormwater runoff must be contained in an accessible structure such as a maintenance hole. Orifices are typically installed on a traditional “tee” riser section or a baffle. Orient the orifice to minimize the potential for clogging, allowing for direct visual observation, trapping of sediment and floatables, and easy access for maintenance.

Concrete is not acceptable for orifices less than 3 inches in diameter. For orifices less than 3 inches in diameter, use a thin material (e.g., stainless steel, HDPE, or PVC) for the orifice plate and attach the plate to the structure. The orifice diameter must be greater than the thickness of the orifice plate.

4.3. Submittal Requirements

The City reviews public stormwater improvements for compliance with the SWMM through the land use review process (when required) and the public works permit process. Inaccurate or incomplete applications will be returned and will delay the review. Additional information is available on the City's Public Works Permit Process web page. In addition to meeting SWMM requirements, all submitted public works plans must meet the City's Sewer and Drainage Facilities Design Manual, other BES codes and rules, public works permit plan submittal requirements, and drafting standards. Questions related to the general public works permit process should be directed to Public Works Permitting at 503-823-1987 or publicworkspermitting@portlandoregon.gov. For technical questions related to facility design and SWMM-specific submittal requirements, call the BES Development Engineering Hotline at 503-823-7761, Option 3.

4.3.1. Land Use Review

A proposed use or development may trigger a BDS land use review required by the City Zoning Code. Land use reviews can be triggered by sections of the zoning code (e.g., base zones, overlay zones, or plan districts) or by conditions from a site's past land use approvals. To approve a land use application, BDS reviews against relevant approval criteria, some of which relate directly to BES services and regulations. Public rights-of-way are regulated by City Code Title 17, Public Improvements. In some cases, public rights-of-way are also regulated by Title 33, Planning and Zoning (see Portland City Code 33.10.030.B). Even when not directly regulated by Title 33, a nexus can exist between a public right-of-way improvement and the private property improvement that is triggering Title 33, through zoning approval criteria or through a direct impact to proposed on-site improvements. In those cases, BES staff reviewing the land use application may require stormwater management information related to both private development and work in the ROW. Therefore, land use applicants may need to follow submittal requirements for both private (Chapter 3) and public projects.

4.3.2. Public Works Permits

Improvements in the ROW may require a public works permit. The basic submittal requirements include the following:

- A site plan (see Section 4.3.3) submitted with concept development, design development, final plan review, and vellum plans.

- A stormwater report (see Section 4.3.4) submitted with concept development and design development.
- An infiltration test report (see Section 2.3) submitted with concept development and design development.
- A 2-year Maintenance Warranty Plan (see Section 4.4), for vegetated facilities not under contract with BES, submitted to the BES construction manager or inspector at the pre-construction meeting.

Table 4-8 shows additional requirements based on the site and the design. The applicant must provide additional information as requested by City staff.

Table 4-8. Additional Submittal Requirements Based on the Site and Design

Submittal Required	For Sites with the Following Conditions	See Section
Groundwater Investigation Report, at BES discretion	Shallow groundwater	2.2.5.1
Environmental Investigation	Known contamination	2.2.5.3
Geotechnical Report	Infiltration within standard setbacks, landslide potential, shallow groundwater, and sometimes infiltration through fill.	
Landscape Plan	Vegetated facilities that are not under contract with the BES Watershed Revegetation Program	4.3.5
Tree Credit Worksheet	New or existing street trees used for stormwater management	4.4
Arborist Report or Tree Plan in compliance with Title 11	Existing street trees used for stormwater management	
Special Circumstance Request	Design is unable to meet requirements of the Stormwater Management Manual	1.8
Manufactured Stormwater Treatment Technology (MSTT) Submittal Information	MSTTs are used to meet pollution reduction requirements	4.3.6

4.3.3. Site Plan Requirements

The site plans must have a minimum scale of 1 inch to 10 ft, include a north arrow, show adequate space for the stormwater facility within any setbacks, and include the following information:

- ☐ Existing and proposed topography and elevations
- ☐ Existing and proposed impervious surface and type of surface
- ☐ Proposed disturbance areas
- ☐ Property lines
- ☐ Setbacks
- ☐ Building foundation footprints
- ☐ Areas with steep slopes or landslide risks
- ☐ Utility lines and easements
- ☐ Type, location, and size of conveyance features (if present or proposed)
- ☐ Any drainageways, waterbodies, and wetlands
- ☐ Boundary of regulatory district or area (e.g., wellhead protection area)
- ☐ Any areas with soil or groundwater contamination
- ☐ Other sensitive areas
- ☐ Type, location, and size of stormwater facilities
- ☐ Proposed stormwater discharge location
- ☐ All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection
- ☐ The overland flow route (if the facility is not designed to infiltrate the 10-year design storm)
- ☐ Width of ROW and curb height
- ☐ Facility data table (for vegetated facilities)
- ☐ Tree Plan to be in compliance with Title 11 (if existing trees are used for stormwater credit)

4.3.4. Stormwater Report Submittal Requirements

The stormwater report provides technical documentation concerning the project. Submit digitally as a single PDF. Stormwater reports must adequately show that the proposed development can meet stormwater requirements at the time of development and include the following items:

1. **Cover sheet with the following information:**
   - ☐ Project name

- ☐ Property owner
- ☐ Site address
- ☐ Associated permit numbers
- ☐ Submittal date
- ☐ The engineer of record and their full contact information

2. *Designer's Oregon-registration stamp, signature, and this certification statement:*

I hereby certify that this Stormwater 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.

3. *Table of contents*

4. *Project overview and description*

- ☐ Vicinity map
- ☐ Watershed
- ☐ Drainage and conveyance given existing site conditions
- ☐ Type of development or proposed improvements
- ☐ Planning and overlay zones
- ☐ Existing versus post-construction conditions
- ☐ Required permits (local, state, federal)

5. *Methodology*

- ☐ Description of potential impacts from proposal to existing drainage
- ☐ Description of techniques for mitigating impacts
- ☐ Infiltration testing results or recommendations including bore logs
- ☐ Stormwater hierarchy category justification
- ☐ Narrative describing the stormwater management techniques

6. *Analysis*

- ☐ Design assumptions and calculations. For the Presumptive Approach, this is the PAC report; for the Performance Approach, include design storms, computation methods, software used, safety factors, curve numbers, and design coefficients, and clarify variations from the norm.
- ☐ Escape route or inundation level for the 100-year design storm.
- ☐ Table of impervious area(s) treated (including pervious paving) and the facility size (see Table 4-9 as an example.)

Table 4-9 Catchment and Facility Summary

Impervious Area		Stormwater Facility	
Size (ft^2 or ac)	CN	Type	Size (ft^2)

7. *Engineering conclusions*

- ☐ A narrative describing how the site-specific requirements of the SWMM are met, including any flow control and/or water quality requirements. If using the Presumptive Approach, include the PAC Report; otherwise use a table such as Table 4-10.

Table 4-10 Pre- vs. Post-Construction Flow Rates

Catchment ID	Peak Flow Rate (cfs) for a 24-hr storm								Time of Concentration	
	2-yr		5-yr		10-yr		25-yr			
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post

8. Stormwater facility details/exhibits

- ☐ Cross-section(s) showing facility dimensions and elevations of inlets, outlets, and discharge locations demonstrating gravity drainage
- ☐ Delineated catchment area for each stormwater facility
- ☐ Stormwater conveyance features
- ☐ Offsite discharge location(s)

9. Tree credit information (if applicable)

- ☐ A completed Tree Credit Worksheet.
- ☐ Trees to be given credit for stormwater management must be clearly labeled as such with the size (as provided in the Urban Forestry Approved Street Tree Planting Lists) and species included.
- ☐ Approximate setbacks from property lines and structures must be shown.
- ☐ A note must be included on the permit drawings that calls for City inspection after the tree has been planted, or in the case of existing canopy, after the site grading has been completed.

- ☐ 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.

10. Manufactured Stormwater Treatment Technology (MSTT) Data (if applicable)

- ☐ Flow-rate calculations to demonstrate that the MSTT will perform within the approved sizing standards.
- ☐ Identification of high flow or overflow bypass.
- ☐ Facility dimensions and setbacks from utilities.
- ☐ Profile view of the facility, including typical cross-sections with dimensions.
- ☐ All stormwater piping associated with the facility, including pipe materials, sizes, and slopes.
- ☐ Any necessary documentation to demonstrate compliance with the specific Conditions of Approval for that device.

4.3.5. Landscape Plan Requirements (if applicable)

Landscape plans are required for vegetated stormwater facilities and tree credits. If the project has contracted with BES to establish and maintain the vegetated stormwater facility, a landscape plan is not required. The landscape plan must have a minimum scale of 1 inch to 10 ft, include a north arrow, show the facilities, and include the following information:

- ☐ A planting plan that indicates existing vegetation to be preserved; the location of all landscape elements; zones (Zone A for the wet zone and Zone B for the moderate to dry zone if present); and the size, species, and location of all proposed planting within Zone A and Zone B.
    - Graphic symbols for individual plants with species and quantity callouts on the plan
    - Hatch patterns are acceptable, but each hatch pattern should represent 1-2 species only. Quantity callouts are required for each hatch pattern.
- ☐ A plant list or table, including botanical and common names, size at the time of planting, quantity, spacing, type of container, and other relevant information in accordance with landscape industry standards.
- ☐ Trees identified for a tree credit should be clearly labeled (if applicable).
- ☐ Typical (sample) planting plans can be used, however they must reflect the facility geometry and plant counts must be calculated and provided.

4.3.6. MSTT Submittal Requirements (if applicable)

The City requires review of the plans by the MSTT manufacturer. Prior to BES review, submit a letter to BES Public Works Permits that certifies the manufacturer has reviewed and approved the design.

4.4. Submittal Forms

Public Works 2-Year Maintenance Warranty Form

Standard Plan for the 2-Year Maintenance Warranty Period

Public Stormwater Facility Inspection Log

Tree Credit Worksheet

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PUBLIC WORKS 2-YEAR MAINTENANCE WARRANTY FORM

FOR FUTURE BUREAU OF ENVIRONMENTAL SERVICES (BES) FACILITIES

This form is for green street facilities and regional or neighborhood facilities constructed as public works improvements.

PLEASE FILL THIS FORM OUT COMPLETELY.

Detailed information about submittal requirements is contained in Section 4.3. For assistance in completing this form, consult with the BES Revegetation Program at 503-823-1424.

A complete submittal consists of this form with a Site Plan, Planting Plan, and the Standard Plan for the 2-year Maintenance Warranty Period (if required).

(for official use only)

Received by: ______________________

Date: ______________________

Deemed complete on: ______________________

PROJECT INFORMATION

BES Job Number: ______________________

Job Description: ______________________

____

____

Job Location: ______________________

BES Construction Manager Name and Telephone Number: ______________________

PUBLIC WORKS PERMIT APPLICANT

(Applicant)

Name: ______________________

Phone: ______________________

Email: ______________________

Mailing Address: ______________________

City/State/Zip: ______________________

MAINTENANCE CONTRACTOR

(if different from the Applicant)

Name: ______________________

Phone: ______________________

Email: ______________________

Mailing Address: ______________________

City/State/Zip: ______________________

ATTACHMENTS *(ALL must be checked and attached)*

- ❑ Site Plan (or reference BES Permit #______________, Sheet #____________)
- ❑ Planting Plan (or reference BES Permit #______________, Sheet #____________)
- ❑ Signed Standard Plan for the 2-year Maintenance and Warranty Period

PUBLIC WORKS 2-YEAR MAINTENANCE WARRANTY FORM

All structural components, including inlets, drain pipes, check dams, and liners, must freely convey stormwater and be repaired or replaced if damaged over the duration of the warranty period. I accept, agree to, and assume responsibility for compliance to the terms and conditions contained in this form and the Standard Plan for the 2-year Maintenance Warranty Period. I have provided a copy of the Maintenance Warranty Plan and Inspection and Maintenance Log to the contractor or representative responsible for the maintenance work.

Signature: *(Applicant)* ______________________________ **Date:** ______________

Print Name: ____

Signature: *(Applicant's Representative, if applicable))* ______________________________

Print Name: ____

Phone: ______________________ **Date:** ______________________

STANDARD PLAN FOR THE 2-YEAR MAINTENANCE WARRANTY PERIOD

REGULAR INSPECTIONS

The Permit Applicant named on the Public Works 2-year Maintenance Warranty Form is responsible for inspecting each part of the system at least once every three months for the duration of the maintenance warranty period. Inspections must also be made within 48 hours after all major storm events, defined as greater than 1.0 inch of rain in a 24-hour period. Record activities on the Inspection and Maintenance Log.

VEGETATION COVER AND HEALTH

Vegetation must be healthy and vigorous at the time of installation. The goal of the two-year maintenance warranty period is to maintain this vigor and health, while controlling undesirable vegetation.

- A survival rate of 90% is required at all times over the two-year warranty period; plant replacement is required if the rate is less than 90%.
- Individual bare spots may be no larger than 10 square feet.
- Plant replacement must occur during the planting seasons *(see right)*.
- Planting outside the listed planting seasons requires written approval by the City.
- Replant per the permitted plan, or seek approval for substitutions from the plant list in Section 4.2.3.
- Use of fertilizers is not allowed in stormwater management facilities during the maintenance warranty period.
- Remove dead or dying vegetation; standing dead (brown) stems of rushes and sedges can be "combed out"with a spring rake.
- Trimming or cutting of vegetation is allowed to maintain clearance along sidewalks and curb edges only.

PLANTING SEASONS	
SPRING	FEB 1 – MAY 1
FALL	OCT 1 – DEC 1

WEED CONTROL

A weed is any vegetation not listed on the permitted planting plan.

- Remove weeds entirely, including all roots and root fragments, by hand, before plants set seed.
- No more than 5% coverage by weeds is allowed in a facility at any given time.
- Use of herbicides is not allowed in stormwater management facilities during the maintenance warranty period.

TREE HEALTH

All trees must be healthy and vigorous, with trunk and limbs free from insects, disease, defects, injuries, and decay, throughout the maintenance warranty period.

- Dead, dying, diseased, injured, or otherwise defective trees must be replaced.
- Tree replacement must occur during the planting seasons *(see right).*
- Planting outside the listed planting seasons requires written approval by the City.

PLANTING SEASONS	
SPRING	FEB 1 – MAY 1
FALL	OCT 1 – DEC 1

IRRIGATION

Regular irrigation is required to keep vegetation healthy and vigorous. The irrigation schedule below is typical for most facilities in most years. Actual frequency required depends on season, weather, site conditions, and vegetation characteristics and may be more or less frequent than specified below.

- Irrigation is required once each week (minimum) during the summer irrigation season.
- Irrigation is required once every two weeks (minimum) during the spring and fall irrigation seasons *(see right).*
- Use portable tanks, truck water systems, or temporary above-ground irrigation devices. Temporary above ground irrigation must be approved by the City and removed at the conclusion of the 2-Year maintenance warranty period.
- Tree watering bags may be used from May 15th- October 1st, but must be removed every fall.

IRRIGATION MINIMUMS		
SPRING	MAY 15 – JUNE 30	once every two weeks
SUMMER	JULY 1–AUG 31	once every week
FALL	SEPT 1 –OCT 1	once every two weeks

INFILTRATION

Each facility is designed to drain within 48 hours after the end of a storm event.

A facility with standing water 48 hours after the end of a storm event must be reported to the BES Construction Manager immediately.

SEDIMENT REMOVAL

Sediment is mineral or organic matter deposited into the facility by stormwater runoff. Excess sediment in a facility can impede conveyance and infiltration, reduce storage capacity, and bury vegetation.

- Conveyance capacity must be maintained to at least 75% (minimum) at all times.
- Sediment must be removed from inlets and forebays during each inspection and after every major storm.
- Remove accumulated sediment from inside the facility during routine maintenance visits.

LEAF REMOVAL

Excess leaf material in a facility may impede conveyance and infiltration, reduce storage capacity, and increase nutrient loading.

- During regular maintenance visits, and more frequently during the fall season, remove leaf material from the facility, including inlets, outlets, forebays, overflow structures, and curbs.
- Clean the street gutter line to 10 feet upstream of the curb inlets, or the nearest driveway apron, to maintain open inlets between visits.

TRASH AND DEBRIS REMOVAL

Excess trash and debris in a facility may impede conveyance and infiltration.

- Trash and debris must be removed during every site visit.

EROSION

Erosion within a stormwater facility can reduce infiltration rates, expose plant roots and structures, and clog outlets.

- Maintain soil elevations and grades per plan.
- Significant erosion must be addressed immediately. Notify the BES Construction Manager for guidance.

MULCH

Mulch may be used to inhibit weed growth, retain moisture, reduce soil erosion and compaction, and add nutrients. Mulch may be allowed on a case-by case basis.

- Apply and maintain mulch per plan, or as directed.
- Ensure that no mulch covers plants or comes into contact with tree trunks or woody stems of plants.
- Keep mulch off structures, roadways, shoulders, walks, and lawns.
- Mulch must be fine to medium 100% natural hemlock bark free of dyes and pesticides.
- Submit detailed vendor and mulch product information for review and approval prior to placement.

Signature: *(Applicant)* ______________________________ **Date:** ______________________

Print Name: ____

Signature: *(Applicant's Representative, if applicable)* ______________________________

Print Name: *(and company, if applicable)* ______________________________

Phone: ______________________________ **Date:** ______________________

PUBLIC STORMWATER FACILITY INSPECTION LOG

BES Job # ______________________ **Facility Location (intersection or postal address)** ______________________

This log may be required for review by the City at any time during the 2-Year Maintenance Warranty Period.

INSPECTION DATE	DATE OF MAINTENANCE WORK	WORK PERFORMED BY	Inlet and outlet cleaning	Sediment, debris, trash Removal	Irrigation	PLANT REPLACEMENT: Type and quantity	NOTES	INITIALS OF PERMITTEE

TREE CREDIT WORKSHEET

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Trees may be able to reduce the size of triggering impervious surface. Trees used for tree credit must be clearly labeled on the site plan.

Tree Credit Applicability:

- Applies only in the right-of-way.
- The Bureau of Environmental Services may require a certified arborists' report to verify suitable tree preservation.
- Trees planted in stormwater facilities or used towards environmental zone mitigation cannot also receive tree credit.

CALCULATE TREE CREDIT

TYPE OF TREE	NUMBER OF TREES	STORMWATER CREDIT	TREE CREDIT (SF)
DECIDUOUS • New trees per Title 11 • Existing trees 3" DBH or larger		100 ft^2	
EVERGREEN • New trees per Title 11 • Existing trees 3" DBH or larger		200 ft^2	
Any new or existing tree in a planting strip 8.5' and wider without overhead wires, or an existing tree equal to or larger than 12" DBH		200 ft^2	
		TOTAL	

ES 2015

Chapter 5. Drainageway and Drainage Reserve Requirements and Policies

This chapter outlines the City of Portland's drainage reserve requirements and the related regulations and policies. It includes the following sections:

5.1 Introduction

A drainageway is a constructed or natural channel or depression that may at any time collect and convey water. A drainageway and its drainage reserve function together to manage flow rate, volume, and water quality. A drainageway may be permanently or temporarily inundated.

A drainage reserve is the regulated area adjacent to and including a drainageway. A drainage reserve is typically a 30-foot-wide buffer placed over a drainageway and centered in the middle of the channel that acts as a no-build area by default; it is not an easement.

Drainageways are channels or depressions that continually or periodically convey water; this drainageway has visible water in the winter during larger rainfall events.

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 site disturbance, developments or actions. The Bureau of Environmental Services (BES) will evaluate the factors listed in Section 2.2.3 and Section 5.3 to determine if a drainageway is present. If it is determined that a drainageway exists on a property, then BES will apply a drainage reserve to the drainageway.

Encroachments into a drainage reserve must be reviewed by BES through the encroachment review process. Proposed impacts and encroachment proposals will be reviewed to ensure that the flow rate, timing, and pattern of the drainage continues to be adequately conveyed through the site and to protect water quality. BES staff may allow modifications to a drainageway and its reserve if the drainageway poses landslide, flooding, or other public health or safety concerns. Any proposed encroachments or modifications must also comply with Portland City Code Titles 24 & 33.

Development permit applications must comply with drainage reserve submittal requirements found in Section 5.9. Bureau of Development Services (BDS) staff will verify that erosion control protection and constructed encroachments are placed or built as shown on the site plan and will consult with BES staff on any concerns regarding the adequacy of the applicant's efforts. Violations of or failures to comply with drainage reserve protection requirements will be referred to BES staff for investigation and enforcement.

5.1.1 Importance of Protecting Drainageways

A drainageway and its adjacent riparian or reserve area function together to provide flow rate, flow volume, and water quality benefits to the drainageway and to downstream receiving waters. As documented by the U.S. EPA, tributary streams, and adjacent riparian areas absorb, intercept, and store water, thus helping to reduce downstream flooding; facilitate chemical cycling, which contributes to water quality improvements; trap and transport sediments; alter or absorb pollutants; provide essential habitat for plants and animals; and strongly influence the health of downstream waterbodies. (Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence (Final Report), EPA/600/R-14/475F, 2015.) Drainage reserves provide protection for intermittent and perennial drainageways (including tributary streams) in order to preserve these functions.

Flow Conveyance, Rate, and Volume

One primary defining function of drainageways is the conveyance of water. In a natural stream system, water is conveyed through irregularly shaped channels with rough streambeds and woody debris, which reduce water velocities in the stream and attenuate peak stream flows. In a natural stream system, water is in contact with the ground surface, hydrating adjacent wetlands and taking advantage of the infiltration capacity of the landscape, thus decreasing total runoff volume. In a piped stream network, water is rapidly transported downstream, resulting in floods and high flows that peak more rapidly than in natural watersheds.

Vegetation plays a significant role in influencing the rate and volume of stormwater runoff. Specifically, vegetated riparian areas intercept precipitation, increase the permeability of soils, slow the above- and below-ground flow of water, and contribute to groundwater recharge.

Water Quality

Drainageways provide important water quality benefits to downstream receiving waters. Smaller tributary streams alter, remove, and transport nutrients, organic matter, contaminants, sediments, and other compounds, thus impacting the downstream water quality, sediment deposition, nutrient availability, and living components of an ecosystem.

Smaller headwater streams and their associated riparian areas provide valuable sediment removal and filtration of pollutants found in urban systems. Vegetation protects water quality by reducing erosion and sedimentation, facilitating biogeochemical processes that provide essential habitat resources and mitigate pollution, and maintaining cooler water temperatures. When natural streams and riparian areas are degraded, or altogether eliminated in the case of a piped stream, the capacity to filter pollutants is greatly reduced. Without overbank flooding and opportunity for filtration of sediment and pollutants, these pollutants are immediately transferred downstream.

Native Plantings and Invasive Species Removal

The replacement of native vegetation with invasive vegetation can have detrimental impacts on drainageways, riparian systems, and watershed health. Riparian habitats and drainageways are considered particularly prone to invasion and are especially susceptible to hydromodification impacts of invasive species. Hydromodification is the alteration of the natural flow of water, timing, frequency, and volume of runoff from the land surface as a result of urbanization. Invaded ecosystems have decreased capacity to retain and remediate pollutants, and invasive plants have been shown to adversely affect water quantity and quality by altering important functions such as retention, interception, soil infiltration, erosion, water chemistry, soil chemistry, and soil microorganisms, animals, and plants (soil biota). Finally, as vegetation structure is made uniform in the region by a few species, native trees and shrubs are unable to reproduce, disappearing from the landscape, eliminating canopy, raising water temperatures, and eliminating natural sources of large wood (Invasive Species in Portland Watersheds 2nd Ed., City of Portland, 2018).

Due to the water quantity and water quality impacts of invasive vegetation and the importance of diverse native vegetation, drainage reserve mitigation plantings must be native as listed on the Portland Plant List. Other City programs and rules, such as ENN-7.04, Nuisance Plants Required Removal Program, apply to drainageways and invasive species must be removed from mitigation planting areas.

5.2 Applicability

Portland City Code Chapter 17.38 gives BES the authority to require drainage reserves when a drainageway is present that meets the definition in Portland City Code Section 17.38.020. Most commonly, drainage reserve requirements are applied during land use reviews, building permit reviews, or other development processes. However, drainage reserves may also be required independently of development activity. For example, drainage reserves may be applied as part of, but not limited to, a City enforcement action for unpermitted site work located near a drainageway, or upon the discovery and on-site verification of a drainageway by City staff. In the latter case, notice of drainage reserve placement will be given to affected property owners. Established drainage reserves are documented in various records including permit records, city maps, and property deeds. In situations where other local, state or federal regulations apply and are more stringent than the SWMM in protecting of drainageways, as determined by BES, those other requirements govern.

5.2.1 Exemptions

Drainage reserves are not applied in the following circumstances:

- The drainageway is adequately protected by an Environmental Protection overlay zone ("p" on Portland's official zoning maps) or other overlay zone of sufficient size that provides equivalent or better protection as determined by BES. If the overlay zones are insufficiently sized to cover the drainageway width or if the zones provide inadequate protection as determined by BES, BES may place drainage reserves in conjunction with the overlay zone to ensure adequate protection per the purpose of this manual. Drainage reserves will not be applied in Pleasant Valley Natural Resources overlay zones ("v" on Portland's Official Zoning Maps) when the drainageway is considered an identified stream or waterbody per Title 33. Drainage reserves will be applied in Environmental Conservation overlay zones ("c" on Portland's official zoning maps).
- The drainageway is protected by a tract (e.g., Environmental Resource Tract, Drainage Reserve Tract, or Conservation Tract) that equally or better meets the purpose of this chapter as determined by BES.

5.3 Identifying Drainageways on Properties

The presence of a drainageway will be determined by BES with any combination of the following tools: satellite imagery; existing development plans; aerial photos; LiDAR maps; hydrologic and hydraulic flow models; existing infrastructure; topography; physical site characteristics; information gathered from site visits; and other available information. During any site visits, BES will look for indicators of conveyance. Indicators may be present in wet or dry seasons. The determination of an onsite drainageway does not depend on water being present at the time of determination, only on factors that demonstrate the presence of water and flow at some point in time.

5.4 Placement of Drainage Reserves

A drainage reserve is established and measured based on the identification and location of the drainageway. BES will place a drainage reserve over any portion of a property with flow conveyance features that meet the drainageway definition. Placement of a drainage reserve may be based on any combination of the factors listed below; not all the factors must be present to require a drainage reserve.

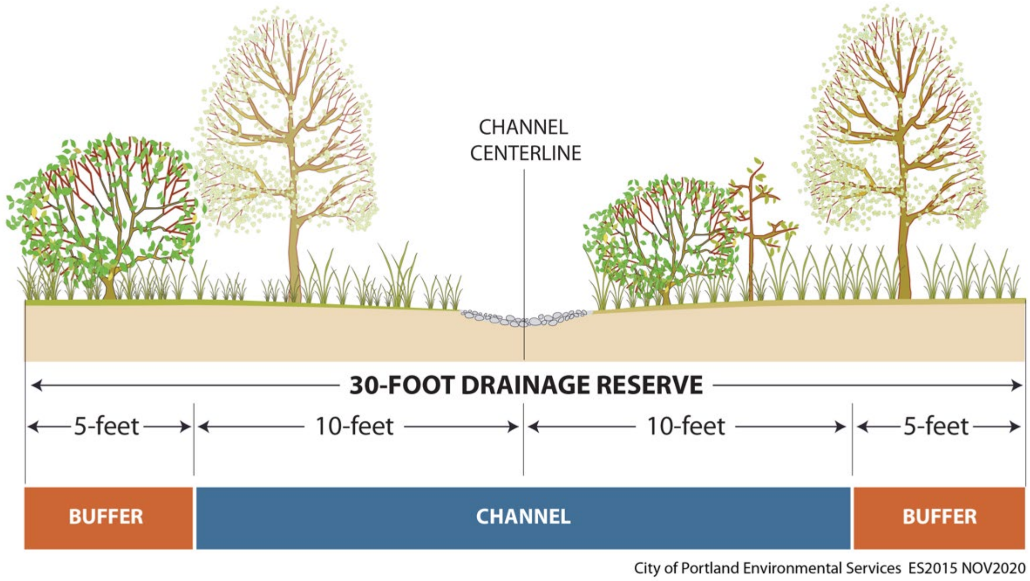
- Topography.
- Soil type, channel substrate and erosion/incision indicating a drainageway.
- Evidence of drift lines, waterborne sediment deposits, or sorting.
- Soil saturation within 18 inches of the surface.
- Vegetation characteristics of riparian, streambank, or wetland habitats.
- Visual topographic or vegetative connection to nearby wetlands, streams, seeps, springs, or sensitive natural areas.
- Visibly flowing or ponding water.
- Volume and velocity of existing drainage (including groundwater flows) within, upstream of or downstream of the site.
- Existing and proposed infrastructure (e.g., culverts, right-of-way ditches, outfalls, municipally owned stormwater control structures, or stormwater facilities along the drainageway or its outlet).

BES will apply a drainage reserve if drainageway(s) are identified on a site as determined in Section 5.2. A drainage reserve is typically 30 feet in width, extending 15 feet from the centerline of the identified drainageway to each side, with the following exceptions:

- Depending on the characteristics of a drainageway, a drainage reserve may be wider than 30 feet if needed to protect the channel and bank.
- An applicant may request a smaller reserve area if the applicant can demonstrate that a smaller area will provide sufficient flow conveyance and water quality protection. BES will review and determine whether a smaller reserve sufficiently meets the drainage reserve goals through the encroachment review process.

Drainage reserves run with the land, meaning that the benefits and responsibilities of the drainage reserve are bound to the property and are passed on to any subsequent property owners. Drainage reserves must be protected during any currently proposed or future development to ensure the continuation of flow conveyance, water quality protection, and other benefits. See Section 5.10 for long-term protection requirements and Section 1.9 for Administrative Review and Appeals requirements.

Figure 5-1 Drainage Reserve Cross Section



5.5 Drainage Reserve Encroachments

Encroachments into the drainage reserve can cause floodplain and floodway impingements for high-flow conditions, erosion, and water quality impairment and can result in the cumulative loss of floodplain. Encroachments in drainage reserves can also divert flows, reduce flow capacity and destabilize banks, impede fish and wildlife passage, and impact other important natural resource functions. BES will evaluate proposals that encroach into a drainage reserve based on the encroachment feature's proximity to the drainageway and potential impacts of the encroachment. Encroachments include temporary and permanent development, including but not limited to, culverts, outfalls, fences, structures/buildings, grading, excavations and fills, paved areas, decks and deck footings. See Section 5.7 for the design criteria for Drainage Reserve Encroachments. There are two types of encroachments (see Figure 5-1 for cross section identifying encroachment areas):

- **Drainage Reserve Buffer Encroachment.** An encroachment located within the outer 5 feet of a drainage reserve and adjacent to the channel encroachment area.
- **Drainage Reserve Channel Encroachment.** An encroachment located within 10 feet of the channel centerline. For drainage reserves with a total width other than 30 feet, the channel encroachment area will be determined on a case by case basis through the encroachment review process.

Encroachments in the Right-of-Way

Encroachments to drainageways in the public right-of-way and public improvements to drainageways are addressed during the City's review of the design, which may include a Public Works Permit. Design requirements for public improvements of surface conveyance are found in the Sewer and Drainage Facilities Design Manual.

5.5.1 Allowable Encroachments and Activities

All allowable encroachments and activities are subject to BES review. Certain development activities are allowed with less review from the drainage reserve encroachment requirements in Section 5.5.2,unless the activities could result in a violation of the City's regulatory permits or other municipal regulations. The following are allowable encroachment activities:

- Building soft surface trails within the drainage reserve buffer encroachment area provided they meet the Portland Parks and Recreation Trail Design Guidelines. Trail width may not exceed 30 inches.
- Maintenance and repair of existing culverts or water crossing structures in drainage reserves when coverage and utility size are not increased. Replacement of culverts or water crossing structures is not considered maintenance and requires drainage reserve encroachment review.
- Operations, maintenance and repair of drainage facilities managed by Drainage Districts as defined in Chapter 33.430.
- Replanting with native vegetation listed on the Portland Plant List when planted with hand-held equipment.
- Removal of vegetation on the City's nuisance plant list. Plant removal must be done with hand-held equipment.
- Installation of temporary fencing. The fence must be removed within 5 years.
- Installation of split-rail fencing in the Drainage Reserve Buffer. Installation of split-rail fencing in the Drainage Reserve Channel may be allowed, unless BES determines that the fencing would adversely impact flow conveyance.
- Single outfalls exiting from stormwater management facilities are allowed to encroach into the drainage reserve channel if they meet the standards that govern stormwater outfalls in the City's environmental zoning code (Portland City Code, Chapter 33.430). Approval requests for all other outfalls will be subject to encroachment review requirements and submittal requirements.
- Construction of underground utility infrastructure in the drainage reserve buffer, including but not limited to storm and sanitary sewers, sewer laterals, water mains, phone and cable lines, power lines, and gas lines as long as the disturbance area is replanted with native plants and will meet the vegetation density requirements of Section 5.6.
- Temporary, emergency procedures necessary for the protection of life, health, safety or property. Temporary emergency procedures for the safety or protection of property that result in permanent impacts must meet the regulations of this chapter after the emergency has passed.

5.5.2 Encroachment Requirements

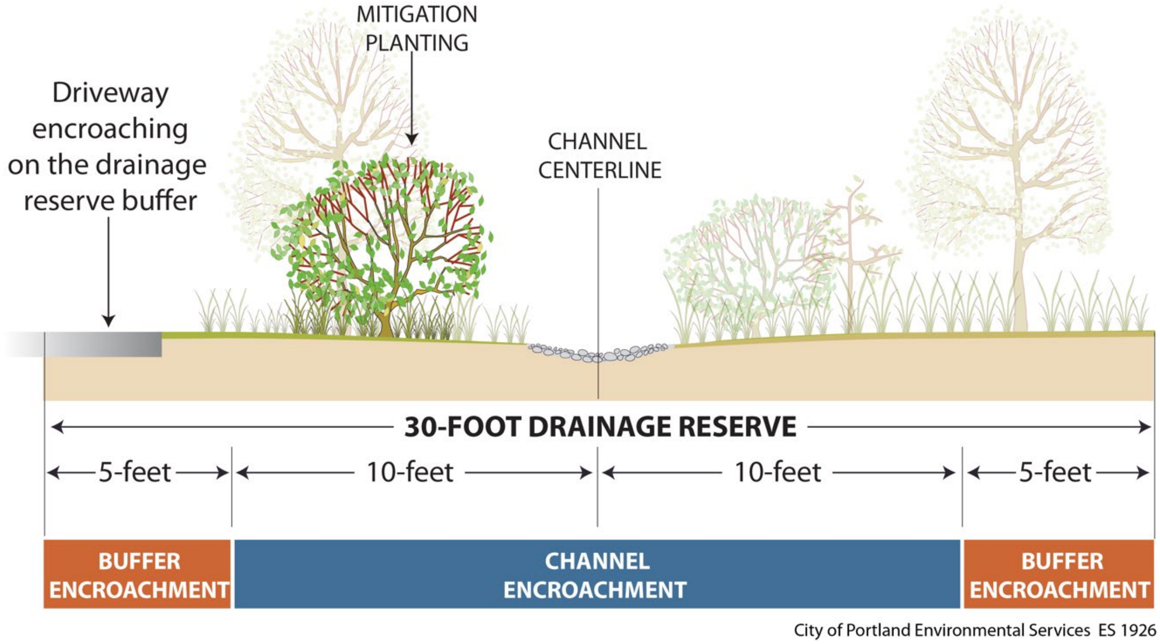
For proposed development activities and encroachments into the drainage reserve buffer and drainage reserve channel, the applicant must clearly demonstrate that the following requirements are met, as determined by BES:

- The proposed encroachment will be limited to the maximum extent practicable.
- Land within the limits of the drainage reserve will remain in natural topographic condition to the maximum extent feasible.
- The proposed encroachment will maintain conveyance capacity across the site.
- The encroachment will occur in the most environmentally sensitive manner, considering seasonality, slope, soil, geologic, and erosion control issues to limit disturbance impacts to flow capacity, connectivity, channel stability, and water quality.
- Heavy machinery uses during construction that produces ground compaction within the drainage reserve limits will be limited to the maximum extent practicable. Low, ground-pressure vehicles (such as spider hoes) may be allowed if the applicant can show adequate soil and vegetation protection.
- Temporary and permanent encroachments, and associated disturbance areas will meet applicable planting requirements as described in Section 5.6 (Vegetation Requirements).
- Permanent disturbances to the drainage reserve will be mitigated at a minimum of 1.5:1 ratio of mitigation area to disturbance area. Temporary disturbances to the drainage reserve are required to mitigate at a 1:1 ratio in the disturbance area.
- Mitigation for drainage reserve encroachments will be planted on the same site, and within the drainage reserve boundary to the maximum extent practicable. Mitigation may occur outside of the drainage reserve, as approved by BES and in those cases the reserve boundaries may be expanded to encompass mitigation areas placed outside of the standard reserve width.
- All structures, mitigation plantings, and drainageway improvements will be maintained in accordance with the submitted Operations & Maintenance (O & M) Plan and will meet the O & M requirements in Section 5.10.1.

Related Requirements

Other city regulations such as Title 10, Erosion Control, and Title 11, Trees, may apply to the proposed work that would result in an encroachment.

Figure 5-2. Example of Drainage Reserve Encroachment



5.5.2.1 Additional Requirements for Channel Encroachments

Channel encroachment requirements are in addition to the encroachment requirements listed in Section 5.5.2, and BES may require additional information on drainageway flows. Hydrologic or hydraulic modeling may be required, depending on site conditions and the extent of the proposed encroachment.

For proposed channel encroachments, the applicant must clearly demonstrate that the following additional requirements will be met, as determined by BES:

- The encroachment will not worsen any existing drainageway conditions, such as channel erosion, channel hardening, or water impoundment.
- The channel encroachment will maintain the existing channel capacity or enhance storage and conveyance volumes, depending on the environmental resource needs of the site.
- Flows will be conveyed around the encroachment area during construction as appropriate when the encroachment involves in-water work.

5.6 Planting Requirements

Temporary and permanent encroachments and all associated disturbance areas within a drainage reserve must meet the following mitigation planting requirements:

- Plantings must be native, as listed on the Portland Plant List. Choose plants appropriate for the native plant community type as described in the Portland Plant List.
- Vegetation coverage within the drainage reserve area must achieve 90% coverage within one year after construction.
- Planting densities for encroachments within the drainage reserve buffer (outside of the channel) must meet the requirements described in Table 5-1.
- Planting densities for encroachments within the drainage reserve channel must meet the requirements described in Table 5-2.
  - Invasive species must be removed from mitigation planting areas.
- An O & M plan is required to ensure long term protection of plantings (see Section 5.10.1).

Related Requirements

See Portland City Code Title 11 for tree requirements relating to development situations and Title 33 for vegetation requirements related to applicable environmental zoning. Other City programs and rules, such as ENN-7.04, Nuisance Plants Required Removal Program, apply to drainage reserves.

Table 5-1. Planting Density for Drainage Reserve Buffer Encroachments

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
50	Herbaceous plants	100	4” pots	12”
OR				
60	Herbaceous plants	100	#1 Container	12”
4	Small shrubs	100	#1 container or 12-36” tall bare root stock	Per plan
OR				
120	Herbaceous	100	Plugs	6”

Table 5-2. Planting Density for Drainage Reserve Channel Encroachments.

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
2	Trees	100	6’ min height or 1 ½” caliper	Per plan
5	Shrubs	100	#1 container or 12-36” tall bare root stock	3’
35	Herbaceous plants	100	4” pots	12”
OR				
120	Herbaceous plants	100	Plugs	6”

5.7 Drainageway Design

Drainageways must be sized to ensure that the current flow rate and pattern of drainage continues to be adequately conveyed through the site. All sites with proposed encroachments are required to demonstrate that the encroachment will not worsen any existing drainageway conditions. Discharges to drainageways must follow the requirements listed in Section 1.3, Stormwater Management Requirements.

Current flow volumes and drainageway capacities may be determined by reviewing a number of sources, including but not limited to the following:

- Drainage basin hydrology and hydrologic records.
- Delineation of the drainage catchment.
- Modeling information, including volume, velocity, and water surface elevation, using a modeling approach approved by BES.
- Historical data, such as permit records, photographs of past flooding limits, or monitoring data.
- Topographic features, if any, including LiDAR or other map-based methods depicting channel migration zones, high water marks or other demarcations of drainage capacity.
- Soil inundation measures.

5.7.1 Design Criteria for Drainage Reserve Encroachments

Drainageways meeting the definition in this manual can be either constructed or natural. Constructed channels can be either natural or artificial. Different design criteria for encroachments apply depending on this distinction. Natural channels provide multiple benefits including conveyance, water quality and habitat value. Artificial channels are engineered to provide efficient conveyance of water, protect water quality, and are not expected to provide additional watershed functions. All drainageways will be considered natural unless evidence is provided demonstrating that they are artificial. In order to be considered an artificial channel the drainageway must be built in dry land, not be a rerouted natural drainageway, and take only rainfall-generated runoff. A rerouted natural drainageway is still considered a natural drainageway.

Design Criteria for All Encroachments

- Scale the level of analysis with the complexity of the project, proposed impacts, potential risks, and channel size.

- Demonstrate that conveyance capacity is maintained across the site and there will be no increase in adverse impacts to adjacent properties from the 25-year design storm event. The geographic extent of the 25-year event may be altered within the development site but should remain consistent, or be reduced, for neighboring properties.
- Protect water quality by stabilizing any disturbed area with adequate erosion control, installing native plants per planting requirements (See Section 5.6), and using bioengineering techniques as needed.

Additional Design Criteria for Encroachments into Natural Channel Systems

- Design channel to be stable for the 2-year design storm event using shear stress and stable channel design guidance in the Sewer and Drainage Facilities Design Manual (SDFDM). Additional stabilization in the channel may be required or desired for larger storm events depending on specific site conditions.
- Design distinct low-flow (typically ½ of the 2-year event) areas to provide habitat and design high-flow areas to maintain floodplain connectivity for flows above bankfull flow conditions.
- Maintain or restore natural channel geometry both in cross-section and planform. Use existing conditions, a reference reach, or other methodologies to guide channel geometry and bed material selection.
- Evaluate channel stability by providing analysis of shear stress, bed stability, scour, sediment transport and mobility, and bed and bank treatments.
- Design a natural channel bottom and use bioengineering techniques to stabilize the channel. Natural materials such as, vegetation, live stakes, and wood should be used. Generally, matching existing conditions or meeting vegetation density requirements in this chapter (vegetation cover, bed material and cross-section) in channels that are not actively eroding or significantly degraded will be adequate.
- Use of rock armoring should be minimized. It may be approved for use in areas surrounding outfalls, inlets, culverts and bridge crossings, and other locations requiring additional protection, as approved by BES. Rock armoring

Additional Reference Material

Stream restoration design guidance is available in the Natural Resources Conservation Service Stream Restoration Design (National Engineering Handbook 654).

Additional reference material is in Appendix B.3

should be minimized and must be planted with live stakes of native plant stock, ½ inch in diameter. Stakes must be used at a density of two to three stakes per 9 square feet.

Design Criteria for Artificial Channel Systems

Artificial channel systems must be designed using guidance in the SDFDM for open channels using stable channel design requirements. Design channels with vegetation to provide water quality benefits, unless otherwise approved by BES.

Design Criteria for Piped Drainageways

In limited cases, BES may allow a drainageway to be conveyed in a pipe. For these situations, design pipes to meet conveyance capacities for storm-only pipes in the SDFDM.

Construction Considerations

During site construction, water must be safely conveyed around or through the drainageway. The channel must 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 Portland City Code Title 10, or if such conditions are otherwise required by regulatory agencies including the Oregon Department of Fish and Wildlife Timing Guidelines for In-water Work.

5.8 Crossings, Bridges and Culverts

Appropriate crossing methods may be allowed as a channel or drainage reserve buffer encroachment. Additional guidance for culverts and crossings is provided in Appendix B. Drainageway impacts must be avoided wherever practicable, with the following requirements:

- Proposed crossings must minimally impact slope, width, depth and bed composition of the drainageway.
- All crossings must be designed to pass the peak discharge for the 25-year design storm without surcharging the inlet (per the requirements in SDFDM). High-flow hydraulic capacity sizing guidance can be found in the Federal Highway Administration Hydraulic Design for Culverts.

Related Requirements

Proposed bridge and culvert crossings of streams or tributaries may be subject to additional requirements, as follows:

- Culverts and bridges within floodplains regulated by the Federal Emergency Management Agency should be reviewed and approved by the City of Portland Bureau of Development Services.
- Culverts and bridges placed in streams or drainageways determined to be "waters of the State" require approval from the Oregon Department of State Lands and, the U.S. Army Corps of Engineers.
- Culverts and bridges which convey or cross flows from or through water quality sensitive areas require a local representative of Oregon Department of Fish and Wildlife (ODFW) or other applicable state or federal agency to determine if fish passage is required and to identify site- specific design criteria.
- All culverts and bridges should be designed for fish passage in accordance with ODFW guidance, unless otherwise exempted by the ODFW and the City.
- Culverts and bridges located in City of Portland Environmental and River Environmental Zones must comply with requirements in Portland City Code Title 33.
- Drainageways may also be unidentified watercourse flood zones under Portland City Code Chapter 24.50 of the Portland City Code, even if they are not identified in a federal insurance study, and may be subject to the applicable requirements of that Chapter .

Natural Streambed Channels

Channel crossings must be designed to span a total of 1.2 times the active channel's width plus 2 feet, unless otherwise approved by BES. Natural channels should have natural streambed material. Recommended crossing configurations include bridges and no-slope, and stream simulation culvert design as described in Appendix B.

Artificial Channels

A piped culvert without a natural stream bed may be allowed in certain situations where fish passage is not required, and where upstream and downstream connectivity would provide only minimal environmental benefit Examples include roadside ditch systems and artificial conveyance channels. A crossing designed with a piped culvert must provide outlet protection against downstream scour as outlined in the SDFDM.

5.9 Drainage Reserve Submittal Requirements

Existing conditions and proposed conditions site plans are required for all projects when a drainageway is located within 50 feet of a permanent or temporary disturbance area. Additional submittal requirements apply for proposed encroachments into a drainage reserve. Table 5-3 of submittal requirements is provided for reference. Contact BES for requirements based on the specific proposal.

Table 5-3. Summary of Drainage Reserve Submittal Requirements

Type of Requirement	No Impact to Drainage Reserve	Drainage Reserve Buffer Encroachment (within the outside 5-foot edge of the drainage reserve)	Channel Encroachment (typically extends 10 ft on either side of the centerline)
Topographic survey	A formal survey may not be required	Required	Required
Existing conditions site plan	Required	Required	Required
Proposed site plan	Required	Required	Required
Mitigation plan/Landscape plan	Not required	Required	Required
Construction management plan and erosion control plan	May not be required	Required	Required
Supplemental narrative	Not required	Required	Required
Engineering analysis	Not required	May be required	Required
O & M plan and O & M form recorded with the county	Not required	Required unless the encroachment does not require mitigation	Required
Notice of Condition Drainage Reserve Form recorded with the County	Required if the encroachment does not require mitigation	Required if the encroachment does not require mitigation	O & M Required Notice of Condition Form not required.

Drainage reserve and channel encroachments are depicted in Figure 5-2.

5.9.1 Existing Conditions Site Plan

The existing conditions site plan must include the following items:

- ☐ Existing improvements, such as structures, impervious areas, utility lines and, fences.
- ☐ Property lines.
- ☐ Topography showing existing contour lines at 2-foot intervals or property slope information (Property slope information may be allowed in place of a survey and contour lines. Property slope information is available at portlandmaps.com. Directions for determining average slope are also available at Portland City Code 33.930.060.).
- ☐ The location of drainageways and drainage reserves. A standard drainage reserve is 15 feet from each side of the drainageway's centerline. A survey of the drainageway may not be required if no encroachments are proposed, in which case the location of the drainageway and drainage reserve may be approximated.
- ☐ Development sites with multiple drainageways do not need to survey drainageways that are not within 50 feet of the temporary and permanent disturbance areas. However, it should be noted on the existing conditions plan that multiple drainageways exist on the site.
- ☐ Drainage patterns, using arrows to indicate the main direction of drainage flow.

5.9.2 Proposed Site Plan

The proposed site plan must include the following items:

- ☐ Proposed development, including but not limited to proposed buildings, walkways, decks, retaining walls, bridges, garages, utility lines, stormwater management systems, grading, and proposed planting areas.
- ☐ An outline of proposed disturbance areas indicating both temporary and permanent disturbance areas.
- ☐ The location of the drainage reserve in relation to disturbance areas. Indicate the distance between the two when the disturbance is within 50 feet of the drainage reserve.
- ☐ When a stormwater outfall is proposed, include the type, location, and size of any stormwater facilities discharging to the drainage reserve and the proposed stormwater discharge locations. Provide the cross-section and plan view of any proposed discharge locations.

- ☐ Any additional requirements specific to the site or project.
- ☐ Indicate on the site plan how the drainageway is being protected during construction.

5.9.3 Additional Submittal Requirements for Encroachments

In addition to the above requirements, the following items are required for drainage reserve buffer encroachments and channel encroachments unless the applicant contacts BES staff and is informed of items not required for the specific proposal.

Existing and Proposed Site Plan Requirements

Existing and proposed site plans should include the following:

- ☐ A site plan showing the proposed encroachments. Examples of proposed encroachments are listed in Section 5.5.
- ☐ Grading plan showing 1-foot contours within the drainage reserve.
- ☐ Surveyed cross-sections of existing conditions and proposed conditions as appropriate and depending upon the impact to the drainage reserve including:
  - A minimum of three surveyed cross-sections of the existing drainage reserve where the drainage reserve enters and exits the property, and also at the location of the proposed encroachment.
  - Additional surveyed cross-sections at points of significant change and configuration (e.g., grade or size of channel).
  - Additional cross-sections as appropriate to describe proposed alterations to the reserve or channel.
  - A longitudinal profile of the drainageway thalweg that includes the calculated average channel slope.
  - Cross-sections should be wide enough to show grading impacts and the depth of the 25-year storm.
- ☐ If a pipe, culvert, or crossing is proposed, include longitudinal-profile, diameter, depth, slope, type and invert elevation of the pipe, culvert or crossing. The longitudinal profile should extend as far upstream and downstream as necessary to capture hydraulic effects caused by the drainageway crossing.

Mitigation Plan/Landscape Plan

The applicant must provide a plan or plans that show the following:

- ☐ Proposed restoration and mitigation within the drainage reserve area and on the site as described in Section 5.6.
- ☐ The existing trees and vegetation within the proposed drainage reserve disturbance area(s).
- ☐ A plant list, or table of proposed plantings, including botanic and common names, size at time of planting, quantity, spacing, evergreen or deciduous species, and other information in accordance with landscape industry standards.
- ☐ The method of irrigation, if needed, to be used for the establishment period.

Construction Management Plan and Erosion Control Plan

The construction management plan and erosion control plan should include the following:

- ☐ Construction staging and access plan showing staging areas and access paths.
- ☐ Temporary and permanent disturbance areas.
- ☐ Measures to protect drainage reserve areas on the site during construction.
- ☐ Measures to permanently protect disturbed soil.
- ☐ Temporary diversion plan if grading is proposed in the drainage reserve channel.
- ☐ A dewatering plan may be required under certain conditions. Source Control Manual dewatering requirements may apply.
- ☐ Construction timetable that notes any seasonal construction limitations for drainage reserve area protection and documents any coordination with appropriate local, regional, special district, state, and federal regulatory agencies, if applicable.

Supplemental Narrative

The supplemental narrative should include the following when applicable:

- ☐ A description of the project site.
- ☐ A description of the proposed encroachment (reserve encroachment or channel encroachment) and proposed changes to the drainageway.

- [ ] An explanation of how the encroachment and impacts have been minimized to the maximum extent practicable.
- [ ] A description of compliance with state and federal regulations.
- [ ] A description of the measures taken during construction to protect the drainage reserve area. For example, describe how trees will be protected, erosion controlled, construction equipment controlled, and construction scheduled. Include a flow-diversion plan if necessary.

Engineering Analysis Submittal Requirements

Applicants should demonstrate that the proposed encroachment maintains the conveyance capacity of the channel, maintains a stable channel, and is protective of water quality. BES will automatically assume that these conditions have been demonstrated if all of the following are true: the disturbance in the reserve is temporary; it does not adversely impact existing grading; and it does not result in construction of a new structure.

Hydrology calculations: The following hydrology calculations and analysis are required to be stamped by an Oregon licensed professional engineer:

- [ ] Hydrology calculations for the 25-year, 24-hour storm event for the existing conditions based on a modeling approach approved in the SDFDM. Delineate the drainage basin accounting for piped and rerouted catchment areas.
- [ ] If the encroachment is not within the extent of the 25-year, 24-hour storm conveyance channel, then no additional hydrologic analysis is necessary.
- [ ] If the encroachment is within the extent of the 25-year, 24-hour storm conveyance channel provide hydrology calculations demonstrating the impacts of the encroachment.
- [ ] If the encroachment maintains conveyance capacity of the existing drainageway for the 25-year, 24-hour storm event, no additional hydrologic analysis is necessary.
- [ ] If the encroachment will cause a change to the 25-year, 24-hour conveyance channel geometry or location, then provide the following:
    - Calculations showing impacts of the encroachment to flow in the drainageway, including decreases in flow conveyance volume, flow path alteration, or ponding caused by any structure.

- Documentation demonstrating that any change to the drainageway channel geometry or location results in no adverse impacts to the natural function of the drainageway (e.g., channelization or increased erosion) or neighboring properties (e.g., flooding).
- Water surface elevations for design events under existing and proposed conditions in plan, cross-section, and profile. Hydrology calculations must extend far enough upstream and downstream to capture any hydraulic impacts of the encroachment.
- Designs for bed and bank stabilization using bioengineering.
- If the bed will be disturbed, provide specifications for the channel bed material and replanting based on best professional judgement considering existing conditions, shear stress analysis, scour analysis, sediment mobility calculations, and other relevant information.

- [ ] If a crossing or culvert is proposed, provide the following:
    - Hydraulic calculations demonstrating compliance with culvert capacity requirements for high flow conveyance in the SDFDM.
    - If a natural bed is proposed, bed material design to accommodate specific hydraulic conditions in the crossing or culvert.
    - A scour analysis for bed stability and structural stability.
- [ ] If a private pipe is proposed, demonstrate that there is adequate capacity to convey the 25-year event without adverse impacts to neighboring properties.

Operations and Maintenance (O & M) Plan Submittal Requirements

An (O & M) Plan is required for a drainage reserve that will be impacted by a permanent or temporary disturbance. Drainageways and conveyance features must be restored to acceptable conditions, as determined by BES. O&M plans must be recorded with an O&M Form in the County of the subject property. Standard O&M plans for drainage reserves, culverts and outfalls are in Section 5.10.1.

5.10 Notice of Drainage Reserve and Operations & Maintenance

Stormwater conveyance features include drainageways, culverts, outfalls, and other features that are used to transport drainage, stormwater, and surface waters. Conveyance features serve important hydrologic, hydraulic, and water quality functions for Portland's waterways and stormwater systems.

Drainageways, associated drainage reserves and required mitigation for any related encroachments, must be protected and maintained to preserve key watershed processes. Related encroachments, including culverts and outfalls, must be maintained in good operating condition to minimize negative effects on watershed processes and ecological functions while adequately conveying flows downstream. The private property owner is responsible for preserving and maintaining drainage reserves and conveyance features as necessary and as required.

To help ensure long-term protection of drainage reserve areas, a notice about the drainage reserve must be recorded against the property deed through the applicable County recorder's office via a Notice of Drainage Reserve Form or an Operations and Maintenance (O&M) Plan and Form. Both forms notify current and future property owners of the presence of a drainage reserve onsite and associated restrictions and required maintenance activities. The type of form required will depend on the impact to the drainage reserve. It is the property owner's responsibility to record the relevant document with the County. BES may record the Notice of Drainage Reserve Form during a development review process, typically at land use, with notification to the property owner.

A Notice of Drainage Reserve Form is required when the drainage reserve has not been impacted or when an encroachment into the drainage reserve does not require mitigation. Notice of Drainage Reserve Form submittals must include:

- A Notice of Drainage Reserve Form recorded with the appropriate county; and
- A site plan showing the location of, or approximate location of, the drainageway and drainage reserve.

An O&M Plan and Form are required when the proposed encroachment or associated mitigation requires future maintenance. This includes but is not limited to culverts, outfalls and mitigation plantings. O&M submittals to BES must include:

- A Standard O&M Plan for conveyance features indicating how the restored features will be maintained.

- A completed O&M Form that has been recorded with the appropriate county.
- A Site Plan as required in Section 5.9.

5.10.1 Standard O&M Plans

A drainage reserve must be restored to its optimal condition, as determined by BES, following the construction of encroachments or the completion of other work in the drainageway. Standard O&M Plans for drainage reserves, culverts and outfalls are listed in the next section. Site specific O & M plans may be allowed as approved by BES.

STANDARD OPERATIONS AND MAINTENANCE PLAN

5.10.1.1 Drainage Reserve Buffer or Channel Encroachment

Natural and structural components must freely convey stormwater and protect water quality.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Clogged conveyance capacity	• Identify obstructions and clear them immediately; maintain at least 70% conveyance capacity at all times. • Remove sediment by hand, minimizing damage to native vegetation. • Trim vegetation, large shrubs, or trees that are blocking conveyance.
	Erosion	• Control erosion when occurring using appropriate erosion control methods. • Maintain rock splash pads, channel stabilization efforts or energy dissipaters to prevent erosion. • Stabilize soils with plants from the Portland Plant List. • Use biodegradable erosion control materials. Remove non-biodegradable erosion control materials (such as reinforced silt fence, bio-filter bags, or erosion blankets) once the plants are established and the site is stabilized.
	Bank/Side slope maintenance	• Stabilize and plant slopes using appropriate erosion control measures when erosion is occurring.
Vegetation within the drainage reserve mitigation area must be well maintained, healthy, and dense enough to provide filtering while protecting underlying soils from erosion.		
	MAINTENANCE INDICATOR	**CORRECTIVE ACTION**
	Dead or dying vegetation	• Replace vegetation to maintain 90% cover density within 1 year, and control erosion where soils are exposed within the drainage reserve mitigation area.
	Nuisance or prohibited plants are discovered within the drainage reserve mitigation area	• Remove vegetation identified as a nuisance on the Portland Plant List upon discovery (such as Himalayan blackberries and English Ivy) and when nuisance vegetation is contributing to more than 25% of the vegetation coverage. • Remove nuisance vegetation with hand-held equipment to the maximum extent practicable. All vegetation removal or trimming activities must be protected to prevent erosion and sediment from leaving the site or negatively impacting resources on the site. Replant and stabilize soils with plants from the Portland Plant List. • Apply mulch around plants as needed for weed suppression outside of the drainage channel. • Irrigate planted areas as needed until vegetation is well established.

Maintenance records: The property owner is required to keep an inspection and maintenance log. Record date, description, and contractor (if applicable) for inspections, repairs and maintenance activities. This log must be available to City inspectors on request.

Pesticides and herbicides: The use of pesticides and herbicides is strongly discouraged due to the potential negative impacts to downstream systems. If pesticides and herbicides are desired use the service of a licensed applicator and a product approved for aquatic use.

Inspections: Drainage reserves that have been modified through a City permit process must be inspected and maintained by the property owner to ensure proper function. All facility components and vegetation must be inspected for proper operations and structural stability, at least 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 1 inch within 24 hours).

Access: Access to the drainageway must be safe and efficient.

Pollution prevention: Spill prevention measures must be exercised when handling substances that could contaminate stormwater. Releases of pollutants must be corrected as soon as identified.

STANDARD OPERATIONS AND MAINTENANCE PLAN

5.10.1.2 Culverts

Structural components must be operated and maintained in accordance with the design specifications. Culvert inlets and outlets must be maintained for an unimpeded and controlled flow of water.

	MAINTENANCE INDICATOR	CORRECTIVE ACTION
	Clogged conveyance capacity	• Clear pipes when conveyance capacity is compromised. • Remove accumulated debris and sediment when it blocks 1-foot or 50% of conveyance capacity, whichever is smaller.
	Sediment accumulation	• Remove sediment accumulated in pipes using proper containment.
	Erosion or exposed soils	• Control erosion when erosion channels are forming. • Use biodegradable erosion control materials. • Remove non-biodegradable materials (such as reinforced silt fences, bio-filter bags, or erosion blankets) once the plants are established and the site is stabilized. • Stabilize soils with plants from the Portland Plant List.
	Cracked or broken pipe/structure	• Repair or replace broken or cracked components.
	Scouring at the entrance or exit	• Ensure scour protection is provided at the inlet and outlet per original design.
	Bank/side slope stabilization	• Stabilize sloped banks with approved plantings from the Portland Plant List.

Maintenance records: Training or written guidance for protecting and maintaining culverts (including this O&M Plan) must be provided to all property owners and tenants. The property owner must keep a log, recording inspection dates, observations, and maintenance activities. This log must be available to City inspector upon request.

Inspections: Culverts must be inspected and maintained by the property owner to ensure proper function. Inspect facility components for proper operation and structural stability, at least2 times per year and within 48 hours after each major storm event (defined as 1 inch in 24 hours).

Access: Access to the culvert must be safe and efficient.

Pollution prevention: Implement spill prevention measures when handling substances that could contaminate stormwater. Releases of pollutants must be corrected as soon as identified.

5.10.1.3 Outfalls

Structural components must be operated and maintained in accordance with the design specifications.
Outfall inlet & outlet must be maintained to ensure an unimpeded and controlled flow of water.

	MAINTENANCE INDICATOR	CORRECTIVE ACTION
	Clogged inlets or outlets	• Clear inlets and outlets, including piped outfalls when they are plugged. • Address sources of sediment and debris.
	Clogged conveyance capacity	• Clear overland flow paths and drains to maintain 70% conveyance capacity. • Identify causes for altered flow; clear obstructions upon discovery.
	Sediment accumulation	• Remove sediment from pipes using proper containment.
	Erosion or exposed soils	• Maintain rock splash pads or energy dissipation structures. • Identify and control sources of erosion when erosion channels are forming. • Use biodegradable erosion control materials. • Remove non-biodegradable erosion control devices (such as silt fences) once the plants are established and the site is stabilized. • Stabilize soils with approved plants from the Portland Plant List.
	Cracked or broken pipe/structure	• Repair or replace broken or cracked components when necessary.
	Check dams missing, scattered or with gaps	• Maintain and repair check dams as per standard details.
	Scouring at the entrance or exit	• Ensure energy dissipation structures (such as splash pads, rock rip-rap, gravel, and log check dams) are properly installed. Replenish materials as necessary.
	Bank/side slope stabilization	• Stabilize sloped banks with approved plantings from the Portland Plant List.

Maintenance records: Training or written guidance for protecting and maintaining outfalls (including this O&M Plan) must be provided to all property owners and tenants. The property owner must keep a log, recording inspection dates, observations, and maintenance activities. This log must be available to City inspectors upon request.

Inspections: Outfalls must be inspected and maintained by the property owner to ensure proper function. All facility components must be inspected for proper operations and structural stability, at least 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 1 inch in 24 hours).

Access: Access to the outfall must be safe and efficient.

Pollution prevention: Spill prevention measures must be exercised when handling substances that contaminate stormwater. Releases of pollutants must be corrected as soon as identified.

Notice of Drainage Reserve Form for Recording Against Property Deed

This Notice of Drainage Reserve Form supersedes document number ______________________

(for official county use only)

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

After recording, return copy to:

CITY OF PORTLAND
BUREAU OF ENVIRONMENTAL SERVICES
1900 SW Fourth Avenue, Suite 5000
Portland, OR 97201

Notice of Drainage Reserve

Site Legal Description:

____ is the owner or are the owners of the lot or parcel with Property ID No. ____________________located at ______________________________ ("the Property"). The Property contains one or more drainageways and drainage reserves as those terms are defined by Portland City Code ("PCC") Chapter 17.38. PCC Section 17.38.030 authorizes the City's Bureau of Environmental Services ("BES") to protect drainageways, and the City's Stormwater Management Manual specifies how BES identifies drainageways and places drainage reserves.

To assure long-term protection of the drainageway(s), BES has placed a drainage reserve over the drainageway(s) on this property, as noted in the attached site plan or description. The drainage reserve is 30 feet in width, extending 15 feet from the centerline of the identified channel on each side, unless otherwise noted on the attached site plan or description. Drainage reserve widths may be revised during future development review processes that impact the drainage reserve, based on additional information. Within the drainage reserve, construction and other development, alteration of stormwater flow paths, and disturbance of vegetation is prohibited without BES's written approval of those activities and of a drainage reserve operations and maintenance plan. In addition, current and future owners of the Property must ascertain and comply with all applicable land use and building permit requirements, the Stormwater Management Manual, and conditions of approval and should confer with BES review staff.

Check all that apply:

Multiple drainageways exist on this property.

Site plan or description of the location of the drainageway attached (required).

Any failure to comply with these terms may result in enforcement actions by BES. The owner or owners also accept that the City requires this Notice of Drainage Reserve Form to be recorded with the chain of title with the county in which the Property is located. Unless BES states otherwise in writing, it is the property owner's responsibility to record this document with the County

A revised Notice of Drainage Reserve Form must state that it supersedes a previous Notice of Drainage Reserve Form (with cited county document number; See Page 1)

THIS PAGE MUST BE SIGNED IN THE PRESENCE OF A NOTARY.

By signing below, the owner or owners accept and agree to the requirements of PCC Chapter 17.38 and associated administrative rules with respect to the drainage reserve(s) on the Property identified in this Notice.

____
Signature Property Owner or
Authorized Representative (1)

____
Signature Property Owner or
Authorized Representative (2)

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:

CITY OF PORTLAND
Stormwater Management Manual

OPERATIONS & MAINTENANCE FORM

DRAINAGE RESERVES

☐ This O&M Form supersedes 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 (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:

Party Responsible 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, and associated administrative rules.

The requirements are based on the current version of the *City of Portland Stormwater Management Manual* on the date of permit submittal.

OPERATIONS & MAINTENANCE FORM

DRAINAGE RESERVES

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 recorded with this O&M Form. The owner further acknowledges that this form and associated documents have 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 drainageway to a functional state as approved under original requirements.

The owner also accepts that the City requires property owners to submit to BES and record with the applicable County complete and accurate O&Ms enforceable under City Code 17.38. Property owners must consult with the City prior to making changes to the O & M plan to determine if a new permit or O & M submittal is required.

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.

SITE PLAN

☐ **I have attached a site plan** *(required)*.

Attach a scaled site plan to this submittal that includes all of the information required as shown in Chapter 5.9 of the *Stormwater Management Manual.*

Maintaining the drainageway and drainage reserve(s) shown on the attached site plan is a required condition of building permit approval for the identified property. Property owners are required to 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 only be modified with both written consent of current owners and written approval of the Bureau of Environmental Services.

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:

5.11 Enforcement

Unauthorized encroachments and adverse impacts within the drainage reserve, and failures to comply with O & M Plans are violations of Portland City Code Chapter 17.38 and the SWMM. BES enforcement rules and tools are established in the BES Enforcement Administrative Rules (Portland Policy Document ENB-4.15).

BES investigates and administers enforcement actions on all potential drainage reserve violations. BES may also refer violations to BDS Code Enforcement if drainage reserve encroachments or impacts did not occur in accordance with approved building or development permits.

BES staff may use a variety of methods such as education and technical assistance to remediate or mitigate violations. Staff may work with property owners to establish agreeable compliance schedules to address deficiencies. However, BES reserves the right, at any time, to remediate and engage in associated cost recovery for violations posing an imminent threat to public safety or water quality

Chapter 6. Vendor List Submittal Requirements

This chapter outlines requirements for vendors submitting MSTTs or blended soil for inclusion on City vendor lists.

6.1 Introduction

This chapter outlines requirements for vendors submitting their products for inclusion on one of the following lists:

- Approved Manufactured Stormwater Treatment Technologies (MSTTs); and
    - Vendors of the Blended Soil Specification for Vegetated Stormwater Systems.

6.2 Manufactured Stormwater Treatment Technologies (MSTTs)

BES maintains a list of approved MSTTs on the BES Stormwater Management Manual website. MSTTs on the list have been reviewed and approved by BES to meet the water quality treatment standards of the SWMM when properly maintained. Projects proposing the use of MSTTs to meet SWMM water quality requirements must select devices on the list and also meet BES' conditions of use, including the sizing requirements. In limited situations, BES may allow use of MSTTs that are not on the approved list as discussed in Section 2.5.3.6.

Applicants seeking to place their product on the list must apply for approval by BES and follow the submittal and review requirements in this chapter. BES has decision-making authority to approve, deny, revoke, or revise the use of an MSTT within the City at any time, regardless of previous certification by WA DOE or prior approval by BES.

6.2.1 Requirements

The applicant's device must have a current General Use Level Designation (GULD) for Basic Treatment under the Washington State Department of Ecology (WA DOE) Technology Assessment Protocol-Ecology (TAPE) program. Information about the TAPE field-testing protocol is provided on the WA DOE TAPE Program website.

BES will accept an application for review no sooner than 2 years after the date of the WA DOE GULD approval to ensure applicants successfully meet the application requirements described in Section 6.2.2.1 (see references requirements).

6.2.2 Application and Evaluation Process

To begin the application process, applicants seeking BES approval for a device must submit a complete application to the City. Once the application is complete, BES will notify the applicant and provide a list of the review committee members and the point of contact at BES. The applicant must direct all correspondence and communication regarding the application to the designated point of contact at BES. The applicant must provide a public presentation about the MSTT which includes attendance by the review committee members. They are also required to attend a technical interview conducted by members of the review committee. The review committee will determine whether the MSTT can be approved, and if approved, the conditions of use. BES reviews one completed application at a time, in the order received.

Public Records and Confidential Information

All documents provided to the City by the applicant will be considered public records and thus subject to public disclosure pursuant to Oregon public record laws (ORS 192.311 to 192.431). Any portion of an application the applicant claims as exempt from disclosure must meet the requirements of a statutory exemption. 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 containing information that is 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. Only the members of the review committee will review information that is exempt from public disclosure.

6.2.2.1 Requirements for a Complete Application

For an application to be complete, it must include all data and documentation necessary to verify performance. BES may request additional documentation or data during the review process. The application must include the following:

Application Form. The application form (“MSTT Form”) is at the end of this section.

Application Fee. The application fee indicated on the MSTT Form is due when the applicant submits the application. Make checks out to the City of Portland in the amount shown on the MSTT Form. The fee covers City staff time to process, coordinate, and review the application.

Cover Letter. The cover letter should be no more than 2-3 pages long, and it must include the following:

- The name of the device, with a short description of its intended application in the City of Portland.
- A short summary of the history of testing under the TAPE program, including the dates of the GULD certification and any subsequent revisions.
- A summary of the treatment performance goals and targeted pollutants for which the device received TAPE certification.
- The signature of a company representative authorized to submit the application.

TAPE Documentation. The applicant must submit all final documentation used to support the TAPE GULD certification. The required documentation includes the following:

- The Technology Evaluation Report (TER), including appendices and any third-party review memoranda.
- The Quality Assurance Project Plan (QAPP), including any appendices.
- The most recent GULD certification awarded by WA DOE.

Submit the TAPE documentation to BES as it was submitted to WA DOE. Do not re-order or otherwise modify the TER or QAPP. If the TAPE GULD approval was dependent on sizing modifications or reduced treatment flow rates, provide the justification and analysis. If TAPE GULD certification required post-installation maintenance monitoring or analysis, provide the results of the analysis as supplemental information.

Design Information. Submit standard details for all configurations, orientations, and bypass options under consideration. Provide criteria and sizings for all unit components and sizing criteria. Provide flow-based sizing to meet the City of Portland's pollution reduction requirements, including any sizing assumptions or requirements per the TAPE GULD certification for the receiving drainage area (square feet or acres). If a unit is also designed for volume-based sizing, provide that information as well, as measured in a unit's receiving drainage area (square feet or acres).

References. Provide references from at least two public agencies that have used the MSTT in the public right-of-way for a minimum of 18 months. The references should be from public works departments or stormwater operations and maintenance groups that have monitored or documented inspection frequencies and maintenance activities and requirements. Alternatively, BES may be willing on request to evaluate other sources of operations and maintenance data for installations managing runoff from the right-of-way or in commercial parking lot applications. The data should be representative of applications in the Pacific Northwest.

Additional Product Information. Provide the most recent installation guides, maintenance guides, and recommended plant lists (as applicable) if they have been updated since the TAPE GULD designation. Provide current marketing materials only for the MSTT under consideration.

Application Submittal
Submit all of the required documents digitally, including one set of PDF files and one set of native files if available in a standard format (e.g., if analysis or data tracking was done using Excel, submit the original Excel files). Submit the application including all related documentation and the application fee to the following address:

City of Portland, Environmental Services
ATTN: Code, Rules, and Manual Group
1120 SW 5th Ave., Suite 613
Portland, OR 97204

6.2.2.2 BES Evaluation Process
After BES determines the application is complete, it will work with the applicant and members of the review committee to schedule an appropriate time for the public presentation and interview with the review committee. The goal is for these events to occur within 30 business days of confirmation that the application is complete.

Public Presentation: The presentation will be open to the public and include members of the review committee. The presentation should last 30-45 minutes, with the remainder of the hour devoted to answering questions from the audience.

Technical Interview: At the end of the public presentation, there will be a separate meeting to allow the review committee to interview the applicant about the proposed MSTT. The interview will not be open to the public: attendance will be limited to members of the review committee and the applicant. The applicant should be prepared to respond to questions about each of the key sections of the TER as they apply to the Portland area. Applicants should also be prepared to discuss local or regional examples of operations and maintenance programs implemented by public agencies and private entities.

6.2.3 BES Review Determination
The members of the review committee will make reasoned decisions about the use of the MSTT in the City of Portland, based on their best professional judgment about the information provided by the applicant. BES' goal is to provide a final decision of approval or denial within 30 business days following the date of the public presentation and technical interview. BES has decision-making authority for approval of MSTTs for use within the City of Portland and may place specific conditions on an approval.

BES will approve or deny the application, and apply conditions of use, based on the GULD certification and other submittal information. BES will take into account considerations that include but are not limited to conditions that:

1. Provide consistency with local zoning or land use requirements.
2. Meet watershed-specific water quality requirements.
3. Guide engineering design including sizing requirements, placement of facilities, and allowed configurations.
4. Consider ease of maintenance, maintenance access, and maintenance frequency requirements.

BES has the authority to apply additional criteria or restrictions on MSTTs for publicly-maintained facilities (e.g., facilities in the right-of-way). The criteria and restrictions may be related to, but not be limited to, maintenance factors such as equipment requirements, access requirements, logistical efficiency, and the frequency of maintenance needs in the right-of-way. BES may require pre-treatment upstream of devices that are publicly-maintained to lengthen intervals between maintenance visits.

BES may at any time suspend or revoke approval of an MSTT if the performance of the technology does not meet the performance criteria at the time the device was approved, or if BES' performance criteria changes due to local, state, or federal pollution reduction requirements, or maintenance considerations. BES may also revise an existing approval, for instance limiting the approval of a device in certain applications, if field observations or operational experience support a change.

6.2.3.1 Appeals

An applicant may request an administrative review of BES' evaluation process for a specific device, per the requirements outlined in Section 1.9.

6.2.3.2 Term of the Approval

BES may require submittal of another application if the technology has changed, pollution reduction requirements have changed, or there has been a change in BES evaluation criteria since the original approval of the technology.

CITY OF PORTLAND
Stormwater Management Manual

MANUFACTURED STORMWATER TREATMENT TECHNOLOGY APPLICATION FORM

Applicants applying for approval of manufactured stormwater treatment technologies must meet the submission guidelines and evaluation requirements in Section 6.2 of the *Stormwater Management Manual*. The technology must have a general use level designation (GULD) from the Washington State Department of Ecology Technology Assessment – Ecology (TAPE) Program.

Applicants must submit all of the required application materials in order for their application to be considered complete. Applicants must submit one set of digital files of all required items and data.

Date of Request: ______________________

REQUIRED APPLICATION MATERIALS

- ☐ Application Fee ($5,000)
- ☐ Cover Letter
- ☐ TAPE Documentation
- ☐ Design Information
- ☐ References
- ☐ Additional Product Information

All applications and payments should be submitted to:

ATTN: Stormwater Manual Group
City of Portland
Bureau of Environmental Services
1120 SW 5th Ave., Suite 613
Portland, OR 97204-1972

APPLICANT INFORMATION

Contact Name: ______________________

Company Name: ______________________

Address: ______________________

Phone: ______________________

Email: ______________________

Website: ______________________

TECHNOLOGY INFORMATION

Name of technology: ______________________

Manufacturer: ______________________

Brief description:

____

____

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6.3 Blended Soil for Vegetated Stormwater Systems

BES maintains an online list of vendors and their products that have successfully demonstrated compliance with BES' standard specification for the blended soil for vegetated stormwater systems. The list is located online (BES Soil Vendor List). For public works projects in the right-of-way, BES provides the list as a service to designers and contractors sourcing material; it is for informational purposes only and it is not a list of pre-approved vendors or products. Contractors for public works projects must demonstrate compliance with BES's standard specification for every project by submitting test reports per the specification requirements (BES Stormwater Soil Specification). See Section 3.2.2 concerning requirements for sourcing blended soil for projects on private property.

First-time vendors seeking to place their product on the list should consult the specifications for the blend (BES Stormwater Soil Specification) and submit the required analytical information that shows compliance with the specification to BESStormmanual@portlandoregon.gov.

BES may at any time remove the name of a vendor from the list of vendors if the vendor submits, or BES obtains, analytical reports showing the vendor's material does not comply with the current BES standard specification for the blended soil for vegetated stormwater systems.

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Definitions

Applicant: Any person, company, or agency that applies for a permit through the City of Portland, including all parties represented or hired by the applicant. Applicant may also be referred to as the Permit Applicant.

Backfill: The material used to refill an excavation.

Baffle*:* A structure built to absorb energy; trap floating debris; or deflect, check, disturb, or regulate flow. A baffle can be a device used in a culvert to facilitate fish passage.

Best Management Practices (BMPs): See PCC 17.04.010 Definitions

Bollard: A post used to prevent vehicular access. A bollard may or may not be removable.

Building: A structure that has a roof and is enclosed on at least 50 percent of the area of its sides.

Bulkhead: A plug installed in a sewer to prevent flow into or out of the sewer system.

Capacity: See PCC 17.38.020 Definitions

Carriage Walk: A walkway that connects the public sidewalk and the street curb.

Catch Basin: A structure with a sumped sediment storage or inverted pipe to capture pollutants located just below the ground surface that collects and guides stormwater runoff to an underground sewer system.

Channel: A depression that conveys water and is open to the air under open low conditions, such as the bed of a stream or river, a ditch, or a conduit.

Check Dam: A low structure or weir placed across an open channel, or a stormwater facility to control water depth, velocity, or channel erosion.

City Storm Sewer: See PCC 17.39.020 Definitions

Cleanout: A pipe constructed vertically from a sanitary lateral or a terminus sewer using a wye fitting and extending to the ground surface to provide a point of entry for sewer cleaning or inspection equipment. Cleanouts can also be used in stormwater facilities and stormwater laterals.

Collector Sewer: A pipe designed to collect flow from two or more sewers.

Combined Sewer: See PCC 17.32.020 Definitions

Combined Sewage: Wastewater containing both sanitary sewage and stormwater flows.

Combined Sewer Overflow (CSO): A discharge of a mixture of sanitary sewage and stormwater at a point in the combination sewer system designed to relieve surcharging flows.

Common Private Sewer System (also called Party Sewer): See PCC 17.32.020 Definitions.

Connection: See PCC 17.32.020 Definitions

Conveyance: See PCC 17.38.020 Definitions

Critical Depth: A flow depth occurring under open-channel conditions that produces the greatest discharge while minimizing the specific energy of the flow.

Critical Flow: The maximum flow quantity carried in an open channel that coincides with a critical depth and velocity.

Crown: The inside top of a pipe measured directly above the invert.

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 maintenance holes, inlets, or catch basins. Water flowing in a culvert generally occurs as an open-channel flow.

Curb: A raised margin formed along the edge of a street or other paved area forming part of a gutter to convey surface water to an inlet or an approved point of disposal.

Department of Environmental Quality (DEQ): See PCC 17.04.010 Definitions

Design Storm: A specified rainfall depth and rainfall distribution used in the design of hydraulic structures to estimate runoff.

Detention Facility: A facility designed to receive and hold stormwater and release it gradually at a significantly slower rate than would otherwise occur. The facility may provide minimal or no volume reduction. Examples include a detention tank, vault, or oversized pipe.

Development Activities: Any human-induced activity on 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 Footprint: The new or redeveloped area covered by buildings or other roofed structures and other built surfaces that either 1) do not allow stormwater to percolate into the ground, such as roads, parking lots, and sidewalks; or 2) are covered by pervious paving materials and systems.

Discharge Point: See PCC 17.38.020 Definitions

Discharge Rate: See PCC 17.38.020 Definitions

Disturbance: An action that causes an alteration to site development, soil or vegetation. The action may create temporary or permanent disturbance. Examples include development, exterior alterations, exterior improvements, demolition and removal of structures and paved areas, and cutting, clearing, damaging, or removing native vegetation.

Disturbance Area: The area where all temporary and permanent disturbance occurs. For new development the disturbance area must be contiguous. Native vegetation planted for resource enhancement, mitigation, remediation, and agricultural and pasture lands is not included. The disturbance area may contain two subareas, the permanent disturbance area and the temporary disturbance area:

- **Permanent Disturbance Area:** The permanent disturbance area includes all areas occupied by existing or proposed structures or exterior improvements. The permanent disturbance area also includes areas where vegetation must be managed to accommodate overhead utilities, existing or proposed non-native planting areas, and roadside areas subject to regular vegetation management to maintain safe visual or vehicle clearance.
- **Temporary Disturbance Area:** The temporary disturbance area is the portion of the site to be disturbed for the proposed development but that will not be permanently occupied by structures or exterior improvements. It includes staging and storage areas used during construction and all areas graded to facilitate proposed development on the site, but that will not be covered by permanent development. It also includes areas disturbed during construction to place underground utilities, where the land above the utility will not otherwise be occupied by structures or exterior improvements.

Diversion Structure: a sewer maintenance hole or structure with a regulating device to divert flow to another pipe, a point of disposal, to a storage facility, or pollution reduction facility.

Drainage Basin: a defined area that contributes sanitary, stormwater, or combined sewage flows to a point-of-interest or a sewer facility.

Drainage: Waters generated at or conveyed through a particular site. Drainage is predominantly surface runoff generated from rainfall. Groundwater naturally occurring at the surface (such as seeps or springs) or pumped to the surface is considered drainage.

Drainage Reserve: See PCC 17.38.020 Definitions

Drainageway: See PCC 17.38.020 Definitions

Energy Dissipation: Any method used to slow or reduce the total energy of flowing water.

Energy Grade Line: A calculated characteristic determined by adding the potential head and velocity head to describe the total energy of flow at any point in a sewer.

Engineered Fill: Soil fill that is wetted or dried to near its optimum moisture content and placed in discrete lifts (e.g., twelve inches or less) where each lift is compacted to a minimum percent compaction as specified by a geotechnical engineer. Engineered fill is tested in the field for compaction, and placement of fill is typically documented and signed and stamped by a professional civil engineer or certified engineering geologist.

Existing Offsite Conditions: The conditions of the offsite drainage patterns, vegetation, and impervious cover at the time of analysis, including any problems recorded or observed in the study area at the time of analysis.

Facial Challenge: A challenge to a requirement that is based on an argument that the requirement cannot be applied fairly or reasonably in any situation. By contrast, an as-applied challenge is one based on an argument that a requirement should not be applied to the challenger’s particular situation because of factors that, in the challenger’s view, distinguish it from similar situations.

Factor of Safety: 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.

Floodplain: The land subject to periodic flooding from a surface water body, including the 100-year floodplain as mapped by FEMA Flood insurance studies or other substantial evidence of actual flood events.

Flow: The rate of water moving within a natural or man-made system. Flow is measured as a ratio of volume per unit of time, 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 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 and the elevation at which overtopping of the structure or facility that contains the water would occur.

Gabion: An external wire structure filled with earth or stones typically used to stabilize slopes or to dissipate flow energy.

Geotextile: 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.

Grade: Either 1) the elevation assigned to the pipe invert; or 2) the slope of the pipe between maintenance holes or structures.

Groundwater: See PCC 17.38.020 Definitions

Growing Medium: The material that supports plants and microorganisms that improve the function of vegetated stormwater facilities. Growing medium may include stormwater facility blended soil, blended topsoil, or native soils.

Headwall: A structure usually applied to the ends of a culvert or outfall to support an adjacent embankment and protect the pipe end from damage.

Headwater (HW): The depth of water impounded upstream of a culvert caused by a constriction, friction, or the configuration of the culvert entrance.

Hydraulic Gradient (HGL): The calculated slope between the potential head difference measured at different points along a pipe or conduit.

Hydrograph: A graph showing the flow rate past a specific point over time.

Hydromodification: The alteration of the natural flow of water, timing, frequency and volume of runoff from the land surface as a result of urbanization. Hydromodification results in negative impacts to receiving water bodies throughout the year. Reduced summer baseflow limits habitat value. During storm events, an increase in runoff energy and frequency leads to the degradation of natural stream and wetland systems through incision, bank erosion and sedimentation.

Impervious Surface: See PCC 17.38.020 Definitions

Infiltration: See PCC 17.38.020 Definitions

Inlet: Either 1) A structural facility located just below the ground surface that guides flow via an inlet pipe to an underground sewer system; or 2) the entry point, such as downspouts, piping, or curb cuts, into an onsite stormwater management system or discharge point.

Invert: The inside bottom of a pipe or conduit measured directly below the crown.

Maintenance Hole: A structure commonly known as a manhole that provides access to underground utilities for maintenance and inspection purposes.

Municipal Separate Storm Sewer System (MS4): A conveyance or systems of conveyances such as municipal streets, catch basins, curbs, gutter, ditches, manmade channels or storm drains owned by the City of Portland and designed or used for collection or conveyance of stormwater.

Nonconforming Sewer: See PCC 17.32.020 Definitions.

Open Channel: A means of conveyance for fluids that is partially or fully exposed to the atmosphere.

Operations and Maintenance (O&M): The continuing activities required to keep assets and their components functioning in accordance with design objectives.

Orifice: An opening in a plate, wall, or partition through which water may flow for the purposes of flow control or measurement.

Outfall: A location where collected and concentrated water is discharged to a receiving water. An outfall can occur at the end of a piped system, a structural facility, or an open drainage channel.

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 fully percolate into the ground.

PBOT: Portland Bureau of Transportation

Permeability: The ability of water to infiltrate soil or another porous material.

Permit: An official document issued by a regulatory body authorizing performance of a specified activity.

Pervious: Either 1) any surface determined to have a runoff coefficient less than 0.8 as defined in the *Sewer and Drainage Facility Design Manual*; or 2) a surface modified in a way to encourage infiltration of water.

Point-of-Interest: Any location where flow information is desired.

Pollutant: See PCC 17.34.020 Definitions

Pollution Reduction Facility (PRF): a facility designed and constructed to treat stormwater runoff by removing pollutants. These facilities can include natural, passive systems involving vegetation and landscaping or manufactured devices that employ physical and mechanical treatment methods.

Pollutants of Concern: See PCC 17.38.20 Definitions

Practicable: See PCC 17.38.20 Definitions

Presumptive Approach Calculator (PAC): A calculation tool used to size vegetated stormwater facilities.

Public Facility: A street, right-of-way, sewer, drainage facility, stormwater facility, or another asset that is owned or managed by the City.

Public Improvement: See PCC 17.04.010 Definitions

Public Right-of-Way: See PCC 17.38.020 Definitions

Public Sewer: See PCC 17.04.010 Definitions

Public Sewer Easement: See PCC 17.32.020 Definitions

Public Works Project: See PCC 17.04.010 Definitions

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: See PCC 17.38.020 Definitions

Repair: Work performed to patch, replace components of, replace, or rehabilitate facilities.

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.

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.

Santa Barbara Urban Hydrograph (SBUH): A hydrologic method used to calculate runoff hydrographs.

Seasonal High Groundwater Level: The highest level that the permanent groundwater table or perched groundwater may reach on a seasonal basis.

Sedimentation Maintenance Hole: A maintenance hole, typically located upstream of a sump or PRF, that functions as a small settling basin to trap settleable solids from stormwater before being discharged into the downstream facility.

Separated System: A sewer designed to receive either only wastewater or only stormwater.

Sewer System: The combination of all public sewer facilities within the City service area designed to collect, convey, and dispose of sanitary, stormwater, and combined sewage flow. The sewer system includes a broad range of facilities such as sanitary pipe, storm drainage pipe, open channels, combined sewer pipes, and related facilities.

Sewer Main: A primary sewer used to collect flow from several sewer collectors or laterals.

Sheet Flow: Uniform flow over plane surfaces without concentration of water into defined channels.

Site: Any tract, lot, or public right-of-way or contiguous combination thereof where development activities are proposed or performed. For utility lines, trenches or other similar work, the site includes only the disturbance area directly related to the linear work activity.

Steep Slope: An inclined surface whose vertical elevation change increases or decreases at a rate greater than 10 percent (1 foot vertical for every 10 feet horizontal). It also includes any surface of less than 10 percent known to be geologically unstable and prone to soil mass movement and mass wasting and instability.

Stormwater: See PCC 17.38.20 Definitions

Stormwater Management: See 17.38.020 Definitions

Stormwater Management Facility: See 17.38.020 Definitions

Stormwater Retrofit: Installation of a new stormwater facility to treat stormwater from existing impervious surface.

Street Flow: The total amount of stormwater runoff collected in a street gutter.

Structure: Any object constructed in or on the ground. Structure includes buildings, decks, fences, towers, flag poles, signs, and other similar objects.

Surcharge: Either 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; or 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.

Surface Flow: Flow resulting from precipitation traveling overland as sheet flow or as concentrated flow in natural channels, streams or structural conveyance systems.

Tenant Improvements: Structural upgrades made to the interior or exterior of buildings.

Temporary Structure: See PCC 17.38.20 Definitions.

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): The dry weight of suspended particles, that are not dissolved, in a sample of water that can be retained by a filter.

Tract: See PCC 17.38.20 Definitions.

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.

Undocumented Fill: Non-native material imported to a site without documentation in records available to the City. This can range from compacted engineered fill where no construction records exist, to a heterogeneous mix of soil types, organics, cobbles, boulders, construction debris, building rubble, trash, industrial waste, or contaminated materials.

Unit Hydrograph: A hydrograph resulting from a unit depth of excess runoff produced by a storm of uniform intensity and specified duration.

Vegetated Facilities: Stormwater management facilities that rely on plantings as an integral component of their functionality.

Water Body: A naturally occurring water feature that includes rivers, sloughs, perennial and intermittent streams and seeps, ponds, lakes, aquifers and wetlands.

Watercourse: A channel in which water flow occurs, either continuously or intermittently with some degree of regularity. Watercourses may be either natural or manmade.

Water Quality Limited: Waters identified by DEQ that do not meet federal 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 the DEQ website.

Water Quality Storm (Pollution Reduction Storm): 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.

Water Table: The water table, also called the groundwater table, is the upper level of an underground surface in which the soil or rocks are saturated with water. The zone of saturation is where the pores and fractures of the soil or rock are saturated with water. Technically, the water table is the surface where the water pressure head is equal to the atmospheric pressure (where gauge pressure = 0). The water table is defined by the levels at which water stands in a well that penetrates the zone of saturation.

Wellhead Protection Area: A drinking water source area where additional groundwater protections are in place to secure the City's drinking water supplies and protect public health. The City regulates the storage, use, and transportation of chemicals in these sensitive areas, and more stringent stormwater management standards may apply.

Wetland: See PCC 17.38.020 Definitions

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Appendix A. Stormwater Design Methodologies

This appendix describes the methodologies and assumptions used in establishing standards for the various stormwater design approaches.

A-1 Stormwater Facility Sizing

Stormwater facilities can be divided into two categories based upon whether or not the sizing method considers storage within the facility (see Table A-1). Stormwater facilities without storage (or where the storage is not considered in sizing) are sized using a design rainfall intensity. Stormwater facilities with storage can be sized to consider storage using a design rainfall depth distributed over a period of time.

Sizing without Storage

- Rate-based facilities are designed to allow runoff to flow through the system without the system backing up. These facilities may either be designed without storage (e.g., some manufactured stormwater treatment technologies (MSTTs), grassy swales, filter strips) or with storage that is not considered in the sizing (e.g., some MSTTs, sumps[1]).

Sizing with Storage

- Volume-based facilities (e.g., ponds, structured detention) are designed to store a volume of runoff long enough to allow particulates to settle when sized for water quality or to slowly release runoff when sized for flow control.
- Rate-volume-based facilities (e.g., basins, planters, green streets, sand filters, soakage trenches, drywells) are designed to allow runoff to flow through the system with a significant storage component in which runoff can back up.

Table A-1. Engineering Design Approaches for Stormwater Facility Sizing

Storage Considered for Sizing	Sizing Basis	Design Objective	Inflow Calculation Method[1]	Design Storm
No	Rate	Treat or infiltrate the peak runoff as it flows through the system	Rational Method	Rainfall intensity
Yes	Volume	Store the total runoff volume and hold it long enough to meet water quality or flow control standards	Santa Barbara Urban Hydrograph Method (SBUH)	Rainfall depth distributed over 24-hours
	Rate-Volume	Treat or infiltrate the runoff considering both the total volume and varying intensities		

1 The Rational Method and SBUH method are described in the SDFDM and in Appendix A.3.

[1] Sumps are in the public right-of-way and drywells are outside the public right-of-way.

Since there are two categories of sizing methods (i.e., sizing with storage and sizing without storage), the City establishes two categories of design storms: a design rainfall intensity is used for sizing rate-based stormwater facilities (i.e., sizing without storage) and a design rainfall depth is used for sizing both volume-based and rate-volume-based stormwater facilities (i.e., sizing with storage).

A.1.1 Rainfall Intensity

The rainfall intensity (i.e., rainfall rate) is based upon a depth of rainfall that occurs over a period of time. As the time period increases, the rainfall intensity decreases. This is because longer averaging periods smooth out the peak rates. (For example, a storm of several hours may include a heavy downpour that lasts only a few minutes; the average rainfall rate during the few minutes of the downpour will be higher than the average rainfall rate over the duration of the storm.) The period of time used to determine the rainfall intensity to design stormwater facilities is the site’s time of concentration (i.e., the time it takes for the stormwater runoff generated from the entire contributing area to reach facility). While the stormwater runoff reaching the facility is from the entire contributing area, runoff entering the facility corresponds to the average rainfall intensity based on the site’s time of concentration. At the beginning of the storm and after the end of the storm, the runoff reaching the facility is from only a fraction of the contributing area.

This concept can be illustrated through an example. In this example, the site has a 5-minute time of concentration and therefore uses a design rainfall intensity based upon a 5-minute average rainfall rate. Five minutes after the design rainfall intensity begins (i.e., at the end of the design rainfall intensity), runoff reaching the stormwater facility from the furthest area will be generated from the beginning of the design rainfall intensity, runoff from the closest area will be generated from the end of the design rainfall intensity, and runoff from all other areas will be generated from sometime in the middle of the design rainfall intensity. At the end of the 5-minute rainfall intensity, all of the site’s stormwater runoff reaching the stormwater facility will have been generated from that 5-minute rainfall intensity.

A.1.2 Rainfall Depth

The rainfall depth is the cumulative rainfall during a storm event. The rainfall depths used in this manual are based upon a 24-hour storm event and are distributed in 10-minute increments over the 24-hour period based on a modified NRCS Type IA distribution. This incorporates both intensities (rainfall depths over 10-minute increments) and a total rainfall depth over a 24-hour storm event.

A-2 Water Quality Design Storm

The water quality design storm is the design storm used to size stormwater treatment facilities to meet the pollution reduction requirements.

A.2.1 Water Quality Treatment Volume Goal

The City's 2008 *National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit* requires the City to "[c]apture and treat 80% of the annual average runoff volume, based on a documented local or regional rainfall frequency and intensity".[2] Additionally, for projects authorized, funded, or carried out by a federal agency, the *National Marine Fisheries Services' Standard Local Operating Procedures for Endangered Species Permit* requires treatment of runoff from ½ the 2-year, 24-hour storm event. Half the 2-year, 24-hour storm event has been used in much of Oregon to roughly approximate 85% of the average annual rainfall[3]. The City's Strategic Plan has a service delivery goal of meeting or exceeding local, state, and federal regulations. Therefore, the City's water quality storm is sized to result in treatment of runoff generated from 90% of the average annual rainfall.

Background

As part of ongoing adaptive management, the City re-evaluated its water quality storm for this manual revision with a new analysis of rainfall data from all of the HYDRA rain gages in the Portland area that had at least 20 years of active service. This evaluation showed that the current water quality storm for rate-based facilities (i.e., *rainfall intensity*) meets the City's goal of treating 90% of the average annual runoff volume. However, the water quality storm for volume and rate-volume based facilities (i.e., *rainfall depth*) needs to be increased to meet the City's desired water quality goal of treating 90% of the average annual runoff volume.

Since 1994, Portland has been using a single treatment storm methodology (0.83 inches over 24 hours; modified Natural Resources Conservation Service (NRCS) Type 1A rainfall distribution). As stated in the 2016 SWMM:

> 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

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[2] Oregon Department of Environmental Quality, NPDES Municipal Separate Storm Sewer System (MS4) Discharge Permit. Issued to: City of Portland and Port of Portland. 2008

[3] The Oregon Department of Transportation's (ODOT) October 22, 2008 Water Quality Design Storm Evaluation and Guidance letter.

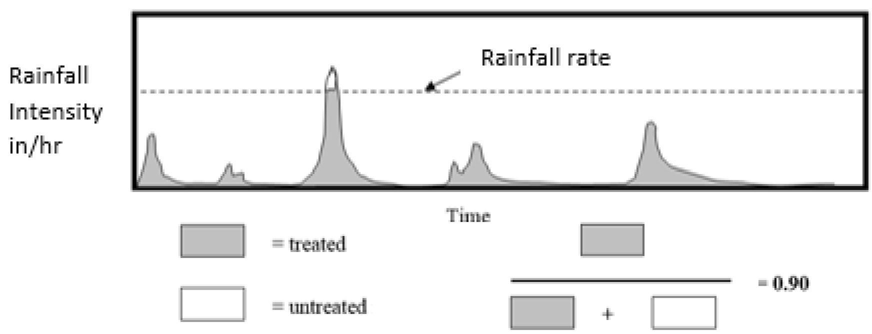
by the 0.83” storm, or a [Volume of the basin/Volume of the runoff] Vb/Vr ratio of 2.

Based on an updated review of the City’s rainfall, described below, the City is increasing the water quality storm depth to 1.61 inches and removing the sizing factor (i.e., the Vb/Vr ratio) previously required for volume-based facilities.

A.2.2 Rainfall Intensity Analysis

For the rainfall intensity analysis, all of the stormwater runoff generated from rainfall rates less than or equal to the design rainfall intensity is assumed to be fully treated, while stormwater runoff generated from rainfall rates exceeding the design rainfall intensity is assumed to receive no treatment. The rainfall intensity corresponding to 90% of the average annual rainfall can be determined by plotting the rainfall intensity and drawing a line at which 90% of the rainfall is at or below that intensity (see Figure A-1).

Figure A-1. Continuous Simulation Determination of 90% Rainfall Rate



In 2004, an analysis of four different rain gages representing the different quadrants of Portland was performed. Long-term rainfall data from each of the four rain gages was grouped into 5-minute, 10-minute, and 20-minute periods. The average rainfall intensity was calculated for each of the 5-minute, 10-minute, and 20-minute periods over the course of each rain gage record.

BES performed a new analysis in 2019 using 27 different rain gages (i.e., all of the HYDRA rain gages with at least 20 years of active service) as shown in Table A-2. The rainfall depths corresponding to 90% of the rainfall for each rain gage were calculated and these values were translated into a rainfall intensity using the calculation below:

$$\text{Intensity}\left(\frac{\text{in}}{\text{hr}}\right) = \text{Rainfall depth over x minutes (inches)} \times \frac{\text{60 minutes}}{\text{x minutes}}$$

Table A-2. Rainfall Intensity Analysis for 90% of Rainfall (for 5-minute periods)

H2 Number	Station Name	5-minute Rainfall Depth (inches)	5-minute Intensity, (in/hr)
1	Ankeny Fire Station	0.0145	0.174
2	Skyline School	0.0130	0.156
3	Sauvies Island School	0.0136	0.163
4	Sylvania PCC	0.0128	0.154
6	Mt. Tabor Yard	0.0137	0.164
7	Hayden Island Pump Station	0.0134	0.161
10	Collins View School	0.0138	0.166
12	Fernwood School	0.0136	0.163
14	Kelly School	0.0141	0.169
20	Gresham Fire Station	0.0157	0.188
21	Holgate Pump Station	0.0138	0.166
41	Vernon School	0.0141	0.169
48	Open Meadows School	0.0142	0.170
58	Bonny Slope School	0.0128	0.154
64	Harney Pump Station	0.0144	0.173
72	Fremont Pump Station	0.0128	0.154
115	Mallory Pump Station	0.0136	0.163
121	Yeon Pump Station	0.0146	0.175
137	Marine Drive Pump Station	0.0132	0.158
145	Pleasant Valley School	0.0147	0.176
146	Cottrell School	0.0148	0.178
152	Beaumont School	0.0142	0.170
153	Cascade PCC	0.0135	0.162
130	Linnton Pump Station	0.0136	0.163
144	Columbia STP	0.0133	0.160
147	Skyline Fire Station	0.0152	0.182
125	Guilds Lake Pump Station	0.0139	0.167

For each duration and percentage of average annual rainfall analyzed, the intensities from all of the rain gages were averaged (see Table A-3). This analysis confirmed the water quality rainfall intensities from the 2004 analysis meet or exceed the intensities corresponding to 90% of the average annual rainfall (see Table A-4).

Table A-3. Rate-Based Pollution Reduction Storm Analysis (2019)

Percentage of Average Annual Rainfall	Average Intensity (in/hr)			
	5-min	10-min	15-min	30-min
60	0.068	0.053	0.048	0.042
65	0.076	0.059	0.056	0.050
70	0.085	0.069	0.066	0.058
75	0.095	0.082	0.077	0.068
80	0.107	0.098	0.092	0.081
85	0.127	0.119	0.113	0.099
90	0.166	0.155	0.146	0.127

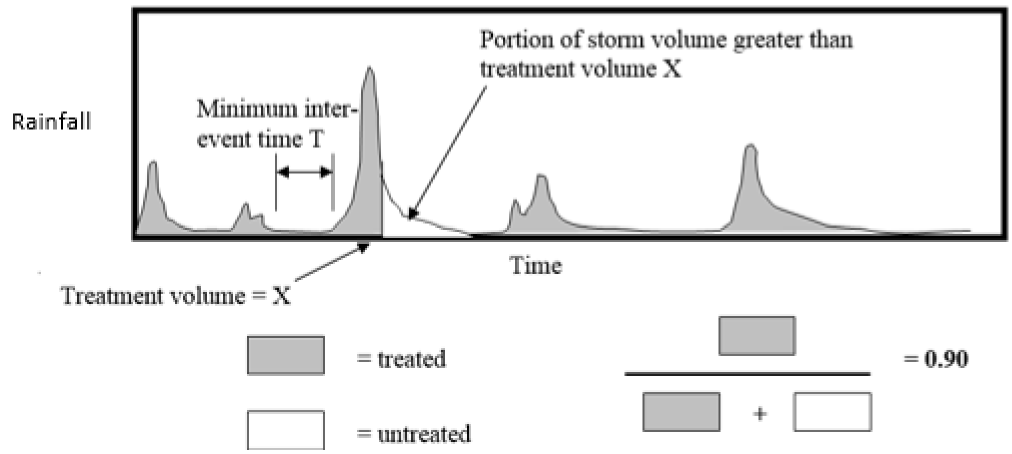
Table A-4. Rate-Based Pollution Reduction Storm Analysis (2004)

Duration	Quadrant	Rainfall Depth (in)	Average Intensity (in/hr)
5 min	**NW**	0.19	0.19
	SW	0.19	
	SE	0.20	
	NE	0.19	
10 min	**NW**	0.15	0.16
	SW	0.15	
	SE	0.165	
	NE	0.16	
20 min	**NW**	0.13	0.13
	SW	0.12	
	SE	0.14	
	NE	0.135	

A.2.3 Rainfall Depth Analysis

BES analyzed the rainfall data from 27 different rain gages (i.e., all of the HYDRA rain gages with at least 20 years of active service) to group the data into discrete storm events and arranged the storm events in increasing order. A storm event's rainfall depends upon how the storm event is defined. To separate a rainfall record into discrete storm events, an interevent period (i.e., a break in the rainfall long enough to consider the storm to have ended) must be defined. In this analysis, the City defined the interevent period as a 12-hour consecutive period with no more than 0.04 inches of rainfall. A rainfall depth of 0.04 inches was used because it is the maximum rainfall depth that does not generate runoff from an impervious surface using a curve number of 98 per the SBUH method. Since the goal is to treat the runoff from 90% of the average annual rainfall, the treatment rainfall depth is set such that 90% of the average annual rainfall from runoff-producing storm events is from storms with a total rainfall equal to or less than that depth (see Figure A-2).

Figure A-2. Continuous Simulation Determination of 90% Treatment Volume



This manual's storm events are designed as 24-hour events distributed in 10-minute increments (see the City's hyetograph in Appendix A-3). The water quality storm is based on all runoff-producing storm events (regardless of duration) condensed into this standardized model, with a standardized peak. The water quality design storm representing 90% of runoff-producing rainfall was calculated to be 1.61 inches.

A.2.4 Conclusion – (New Water Quality Design Storm)

The City's new water quality design storm for volume-based and volume-rated-based facilities is 1.61 inches of rainfall over 24 hours with a Portland-modified NRCS Type 1A rainfall distribution. The sizing factor previously required for volume-based facilities (i.e., the Vb/Vr ratio) has been removed. The rate-based water quality storm rainfall intensities remain unchanged: 0.19 in/hr for a site with a 5-minute time of concentration, 0.16 in/hr for a site with a 10-minute time of concentration, and 0.13 in/hr for a site with a 20-minute time of concentration. See Table A-5.

Table A-5. Water Quality Storm

Sizing Method	Time of Concentration (min)	Rainfall Intensity (in/hr)	24-hr Rainfall Depth (in)
With Storage	N/A	N/A	1.61
Without Storage	5	0.19	N/A
	10	0.16	
	20	0.13	

A-3 Sizing Methods

This appendix describes two main sizing methods: the Rational Method and the Santa Barbara Urban Hydrograph (SBUH) method. These methods are also described in the City's Sewer and Drainage Facilities Design Manual (SDFDM).

Both methods account for the site's characteristics to estimate runoff from a given rainfall; the Rational Method uses a runoff coefficient and the SBUH Method uses a curve number. BES studied the United States Department of Agriculture Natural Resources Conservation Service (NRCS) soil groups in the City and correlated the runoff coefficients and curve numbers to these soil groups. Figure A-3 shows soil groups throughout the City and is for reference only; it is not for site design. For site design, enter an address into Portland Maps and check utilities ->environment-> stormwater management to find the soil type. Table A-6 provides a description of each soil group.

Figure A-3. Soil Groups

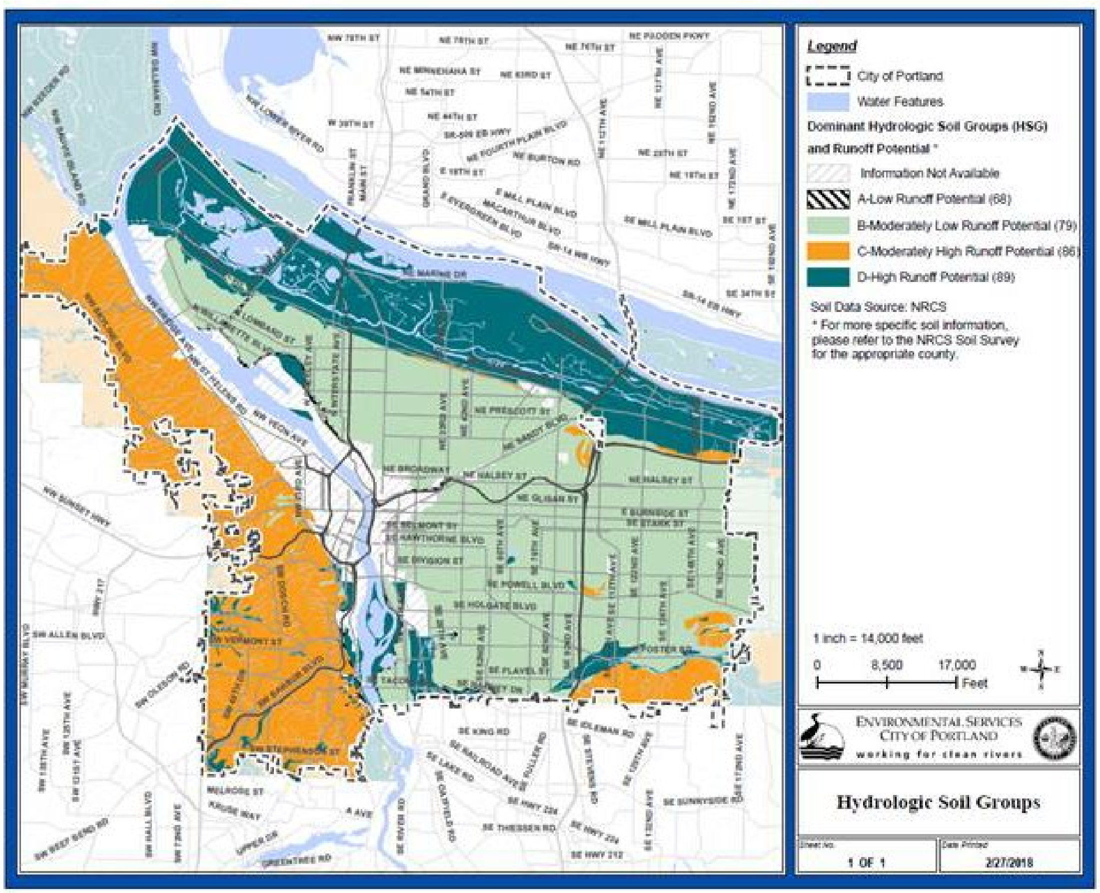


Table A-6. NRCS Hydrologic Soil Group Descriptions

Soil Group	Infiltration Rate[1]	Soils Consist Chiefly of
A	High	Deep, well-drained to excessively-drained sands or gravels.
B	Moderate	Moderately deep or deep, moderately well-drained or well-drained soils that have moderately fine texture to moderately coarse texture.
C	Slow	Soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture.
D	Very slow	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.

1 These rankings (i.e., high to very slow) are when the soil is thoroughly wet and also apply to the rate of water transmission.

A.3.1 Rational Method

The Rational Method is the method approved by the Bureau of Environmental Services (BES) for determining peak flow rates for rate-based facilities. The Rational Method estimates a peak runoff rate at any location in a catchment area of up to 10 acres with a time of concentration (t_c) of up to 30 minutes using the following equation:

$$Q = ciA$$

Where
Q = Peak stormwater runoff rate, cfs
c = Runoff coefficient representing a runoff to rainfall ratio, dimensionless
i = Average rainfall intensity for a storm duration equal to t_c (see Table A-7).
A = Drainage area contributing to the point-of-interest, acres.

Table A-7. Average Rainfall Intensity, i

Design Storm	Time of Concentration (minutes)	Rainfall Rate (inches/hour)
10-year[1]	5	2.86
	10	2.00
	20	1.38
Water Quality	5	0.19
	10	0.16
	20	0.13

1 The SDFDM contains rainfall intensities for other times of concentration and for other design storms.

A.3.2 Santa Barbara Urban Hydrograph Method

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. The SBUH method is the method approved by the City for determining runoff for volume-based facilities and rate-volume-based facilities. The SBUH method depends on several variables: the contributing area, the time of concentration (t_c), the runoff curve numbers (CN), and the design storm.

Contributing Area

The contributing area is the area that drains to the stormwater facility. The contributing area must be quantified in order to evaluate the resulting site runoff.

Time of Concentration

The time of concentration, t_c, for a stormwater facility is the time for the runoff from the entire contributing area to reach the stormwater facility. The t_c is derived by calculating the overland flow time and the channelized flow time. The t_c depends on several factors, including ground slope, ground roughness, and distance of flow.

In the SBUH method, the minimum t_c that can be used is half the time step. Since the City's hyetograph uses 10-minute time steps, the minimum t_c that can be used with the City's hyetograph is 5 minutes. To calculate t_c, refer to BES's SDFDM. If the minimum calculated t_c is less than 5 minutes, use a t_c of 5 minutes.

Curve Numbers

Curve numbers (CNs) were originally developed by the NRCS to translate rainfall into runoff. The higher the CN, the more runoff for a given rainfall depth. The CN changes with development; pre-development CNs in the City have been correlated to the site's soil group and post-development CNs depend upon the post-development surface (the ecoroof curve number correlates to the well-draining soils typically used for ecoroofs). The CNs shown in Table A-8 should typically be used. The SDFDM provides post-development CNs for other surfaces.

Table A-8. Curve Numbers

Development Status	Area Description		Curve Number
Pre-development	Soil Group	A	65
		B	72
		C	79
		D	81
		Unidentified	81
Post-development	Impervious area		98
	Ecoroof		61

If a contributing area has distinct subareas with different CNs, a weighted CN can be used for the entire site. The weighted CN is calculated as follows:

$$\text{Weighted CN} = \frac{(\text{Area 1 } \times \text{CN of Area 1}) + (\text{Area 2 } \times \text{CN of Area 2})}{\text{Area 1} + \text{Area 2}}$$

Design Storm

The SBUH method also requires a design storm to perform the runoff calculations. For volume-based and rate-volume-based facilities, a design storm is composed of two parts: the total depth of rainfall and the distribution of that rainfall over a specified period.

<u>Depth of Rainfall:</u> The depth of rainfall increases as the recurrence interval increases. A 100-year design storm is larger and rarer than a 2-year design storm. The 2-, 5-, 10-, 25-, and 100-year design storm depths are shown below in Table A-9.

Table A-9. 24-Hour Rainfall Depths at Portland Airport

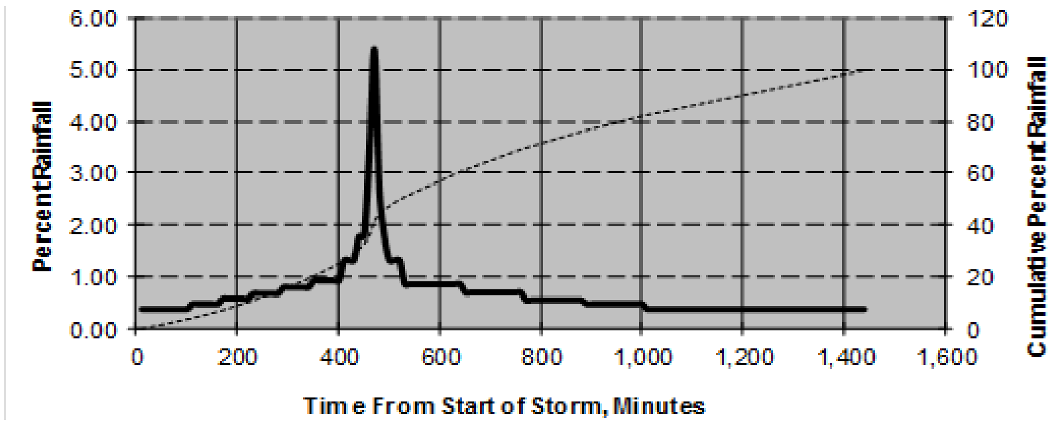
Recurrence Interval (years)	24-Hour Rainfall Depth (inches)
2	2.4
5	2.9
10	3.4
25	3.8
100	4.7

<u>Distribution of Rainfall:</u> During a storm event, rainfall intensities vary over time. The design hyetograph in Figure A-4 is a Portland-modified NRCS 24-hour Type 1A hyetograph and establishes a given fraction of rainfall for each 10-minute time step over a 24-hour period. The design distribution of rainfall begins and ends with a low intensity (0.4% of the rainfall occurs during each of the first ten and last forty-four 10-minute time steps). The peak intensity begins 7 hours and 40 minutes after the storm begins and lasts for 10-minutes; during this peak 10-minute period, 5.4% of the rainfall occurs.

<u>Calculating the Design Storm:</u> The design storm consists of the design rainfall depths distributed in 10-minute time steps over a 24-hour period according to the design hyetograph. The rainfall depth during each 10-minute time step of the 24-hour storm is calculated as follows:

$$\text{Rainfall Depth during Time Step} = \text{Design Rainfall Depth} \times \frac{\text{\% Rainfall}}{100}$$

Figure A-4. Portland-modified NRCS 24-Hour Type 1A Hyetograph



NRCS Type 1A Hyetographic Distrubution - For Use In Water Quality/Quantity Design

Time From Start of Storm, Minutes	% Rainfall	Cumu-lative % Rainfall	Time From Start of Storm, Minutes	% Rainfall	Cumu-lative % Rainfall	Time From Start of Storm, Minutes	% Rainfall	Cumu-lative % Rainfall	Time From Start of Storm, Minutes	% Rainfall	Cumu-lative % Rainfall
0 - 10	0.40	0.40	360 - 370	0.95	22.57	720 - 730	0.72	67.40	1080 - 1090	0.40	86.00
10 - 20	0.40	0.80	370 - 380	0.95	23.52	730 - 740	0.72	68.12	1090 - 1100	0.40	86.40
20 - 30	0.40	1.20	380 - 390	0.95	24.47	740 - 750	0.72	68.84	1100 - 1110	0.40	86.80
30 - 40	0.40	1.60	390 - 400	0.95	25.42	750 - 760	0.72	69.56	1110 - 1120	0.40	87.20
40 - 50	0.40	2.00	400 - 410	1.34	26.76	760 - 770	0.57	70.13	1120 - 1130	0.40	87.60
50 - 60	0.40	2.40	410 - 420	1.34	28.10	770 - 780	0.57	70.70	1130 - 1140	0.40	88.00
60 - 70	0.40	2.80	420 - 430	1.34	29.44	780 - 790	0.57	71.27	1140 - 1150	0.40	88.40
70 - 80	0.40	3.20	430 - 440	1.80	31.24	790 - 800	0.57	71.84	1150 - 1160	0.40	88.80
80 - 90	0.40	3.60	440 - 450	1.80	33.04	800 - 810	0.57	72.41	1160 - 1170	0.40	89.20
90 - 100	0.40	4.00	450 - 460	3.40	36.44	810 - 820	0.57	72.98	1170 - 1180	0.40	89.60
100 - 110	0.50	4.50	460 - 470	5.40	41.84	820 - 830	0.57	73.55	1180 - 1190	0.40	90.00
110 - 120	0.50	5.00	470 - 480	2.70	44.54	830 - 840	0.57	74.12	1190 - 1200	0.40	90.40
120 - 130	0.50	5.50	480 - 490	1.80	46.34	840 - 850	0.57	74.69	1200 - 1210	0.40	90.80
130 - 140	0.50	6.00	490 - 500	1.34	47.68	850 - 860	0.57	75.26	1210 - 1220	0.40	91.20
140 - 150	0.50	6.50	500 - 510	1.34	49.02	860 - 870	0.57	75.83	1220 - 1230	0.40	91.60
150 - 160	0.50	7.00	510 - 520	1.34	50.36	870 - 880	0.57	76.40	1230 - 1240	0.40	92.00
160 - 170	0.60	7.60	520 - 530	0.88	51.24	880 - 890	0.50	76.90	1240 - 1250	0.40	92.40
170 - 180	0.60	8.20	530 - 540	0.88	52.12	890 - 900	0.50	77.40	1250 - 1260	0.40	92.80
180 - 190	0.60	8.80	540 - 550	0.88	53.00	900 - 910	0.50	77.90	1260 - 1270	0.40	93.20
190 - 200	0.60	9.40	550 - 560	0.88	53.88	910 - 920	0.50	78.40	1270 - 1280	0.40	93.60
200 - 210	0.60	10.00	560 - 570	0.88	54.76	920 - 930	0.50	78.90	1280 - 1290	0.40	94.00
210 - 220	0.60	10.60	570 - 580	0.88	55.64	930 - 940	0.50	79.40	1290 - 1300	0.40	94.40
220 - 230	0.70	11.30	580 - 590	0.88	56.52	940 - 950	0.50	79.90	1300 - 1310	0.40	94.80
230 - 240	0.70	12.00	590 - 600	0.88	57.40	950 - 960	0.50	80.40	1310 - 1320	0.40	95.20
240 - 250	0.70	12.70	600 - 610	0.88	58.28	960 - 970	0.50	80.90	1320 - 1330	0.40	95.60
250 - 260	0.70	13.40	610 - 620	0.88	59.16	970 - 980	0.50	81.40	1330 - 1340	0.40	96.00
260 - 270	0.70	14.10	620 - 630	0.88	60.04	980 - 990	0.50	81.90	1340 - 1350	0.40	96.40
270 - 280	0.70	14.80	630 - 640	0.88	60.92	990 - 1000	0.50	82.40	1350 - 1360	0.40	96.80
280 - 290	0.82	15.62	640 - 650	0.72	61.64	1000 - 1010	0.40	82.80	1360 - 1370	0.40	97.20
290 - 300	0.82	16.44	650 - 660	0.72	62.36	1010 - 1020	0.40	83.20	1370 - 1380	0.40	97.60
300 - 310	0.82	17.26	660 - 670	0.72	63.08	1020 - 1030	0.40	83.60	1380 - 1390	0.40	98.00
310 - 320	0.82	18.08	670 - 680	0.72	63.80	1030 - 1040	0.40	84.00	1390 - 1400	0.40	98.40
320 - 330	0.82	18.90	680 - 690	0.72	64.52	1040 - 1050	0.40	84.40	1400 - 1410	0.40	98.80
330 - 340	0.82	19.72	690 - 700	0.72	65.24	1050 - 1060	0.40	84.80	1410 - 1420	0.40	99.20
340 - 350	0.95	20.67	700 - 710	0.72	65.96	1060 - 1070	0.40	85.20	1420 - 1430	0.40	99.60
350 - 360	0.95	21.62	710 - 720	0.72	66.68	1070 - 1080	0.40	85.60	1430 - 1440	0.40	100.00

Last revision 7/13/1998 Bureau of Environmental Services, Portland, Oregon.

A-4 Simplified Approach Sizing Calculations

BES evaluated facility designs and sizes appropriate for small development sites. The process included a review of technical literature, review of BES monitoring data, calculations, and theoretical analysis (see Table A-10). The sizing factors on the Simplified Approach Form were developed as a simple site planning tool for small projects and to accelerate permit review and approval. Generalized assumptions were used; these are documented in the Simplified Sizing requirements in Section 2.5.1. Facilities built to the standards of the Simplified Approach are assumed to meet pollution reduction and flow control requirements.

Table A-10. Simplified Sizing Spreadsheet Column Descriptions

Column	Description
Column (1)	Time in Minutes
Column (2)	Inflow (cfs) Note: Contributing Impervious area = 10,000 ft^2 Time of Concentration = 5 minutes Curve Number = 98 Design Storm = 10-year design storm (3.4 inches over 24 hours) Soil Infiltration Rate = 2 inches/hour
Column (3)	Inflow Volume (cf) = Inflow (cfs) x 60 (sec/min) x 10 (min)
Column (4)	Maximum Infiltration Volume (cf) = Facility Bottom Area (sf) x Soil Infiltration Rate (in/hr) x (ft/12 in) x (hr/60 min) x 10 min
Column (5)	Infiltration Volume (cf) = the smaller of the following: Maximum Infiltration Volume (cf) or [Inflow Volume (cf) + Incremental Storage of previous time step (cf)]
Column (6)	Incremental Storage (cf) = [Inflow Volume (cf) – Infiltration Volume (cf)] x 60 (sec/min) x 10 (min)
Column (7)	Cumulative Storage (cf) = Incremental Storage (cf) + Previous time step's Cumulative Storage (cf)
Column (8)	Percentage Storage Capacity = Cumulative Storage/Facility Storage x 100 Planter Facility Storage = Facility Bottom Area (sf) x Storage Depth (ft) Note: Facility Category = Planter Facility Bottom Area = 650 (6.5% of contributing impervious area) Facility Storage Depth = 1 ft Storage capacity does not exceed 100% and the maximum depth of 12 inches is not exceeded. Facility sizing does not result in an overflow condition.

A-5 Presumptive Approach Calculator

BES developed the Presumptive Approach Calculator (PAC) to provide design professionals a standard tool for sizing basins and planters (both flat and sloped versions) with typical details and configurations in accordance with the City of Portland Stormwater Management Manual. In conjunction with the 2020 SWMM, the PAC was updated to provide new capabilities, including designing facilities with orifices, partial subsurface storage, and partial infiltration.

Prerequisites to Meet the Requirements of this Manual

Professional judgment is required to design facilities with the PAC. To design a facility to demonstrate compliance with this manual using the PAC, the designer must be a licensed design professional such as an Oregon-registered professional engineer or a registered landscape architect. The designer must also be familiar with the area requiring stormwater management and aware of the site constraints that limit the dimensions and design of the facility. The designer must have the following information prior to using the PAC to design a stormwater facility for City approval:

- Results from infiltration testing of the native soil or fill or documentation demonstrating why site constraints prevent infiltration.
- A site design layout that shows the grading, identifies impervious areas and the type(s) of impervious material, delineates the drainage areas from all impervious surfaces, and identifies site constraints (e.g., waterways, easements, property lines, buildings, and foundations).

The information in the stormwater report must be consistent with the information the designer enters into the PAC. The City will require a new stormwater facility design if the site design substantially changes (e.g., the impervious area increases) or the proposed location or depth of the facility changes such that the infiltration testing is no longer representative of the soil in which stormwater will infiltrate.

A.5.1 Instructions for using the PAC

The online PAC initially displays an introductory page. After reading the introduction, clicking the button "I understand. Take me to the PAC." directs users to a page that allows them to create a PortlandOregon.gov account or log in with their existing account. To use the PAC, users must create a PortlandOregon.gov account if they do not already have one and sign in with their account.

A.5.1.1 Access (My Projects Page)

Once signed in, the PAC opens the *My Projects* page. This page allows a user to open an existing project by clicking on the name of a project under the "Project Name" column or create a new project by clicking the "Create Project" button.

A.5.1.2 Creating a Project (Create Project Page)

Selecting the “Create Project” button on the *My Projects* page opens the *Create Project* page. This page requires the user fill in the project name, address, city, and zip code and allows additional project information to be entered. Once all of the required information has been entered, the user can create the project by clicking the “Create Project” button. This takes the user to the *Project Overview* page.

Project Name. This is the name of the development proposal or capital improvement project (CIP) if it has been named; otherwise it is a user-created name, such as the primary site address for the taxlot(s).

Project Address. This is the primary site address. The postal address or site address should be used for projects on taxlots (i.e., parcels). Street names with nearby intersections should be used for projects in the right-of-way.

City. This is the name of the city in which the project is located. If it is not within a city limit, the user should indicate the city it is near (e.g., “near Portland”).

State. This is the abbreviation for the state in which the project is located.

Zip Code. This is the zip code in which the development is located.

Only for projects with a permit #

Permit No. This is the land use case number, building permit number, public works permit number, or CIP project number associated with the facility. All of the numbers that apply should be included. If there are no numbers assigned to the project, this should remain blank.

Designer. This is the name of the designer of the stormwater facility.

Company. This is the name of the company for which the designer works.

Project Summary. This is a brief description of the project and the stormwater facility. This should be only a few sentences

A.5.1.3 Opening an Existing Project (Project Overview Page)

Selecting a project in the *My Projects* page by clicking on a project name within the “Project Name” column (or by clicking “view details” within the desired row) opens the *Project Overview* page. The *Project Overview* page shows the information from the *Create Project* page and allows this information to be edited by clicking on the “Edit” button. It also allows the user to add a catchment for the project by either clicking the “Import Catchment” button to import catchment details or clicking the “Add Catchment” button to enter catchment details. Edit a catchment by clicking the on the name of the catchment or by clicking the “View Details” button within the desired row. Catchments can be exported by clicking the “Export Catchment” button. PAC Reports can be created from this page by clicking the checkboxes by the desired catchments and then clicking the “Generate PAC Report” button.

A.5.1.4 Adding Site Parameters (Catchment Details Page)

The user must enter a separate catchment for each facility. Selecting the "Add Catchment" button or "Details" link next to a catchment on the *Project Overview* page opens the *Catchment Details* page. The *Catchment Details* page allows the user to enter the catchment details (i.e., site parameters). To save the catchment details without entering specific facility information, unclick the "Go to facility" box in the bottom left corner of the page and then click the "Save Catchment" button; this will create a default flat planter associated with the catchment. Otherwise, the catchment details can be saved by clicking the "Go to Facility" button, entering the facility information, validating and checking the results, and then clicking the "Save Catchment and Facility" button at the bottom of the page.

Clicking the "Validate" button (and ensuring the data is valid) and then clicking the "Check Results" button displays the pre-development and post-development stormwater runoff outflow hydrograph for the area that will be impervious after development. The post-development stormwater runoff outflow hydrograph for the impervious area is the facility inflow hydrograph.

Catchment Name. This is the name the user assigns to the catchment. For projects with multiple catchments, each catchment must be given a different name.

Hierarchy Level. This is the set of requirements the facility must be designed to meet. It is based upon the facility's discharge point. The manual describes how to determine which hierarchy level is acceptable for a given project. The City has the authority to require a specific hierarchy level.

- <u>Level 1: Onsite Infiltration.</u> This level should be selected unless 1) site constraints prevent full infiltration or 2) the facility is a water quality-only facility that discharges to an underground injection control (UIC).
- <u>Level 2a: Water Quality-Only.</u> This level should be selected for a facility that discharges 1) to a UIC or 2) to the Columbia Slough, Willamette River, or Columbia River, either directly or via an adequately sized storm-only system.
- <u>Level 2b: Water Quality and Flow Control for Streams and the Storm System.</u> This level should be selected for a facility that discharges, either directly or via a storm-only system, to a waterbody other than the Columbia Slough, Willamette River, or Columbia River.
- <u>Level 2c: Water Quality and Flow Control for the Storm System Only.</u> This level should be selected for facilities that drain to a storm-only system with available capacity, discharging directly to the Columbia Slough, Willamette River, or Columbia River.
- <u>Level 3: Flow Control for the Combined System.</u> This level should be selected for facilities that discharge to the combined system.

Infiltration Testing Procedure. This is the method used to estimate the infiltration rate for soil under the facility. Most projects require infiltrating testing; the user may select not applicable (N/A) only if site constraints require the facility be lined without needing an infiltration test. The user must select one of the following:

- Open Pit
- Encased
- Double-Ring Infiltrometer
- N/A

Required unless there was no infiltration testing

Tested Native Soil Infiltration Rate. This is the rate, in in/hr, at which water within an infiltration test pit dropped during infiltration testing. In other words, this is the field-measured infiltration rate without applying any correction factors. The PAC automatically applies a correction factor of 2 for the open pit and encased tests and a correction factor of 1 for the double-ring infiltrometer test.

Impervious Area. This is the area of the impervious surfaces, measured in square feet from a plane surface, that will drain to the stormwater facility. Impervious surfaces are surfaces that significantly reduce infiltration, such as rooftops or areas covered with traditional pavement or concrete. Permeable pavement designed to infiltrate direct rainfall into the subsurface is not counted as impervious area.

Curve Number (Pre- and Post-Development). This is a rough estimate of the impervious area's capacity to retain rainfall both after development (i.e., post-development) and before it became impervious, in its natural, undeveloped state (i.e., pre-development). For a given storm, the higher the curve number, the smaller the fraction of rainfall retained onsite and the higher the fraction of stormwater runoff generated. The recommended pre-development curve numbers are 72 for soil type B, 79 for soil type C, and 81 for soil type D. The recommended post-development curve number is 98 for typical impervious surfaces.

Time of Concentration (Pre- and Post-Development). The post-development time of concentration is the longest time it takes for stormwater runoff that originates from the furthest area (timewise) to reach the stormwater facility after development. The pre-development time of concentration is the longest time it takes for stormwater runoff to reach the discharge point of the catchment area in its natural, undeveloped state. The PAC restricts the post-development time of concentration to no longer than the pre-development time of concentration. Due to the limitations of the Santa Barbara Urban Hydrograph Method with 10-minute time steps, the minimum allowable time of concentration is 5 minutes. If the time of concentration is less than 5 minutes, 5 minutes must be used.

A.5.1.5 Adding Facility Parameters and Checking Results (Facility Details Page)

The user must add exactly one facility for each catchment. The *Facility Details* page allows the user to enter the facility details. Access this page by clicking the facility name in the catchment table in the *Project Overview* page or by clicking the “Go to Facility” button at the bottom of the *Catchment Details* page after entering all the required catchment details. The user can save the facility information by clicking the “Save Catchment and Facility” button only after entering all of the facility details, clicking the “Validate” button, and then the “Check Results” button.

Overview of Facility

With the PAC, a user can design a flat planter or flat basin of any shape, and a sloped planter or basin (i.e., a sloped facility) with a rectangular shape. All facilities must include the standard blended soil and surface storage, but the user can select other combinations of other components such as subsurface storage, overflows, an underdrain, an orifice, or a liner. The PAC calculates discharges as if there is an overflow pipe connected to an offsite discharge point; the user may be allowed to not install an overflow pipe if it is designed for full infiltration and the PAC-calculated overflow volume is zero. When designing without an overflow pipe, select the overflow height as the maximum allowable ponding depth within the facility (i.e., the surface storage depth excluding freeboard).

Category. This is another way the City classifies a stormwater facility; it is based upon the facility’s slopes. If the longitudinal slope of the facility bottom is 0.5% or greater, the facility is a “sloped facility” and may require check dams, otherwise the bottom is considered to be flat and the facility is either a flat basin or a flat planter. A flat planter has vertical side walls made of a durable material such as concrete while a flat basin has sloping sides comprised of blended soil planted with vegetation. The user must select one of the following three facility categories:

- Planter (Flat) – this facility has a flat bottom (<0.5% slope) with vertical walls made of a durable material such as concrete.
- Basin (Flat) – this facility has a flat bottom (<0.5% slope) with sloping sides comprised of blended soil planted with vegetation.
- Sloped Facility – this facility has a longitudinal slope of 0.5% or greater and can have sloped sides, vertical sides, or one sloped side and one vertical side; it may include check dams that divide the facility into segments.

Facility Category Names

PAC naming conventions have been updated. If the facility was called a “swale” or “sloped planter” in the previous PAC, the user should select “sloped facility”.

Only required for flat basins

Shape. This is the shape of the facility from an aerial view. The PAC can only design sloped facilities with rectangular shapes but can design flat planters and flat basins of any shape. A flat planter's shape is not required for the PAC calculations because, as water rises along the vertical sides of a planter, the water's surface area remains the same, regardless of the facility shape. As water rises along the sloped sides of a flat basin, the water's surface area increases based on a combination of the slope and shape. If the flat basin is not rectangular, the user can select either "amoeba" or "user-defined" for the shape. The "amoeba" shape typically results in an underestimate of the actual surface storage volume and area but requires simpler input by the user. The user-defined shape gives more precise results but requires the user to calculate the water's surface area when the water is at the elevation of the top overflow. If the user selects 'basin' as the facility category, they must select one of the following shapes:

- Rectangle (or square)
- Amoeba (i.e., non-rectangular shape)
- User-Defined (i.e., non-rectangular shape)

Designer Tip: Shape

When designing a basin with an amoeba or user-defined shape, the designer may save time by starting with a rectangle shape to estimate the size needed to meet the requirements and then switch to the desired shape to fine-tune the size.

Location. This is one way the City classifies a stormwater facility; it is based upon the location of the facility, which can either be in the public right-of-way or on a parcel. Facilities in the public right-of-way have different design constraints than facilities on parcels. The user must select one of the following two facility locations:

- Public Right-of-Way (for facilities in the public right-of-way)
- Parcel (for all other facilities including, but not limited to privately-owned parcels, City-owned parcels, and other parcels)

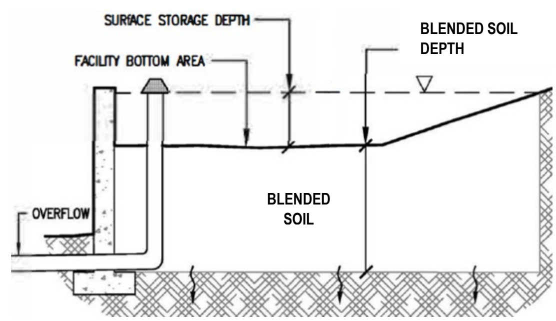
Configuration. This is the combination of main selectable components creating the facility structure. All PAC facilities include blended soil and surface storage and the PAC analyzes all PAC facilities as if they have an overflow pipe (if the facility does not actually have an overflow pipe, the calculated overflow must equal zero). The main selectable components are subsurface storage, an underdrain, a liner, and an overflow to the subsurface storage that is either separate from or connected to the outflow. The PAC can design facilities of six types of configurations (see Table A-11).

Table A-11. Components of the PAC Facility Configurations

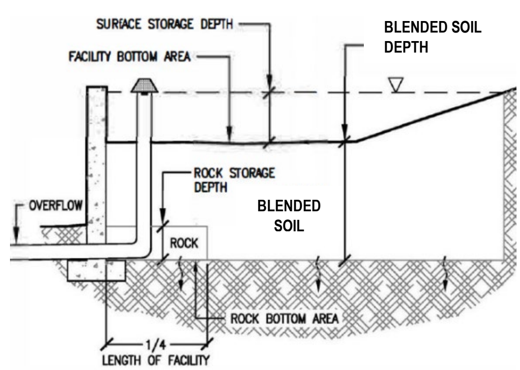
Facility Configuration		Facility Components				
		Subsurface Storage	Underdrain	Liner	Overflow Directed to Subsurface Storage	
#	Infiltration Level				Separate from Outflow	Connected to Outflow
A	Full Infiltration or Partial Infiltration					
B	Full Infiltration or Partial Infiltration	x				
C	Partial Infiltration	x	x			
D	Lined (No Infiltration)	x	x	x		
E	Hybrid – Full or Partial Infiltration	x	x		X	
F	Hybrid – Partial Infiltration	x	x			x

The user must select one of the following configurations. If the user chose hierarchy level 1 (full infiltration), the PAC limits the configuration options to A, B, or E.

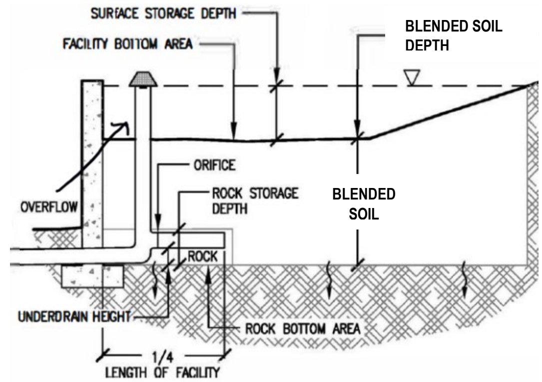
- Configuration A – This is the simplest configuration and the only one without subsurface storage. It is most efficient when the native soil infiltration rate is equal to or greater than the blended soil infiltration rate of 6 in/hr.



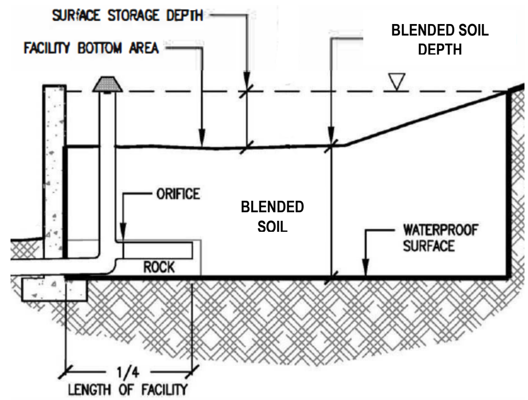
- Configuration B – This is the second simplest configuration in the PAC. It has subsurface storage (e.g., rock) for slower-infiltrating soils and is best applied when the native soil infiltration rate is less than 6 in/hr.



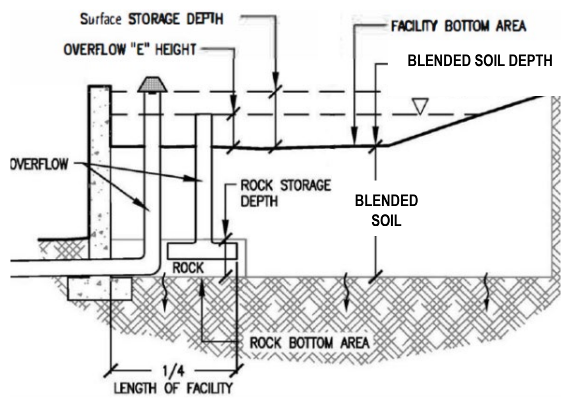
- Configuration C – This configuration has subsurface storage for slower-infiltrating soils and a perforated pipe that allows filtered stormwater to discharge offsite when the stormwater backs up in the subsurface storage. It is best applied when the native soil infiltration rate is less than 2 in/hr.



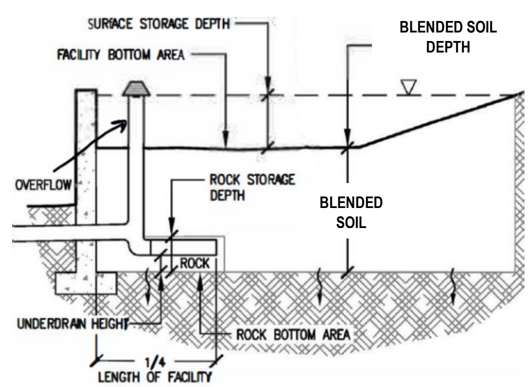
- Configuration D – This is the only facility configuration with an impermeable liner. The liner is placed over the facility-subsurface interface and along the facility sides to prevent subsurface infiltration. This facility configuration should only be selected if site constraints require a liner.



- Configuration E – This facility configuration allows runoff to bypass the blended soil and still infiltrate to the subsurface during large events. It is best applied when the native soil infiltration rate greatly exceeds 6 in/hr. As a hybrid facility (i.e., because it includes a UIC), it requires registration with DEQ.



- Configuration F – This facility configuration allows runoff to bypass the blended soil and sometimes still infiltrate to the subsurface during large events. This option is best applied only on rare occasions. As a hybrid facility, it requires registration with DEQ.



Only for configuration C and D

Orifice (Y/N)? This is a restricted opening on the underdrain to limit peak outflow. The PAC only designs orifices on underdrains that only receive stormwater that has been filtered through the blended soil (i.e., configurations C and D). For facilities with configuration C or D, the user must indicate whether the underdrain has an orifice.

Only for configuration C and D that have no orifice

Why no Orifice. This is the reason why the user selected no orifice for the facility. If the user selects no orifice on a facility with configurations C or D, the user must select one of the following answers to explain why the design does not include an orifice:

- Water-quality-only facility (i.e., the hierarchy is level 2a and flow control is not required)
- Facility meets flow control without orifice (e.g., the hierarchy is level 1 and flow control is met via infiltration)
- Catchment is too small (i.e., the hierarchy is level 2b, 2c, or 3 and the impervious area contributing stormwater runoff to the facility is so small that an orifice with a diameter smaller than 3/8 of an inch would be needed to meet flow control requirements. Table A-12 shows the largest impervious areas for various curve numbers and hierarchy levels where an orifice meeting the minimum diameter requirements would likely be infeasible.)

Only for Hierarchy Levels 2b, 2c, and 3

Catchment is Too Small for Flow Control. If the catchment area is too small for flow control, the user can check this box, which changes the pass/fail criteria to require filtration of the 25-yr storm event runoff without overflow. Table A-12 shows the largest catchments too small for flow control with lined facilities; unlined facilities can provide flow control for even smaller areas.

Table A-6. Largest Impervious Area Where Flow Control May Be Infeasible[1]

Hierarchy Level	Largest impervious area, in ft^2, where flow control may be infeasible based on a post-development curve number (CN) of 98 and a pre-development CN as listed below.		
	CN = 72	CN =79	CN =81
2b	7,200	2,200	1,800
2c	4,200	1,100	900
3	1,000	500	500

1. These areas are based on a lined facility with a blended soil plus rock depth of 18 inches, an underdrain height of 4 inches, and 12 inches of rock covering 1/3 of the facility footprint. For private facilities, these equate to ~6% sizing, except when CN=72 for Levels 2b and 2c (then 8.5% sizing). For public facilities, these equate to ~8.5% sizing, except when CN =72 for Levels 2b and 2c (then 13.5% and 12% sizing respectively.) Unlined facilities can provide flow control for even smaller areas.

Facility Dimensions

The user's selection of the facility configuration, category, and shape determine which facility dimensions the PAC displays. Once all facility dimensions are entered, the PAC calculates whether the facility passed or failed to meet the requirements of the selected hierarchy level. The user may need to adjust the dimensions of the facility or may need to select different facility components to meet the requirements of the selected hierarchy level. See Table A-15 for allowed parameter values.

Above-grade Storage Data

Bottom Area. This is the area of the bottom of the surface storage (i.e., the top of the blended soil), in square feet, not counting any side-slopes.

Bottom Width. This is the average width of the bottom of the surface storage, in feet, not counting any side-slopes, as measured perpendicular to the longitudinal slope. The PAC uses this to calculate a proposed quantity and area for any subsurface storage (e.g., rock) and to calculate a proposed length for an underdrain.

Overflow Height. This is the vertical distance, in inches, from the top of the blended soil to the top of the overflow pipe. For full infiltration facilities without an overflow, the PAC uses the overflow height as a stand-in for the maximum surface storage depth. The PAC restricts the overflow height to the following maximum depths: 18 inches for parcel-based facilities and 9 inches for right-of-way facilities.

Blended Soil Depth or Blended Soil (plus Rock) Depth. The is measured as the distance from the bottom of the facility to the top of the blended soil.

- <u>For facilities with no subsurface storage</u> (i.e., Configuration A), this is the blended soil thickness, in inches, and typically ranges from 1 to 12 inches.
- <u>For facilities with partial subsurface storage</u>, this can be calculated in one of two ways: 1) this is the blended soil thickness, in inches, as measured in a location that is *not* above the subsurface storage, 2) this is also the blended soil thickness, in inches, as measured in a location above the subsurface storage *plus* the subsurface storage thickness, in inches (these measurements should yield equivalent values). This value typically ranges from 12 to 36 inches.
- <u>For facilities with full subsurface storage</u> (i.e., with subsurface storage that extends across the entire facility bottom) this value is the blended soil thickness, in inches, *plus* the subsurface storage thickness, in inches. This value should typically exceed 12 inches, as it should typically be comprised of a minimum of 12-inches of blended soil plus the thickness of the subsurface storage.

Only for basins with rectangular or amoeba shapes	**Side Slope.** This is the horizontal distance, in feet, that the side slope travels with each foot of vertical rise (i.e., the “x” in an x:1 slope). (Side slopes for sloped facilities are described in the sloped facilities section.) The PAC uses these side slopes (along with other parameters) to estimate the volume of surface storage.
Only for basins with an amoeba shape	**Bottom Perimeter Length.** This is the length, in feet, of the edge along the flat bottom area, excluding the side slopes. The PAC uses the perimeter length of the bottom area (along with other parameters) to estimate the volume of surface storage for these facilities.
Only for basins with a user-defined shape	**Surface Area at Overflow Height.** This is the area, in square feet, of the water surface when it is at the elevation of the highest (or only) overflow. For facilities without an overflow, the ‘overflow height’ is used as a proxy for maximum ponding depth).
Only for configuration E	**Overflow E Height.** This is the vertical distance, in inches, from the top of the blended soil to the top of the separate piped overflow that directs overflow to the subsurface storage (i.e., the height of overflow E measured from the top of the blended soil).
Only for configuration E with a user-defined shape	**Surface Area at Overflow E Height.** This is the area, in square feet, of the water surface when the water is at the top of the separated piped overflow that is directs overflow to the subsurface storage (i.e., the surface area of the water when it is just about to crest overflow E).

Below Grade Storage Data

Only for configuration A, B, C, E, F (not D)	**Percent of Facility Base that Infiltrates.** This is the percentage of the facility base (i.e., the area below the blended soil and below any rock) that allows infiltration to the subsurface soil. The facility base is equal to the surface area at the top (or only) overflow elevation. This should be 100% unless there is an obstruction (e.g., a partial liner) preventing infiltration.
Only for configuration B, C, D, E, F (not A)	**Rock Area.** This is the area of subsurface storage (e.g., rock gallery), in square feet. This is referred to as the rock area because rock is typically used, but another material with high porosity may be used. The user can either manually enter this value or click the “Calculate Standard Values” button to have the PAC enter recommended values for the rock area, rock width, and rock porosity. For the PAC calculations, the rock area cannot exceed the water’s surface area at the elevation of the top of the highest (or only) overflow.

Only for configuration B, C, D, E, F (not A)

Rock Width. This is the width of the subsurface storage (e.g., rock gallery) in feet, measured perpendicular to the longitudinal slope. This is referred to as the rock storage width because rock is typically used for subsurface storage, but another material may be used. The user can either manually enter this value or click the “Calculate Standard Values” button to have the PAC enter a recommended value for the rock width, the rock area, and the rock porosity.

Rock Depth. This is the thickness of the subsurface storage, in inches. This is referred to as the rock storage depth because rock is typically used for subsurface storage, but another material may be used. A typical subsurface storage depth is 12 inches

Rock Porosity. This is the porosity of the subsurface storage. The user can either manually enter this value or click the “Calculate Standard Values” button to have the PAC enter a recommended value for the rock porosity (i.e., 0.3), rock width, and rock area. A value of 0.3 should be entered when using the standard rock.

Only for configuration C, D, E, F (not A, B)

Underdrain Height. This is the vertical distance, in inches, from the bottom of the facility (i.e., where the facility meets the subsurface) to the invert elevation of the underdrain. The underdrain height is typically 4 inches.

Only for facilities with orifices

Orifice Diameter. This is the diameter in inches of the orifice on the underdrain. The PAC allows users to select orifice diameters as small as 3/8 of an inch and choose larger sizes in 1/8-inch increments.

Designer Tip: Orifice Sizing

Selecting an appropriately sized orifice can require an iterative solution. An orifice that is too large for a given facility will allow too much filtered water to flow out; an orifice that is too small for a given facility will back up stormwater in the system such that too much unfiltered water overflows. It is often fastest to find the appropriate orifice size by choosing a large facility footprint to minimize overflow, determining the orifice size and then reducing the facility footprint until the design is optimized. After this, check to see if a larger orifice will work and iterate to the optimal design.

The PAC provides a suggested orifice diameter to begin sizing, but to minimize the facility size, the design may require a smaller or larger orifice than the originally suggested diameter.

Only for sloped facilities

Sloped facilities are analyzed by segment in the PAC; check dams can divide the facility into multiple segments. The PAC allows up to 31 segments. For each segment the user is required to input the dimensions described below.

Segment Length. This is the distance, in feet, as measured along the bottom of the surface storage area (i.e., the top of the blended soil), from check dam to check dam or from the end or start of the facility to the nearest check dam or for facilities without check dams, the entire facility length. The check dam width must not be included in the segment length.

Check Dam Width. This is the width of the downstream check dam, in inches, as measured along the flow path. The check dam width is typically the narrow dimension of the check dam. This is used along with the segment length to calculate the total facility length.

Longitudinal Slope. This is the longitudinal slope as measured by the rise over the run (ft/ft) of the facility along the bottom of the surface storage.

Bottom Width. This is the width of the bottom of the surface storage (i.e., top of the blended soil), in feet, not counting any side-slopes, as measured perpendicular to the longitudinal slope. The PAC uses this to help determine if the facility can fit within the landscape width. If the facility has subsurface storage (e.g., a rock gallery), the PAC also uses the bottom surface width (along with other parameters) to calculate the length of any underdrain and the quantity and area of the subsurface storage (e.g., rock) in the final (i.e., lowest elevation) segment.

Side Slope (Right and Left). This is the horizontal distance in feet that the side-slope travels with each foot of vertical rise (i.e., the “x” in an x:1 slope). The PAC allows different slopes for the right and left sides; which side is right or left may be chosen arbitrarily.

Downgradient Depth. This is the maximum depth of water, in inches, as measured from the low-elevation end of the segment, when the surface storage is at its maximum capacity (i.e., the surface storage is full of water).

Landscape Width. This is the width of the landscaped area, in feet, in which the facility will be located. If the landscape width is not wide enough to contain the facility, the PAC will state that the facility fails.

A.5.1.6 Determination of Compliance

Once the user has entered all of the required catchment and facility data, the user can check the data validity by clicking the “Validate” button and then check for compliance by clicking the “Check Results” button. When the “Check Results” button is clicked, the PAC determines whether the facility meets the applicable requirements. If the PAC shows the facility fails to meet any of the applicable requirements, the user needs to adjust the facility parameters until the PAC shows the facility meets (i.e., “passes”) all of the applicable requirements. After validating and checking the results, the user can save the catchment and facility by clicking the “Save Catchment and Facility” button (this opens the *Project Overview* page).

Infiltration Status: For Hierarchy Level 1, infiltration requirements apply. The PAC shows the facility passes if it infiltrates the post-development runoff from the 10-year storm event without any outflow; otherwise it fails.

Pollution Reduction (PR) Status: For Hierarchy Levels 2a, 2b, and 2c and for hybrid facilities (i.e., configuration E and F) of any hierarchy, water quality requirements apply. The PAC shows the facility passes for pollution reduction if all of the post-development runoff from the water quality storm event filters through the blended soil (i.e., the total overflow volume equals zero); otherwise it fails.

All infiltration facilities (i.e., all facilities designed for Hierarchy Level 1) also meet the pollution reduction requirements since 1) hybrid facilities are required to filter the post-development runoff from the water quality storm event and 2) other infiltration facilities filter the post-development runoff from a storm event that is even larger than the water quality storm event (i.e., the 10-yr, 24-hr storm event).

Flow Control Status: For Hierarchy Levels 2b, 2c, and 3, flow control requirements apply. For Hierarchy Levels 2b and 2c, unless the catchment area is too small, if the post-development total outflow (i.e., the filtered outflow plus the surface overflow) from the facility for the applicable design storm(s) does not exceed the pre-development runoff from the site for the corresponding design storm(s), the facility passes; otherwise it fails. For Hierarchy Level 3, unless the catchment area is too small, if the post-development total outflow from the 25-year, 24-hour storm does not exceed the pre-development runoff from the 10-year, 24-hour storm, the facility passes; otherwise it fails. If the catchment area is too small, the facility must instead filter the 25-year, 24-hour storm event without any overflow.

A.5.1.7 Creating a PAC Report

To create a PAC Report, go to the *Project Overview* page, select the catchments for the PAC report by clicking on the checkbox(es) before the desired catchment(s) and then click the “Generate PAC Report” button. The user can open and save a pdf of PAC Report by clicking the “Download” button at the bottom of the PAC report.

A.5.2 Calculations

A brief summary of the PAC calculations are provided in this section.

A.5.2.1 Stormwater Runoff Calculations

The PAC calculates the pre- and post-development stormwater runoff from various design storm events and routes the post-development stormwater runoff through the facility to calculate the filtered outflow and surface overflow. The PAC includes design rainfall from five fixed design storms (the water quality and 2-year, 5-year, 10-year, and 25-year, 24-hour design storms). These design storms are the same for the pre- and post-development condition. The PAC calculates the runoff from each of these design storms and also calculates ½ the runoff from the 2-year, 24-hour design storm for both the pre- and post-development condition.

Stormwater facilities are only present after development. Therefore, only post-development (not pre-development) stormwater runoff is routed through the stormwater facility. The post-development stormwater runoff from each of the five design storms and ½ the runoff from the 2-yr, 24-hour design storm is routed through the stormwater facility. See Table A-13 for a summary of the analyzed scenarios.

Table A-13. Scenarios Analyzed

PAC Analysis Component	Development Status Irrelevant	*Before* Development	*After* Development	Number of Scenarios Analyzed
Rainfall over area	x			5
Stormwater runoff from rainfall over area		x	x	12
Stormwater facility outflow			x	6

Hydrologic Analysis

Rainfall: Each of the five design storms has a fixed total rainfall depth which is distributed across 24 hours in a fixed manner (see Appendix A-3 and Table A-14).

Table A-14. 24-Hour Design Rainfall Depths

Storm Event	24-Hour Rainfall Depth (Inches)
Water Quality	1.61
2-yr, 24-hr	2.4
5-yr, 24-hr	2.9
10-yr, 24-hr	3.4
25-yr, 24-hr	3.8

Stormwater Runoff: The PAC calculates the stormwater runoff from both the pre-development and post-development condition using the Santa Barbara Urban Hydrograph Method (see the SDFDM and Appendix A-3). The PAC uses 10-minute time steps (i.e., 600 seconds in a time step) for the analysis.

1. The PAC estimates a potential maximum retention, in inches (i.e., the potential maximum depth of rainfall the site can retain onsite), and the initial abstraction, in inches (i.e., the depth of rainfall that can occur during a storm before runoff begins). The higher the curve number, the smaller the initial abstraction.

$$Potential\ Maximum\ Retention = \left(\frac{1000}{Curve\ Number} - 10\right)$$

$$Initial\ Abstraction = 0.2 \times Potential\ Maximum\ Retention$$

2. The PAC compares the cumulative rainfall to the initial abstraction. If the cumulative rainfall is equal to or less than the initial abstraction, no runoff occurs. Once the cumulative rainfall exceeds the initial abstraction, runoff occurs for the remainder of the design storm, and the cumulative runoff is calculated in inches, using the following equation:

$$Cumulative\ Runoff\ Depth = \frac{(Cumulative\ Rainfall\ Depth - Initial\ Abstraction)^2}{Cumulative\ Rainfall\ Depth + (0.8 \times Potential\ Maximum\ Retention)}$$

3. The PAC then calculates the stormwater runoff depth in inches for each time step by subtracting the previous time step's cumulative runoff from the current time step's cumulative runoff.

$$Runoff\ Depth = Cumulative\ Runoff\ Depth_{(t)} - Cumulative\ Runoff\ Depth_{(t-1)}$$

4. Using the site-specific impervious area in ft², the PAC calculates the stormwater runoff rate in cfs (i.e., instantaneous stormwater runoff) during each time step.

$$RunoffRate = \left(Impervious\ Area \times \frac{Runoff\ Depth}{12}\right) \Big/ 600$$

5. The PAC routes the instantaneous stormwater runoff through the area being analyzed to calculate the routed stormwater runoff in cfs during the time step.

$$RteRunoff_{(t)} = RteRunoff_{(t-1)} + \frac{600 \times [RunoffRate_{(t)} + RunoffRate_{(t-1)} - (2 \times RteRunoff_{(t-1)})]}{600 + (2 \times Time\ of\ Concentration)}$$

6. The PAC calculates the runoff volume during each time step. In the special case of the ½ the 2-yr, 24-hr design storm, the 2-yr, 24-hr design storm is modeled and the runoff volume from the 2-yr, 24-hr design storm is divided by two.
   - For ½ the 2-yr, 24-hr design storm: $Runoff\ Volume = RteRunoff \times 600/2$
   - For all other design storms in the PAC: $Runoff\ Volume = RteRunoff \times 600$

A.5.2.2 Facility Capacity Calculations

The following are parameters (some of which have been converted from user-input inches into feet) used in the facility capacity calculations (see Figure A-5):

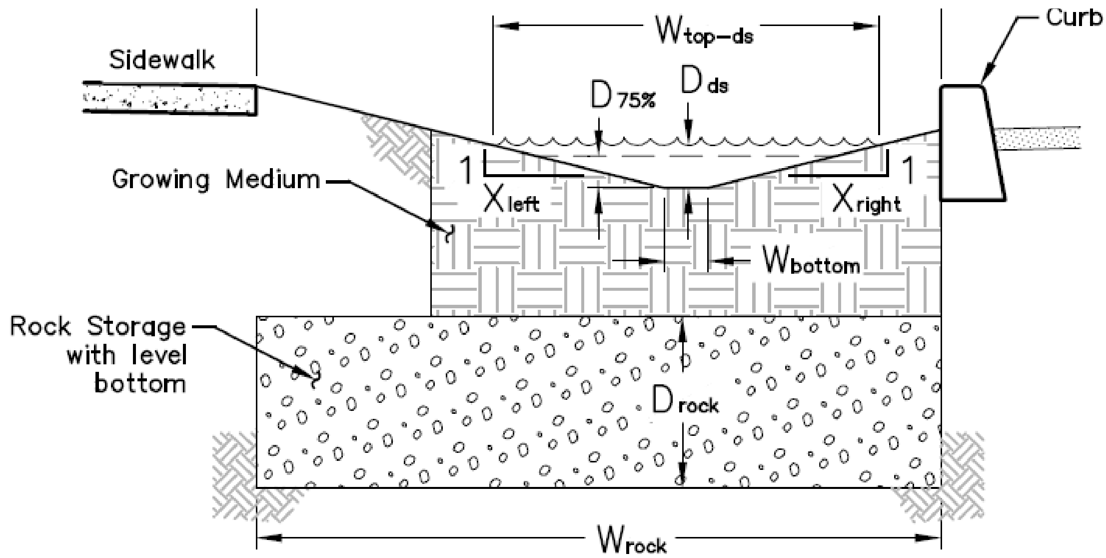
- A_{bottom} = Surface Area at the bottom of the surface storage, ft^2
- A_{top} = Surface Area at the top of the surface storage, ft^2
- A_{75} = Surface Area of water when the surface storage is 75% full, ft^2
- A_E = Surface Area at the top of the lowest overflow (configuration E only), ft^2
- A_{75E} = Surface Area at the top of the lowest overflow (configuration E only), ft^2
- D= Surface Storage Depth, ft
- D_{75} = 75% of the Surface Storage Depth, ft
- D_E = Surface Storage Depth to top of lowest overflow (configuration E only), ft
- D_{75E} = Depth from bottom of surface storage to 75% of the top of the lowest overflow (configuration E only), ft
- V = Surface Storage Volume, ft^3
- V_{75} = Surface Storage Volume at 75% of the surface storage depth, ft^3
- V_E = Surface Storage Volume at the top of lowest overflow (configuration E only), ft^3
- W = Facility Width at the bottom of the surface storage, ft
- L = Facility Length at the bottom of the surface storage, ft
- P = Perimeter Length along the surface storage bottom (amoeba basins only), ft
- D_{soil} = Blended Soil Depth, ft
- D_{rock} = Rock Storage Depth (configurations B, C, D, E, and F only), ft
- W_{rock} = Rock Storage Width (configurations B, C, D, E, and F only), ft
- A_{rock} = Rock Storage Area (configurations B, C, D, E, and F only), ft^2
- P_{rock} = Porosity of the Rock, %
- X = Side slope (rectangular and amoeba-shaped flat basins only), (X:1) (H:V)

The following additional parameters are for sloped facilities only:

- $L_{segment}$ = Length of segment, ft
- W_{dam} = Check Dam Width , in
- Slope = Longitudinal Slope, ft/ft
- X_{right} = Right side slope, (X:1) (H:V)

- X_{left} = Left side slope, (X:1) (H:V)
- D_{dwn}= Surface Storage Depth at the downstream end, inches
- D_{75dwn} = 75% of the Surface Storage Depth at the downstream end, inches

Figure A-5. Typical Cross-Section of a Facility



Surface Capacity

For all facilities, the PAC calculates the volume of the surface storage below the overflow and for configuration E facilities, the PAC also calculates the volume of surface storage below overflow E (i.e., the lowest overflow). (For full infiltration facilities without an overflow, the PAC uses the overflow height as a stand-in for the maximum surface storage depth.) The PAC also calculates the surface area of standing water when the water depth within surface storage is equal to 75% of the surface storage depth (i.e., 75% the height of the overflow).

Flat Planters

Since planters have vertical walls, the surface area of standing water is always the same, regardless of the depth of standing water.

$$\mathrm{A_{75} = A_{75E} = A_{top} = A_{bottom}}$$

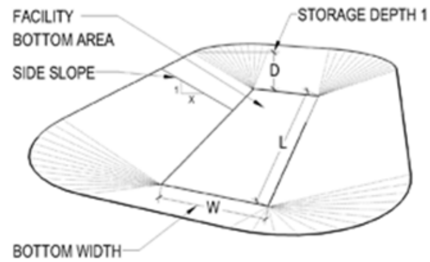
$$V = A_{bottom} \times D$$

$$V_E = A_{bottom} \times D_E \text{ (for configuration E only)}$$

Flat Basins

The surface area is based on the weighted average of the top and bottom areas for user-defined basins and on the bottom area and side slopes for other flat basins.

RECTANGLE SHAPE



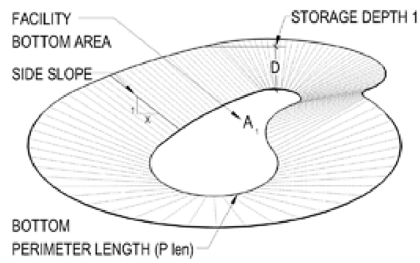
$$A_{75} = LW + 2(L+W)XD_{75} + \pi(XD_{75})^2$$

$$V = LWD + (L+W)XD^2 + \frac{\pi X^2 D^3}{3}$$

$$A_{75E} = LW + 2(L+W)XD_{75E} + \pi(XD_{75E})^2$$

$$V_E = LWD_E + (L+W)XD_E{}^2 + \pi X^2 D_E{}^3/3$$

AMOEBA SHAPE



$$A_{75} = A_{\text{bottom}} + P_{len} D_{75} X$$

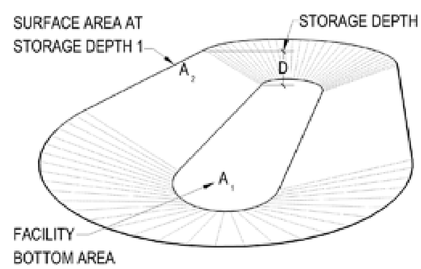
$$V = (XD^2 P_{len}/2) + (A_{\text{bottom}} D)$$

For configuration E only:

$$A_{75E} = A_{\text{bottom}} + P_{len} D_{75E} X$$

$$V_E = (XD_E{}^2 P_{len}/2) + (A_{\text{bottom}} D_E)$$

USER-DEFINED SHAPE



$$A_{75} = (A_{\text{bottom}} \times 0.25) + (\text{A}_{top} \times 0.75)$$

$$\text{V} = (A_{\text{bottom}} + A_{\text{top}}) \times 0.5D$$

For configuration E only:

$$A_{75E} = (A_{\text{bottom}} \times 0.25) + (\text{A}_E \times 0.75)$$

$$\text{V}_E = (A_{\text{bottom}} + A_{\text{E}}) \times 0.5D_E$$

Sloped Facilities

Since sloped facilities may be divided by check dams into segments, the total area and volume is the sum of the area and volume of each segment, respectively. Only segments that are full can overflow the check dams and reach the final segment with the overflow pipe(s). Therefore, for configuration E facilities, the storage below overflow E is the cumulative surface storage volume of all but the final segment plus the volume of surface storage to the top of overflow E of the final segment. See Figure A-6 to Figure A-8.

1. The PAC calculates the upgradient depth of standing water for each segment.

$$D_{up} = D_{dwn} - \left(L_{seg} \times Slope\right) \ or \ 0, whichever \ is \ greater$$

$$D_{75up} = D_{dwn} - \left(0.75 \times L_{seg} \times Slope\right) \ or \ 0, whichever \ is \ greater$$

$$D_{75Eup} = D_{dwnE} - \left(0.75 \times L_{seg} \times Slope\right) \ or \ 0, whichever \ is \ greater$$

2. The PAC then calculates the length of standing water for each segment.

$$L_{100segment} = L_{segment} - \frac{W_{checkdam}}{2} \ or \ \frac{D_{dwn}}{Slope} \ , whichever \ is \ greater$$

$$L_{75segment} = L_{segment} - \frac{W_{checkdam}}{2} \ or \ \frac{D_{75dwn}}{Slope} \ , whichever \ is \ greater$$

3. Next, the PAC calculates the areas and volumes for each segment.

$$A_{75seg} = \frac{L_{75seg}}{2} \times \left[2W + \left[\left(D_{75dwn} + D_{75up}\right) \times \left(X_{right} + X_{left}\right)\right]\right]$$

$$A_{75Eseg} = \frac{L_{75Eseg}}{2} \times \left[2W + \left[\left(D_{75Edwn} + D_{75Eup}\right) \times \left(X_{right} + X_{left}\right)\right]\right]$$

$$V_{seg} = \frac{L_{100seg}}{2} \times \left(\left[\left(D_{up} + D_{dwn}\right) \times W\right] + \left[\left(\frac{{D_{up}}^2 + {D_{dwn}}^2}{2}\right) \times \left(X_{right} + X_{left}\right)\right]\right)$$

$$V_{Eseg} = \frac{L_{100Eseg}}{2} \times \left(\left[\left(D_{upE} + D_{dwnE}\right) \times W\right] + \left[\left(\frac{{D_{upE}}^2 + {D_{dwnE}}^2}{2}\right) \times \left(X_{right} + X_{left}\right)\right]\right)$$

4. Finally, the PAC calculates the cumulative areas and volumes for the facility.

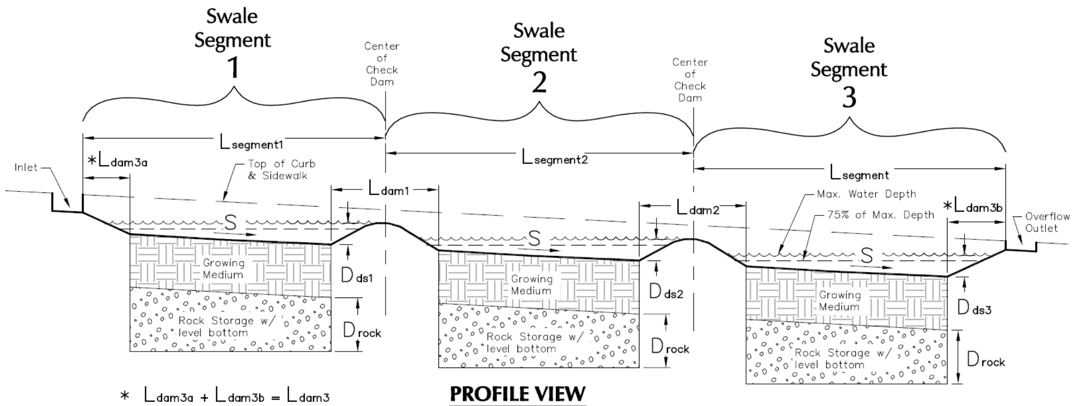
$$A_{75} = \sum_{seg=first}^{seg=last} A_{75segment}$$

$$A_{75E} = \sum_{seg=first}^{seg=last} A_{75Esegment}$$

$$V = \sum_{seg=first}^{seg=last} V_{seg}$$

$$V_E = V_{Esegfinal} + \sum_{seg=first}^{seg=second\ to\ last} V_{seg}$$

Figure A-6. Sloped Facility Configurations A[1], B, C & D[2]



1 For configuration A, rock storage is eliminated.

2 For configurations C & D, the final rock storage segment contains an underdrain that conveys filtered runoff to an approved discharge point.

Figure A-7. Sloped Facility Configuration E

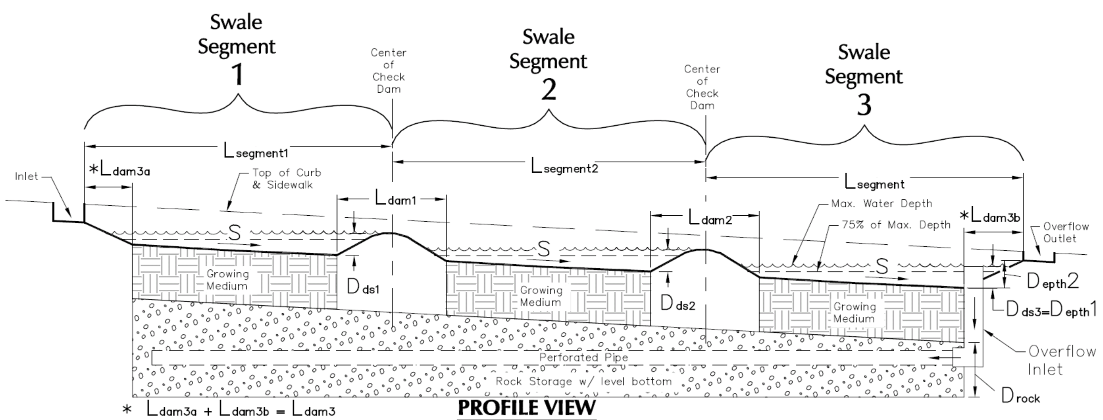
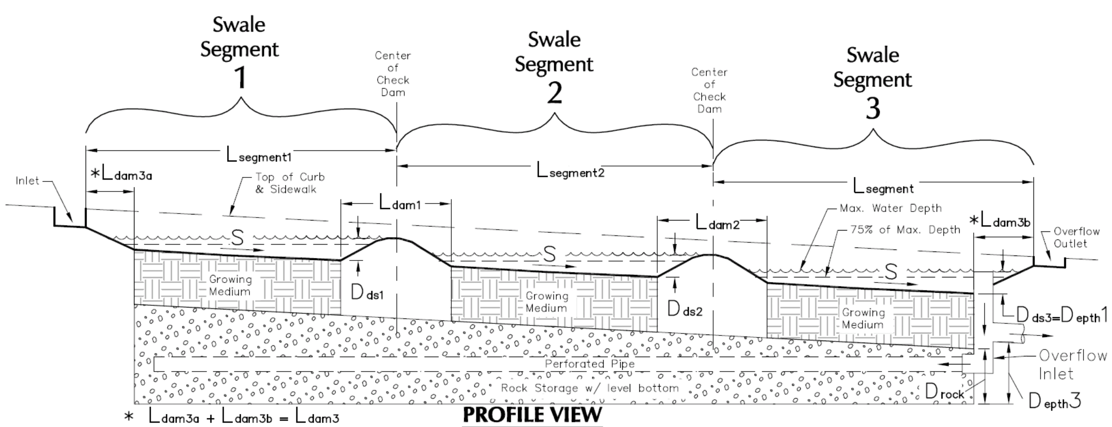


Figure A-8. Sloped Facility Configuration F



Blended Soil Storage Capacity

For all facilities, the PAC calculates the blended soil storage capacity by assuming that the available pore space in the blended soil is 10% at the start of the storm event. For facilities with rock, the PAC divides the blended soil into two sections: a section next to the rock and a section above the rock.

Configuration A

$$CAPACITY_{soil} = D_{soil} \times A_{bottom} \times 0.1$$

Configurations B, C, D, E, and F

$$CAPACITY_{soil\ above\ rock} = (D_{soil} - D_{rock}) \times A_{bottom} \times 0.1$$

$$CAPACITY_{soil\ directly\ above\ rock} = (D_{soil} - D_{rock}) \times A_{rock} \times 0.1$$

Configurations C, D, E, and F

$$CAPACITY_{soil\ next\ to\ rock\ above\ pipe} = (D_{rock} - D_{pipe}) \times (A_{bottom} - A_{rock}) \times 0.1$$

Subsurface Rock Capacity

For facilities with rock, if the user selects the “Calculate Standard Rock Values” button, the PAC calculates the rock storage area as being ¼ the length of the facility multiplied by the smaller of 3 ft wide or the width of the facility. For sloped facilities, all of the rock is in the final segment; if the final segment is less than ¼ of the length of the facility, the PAC calculates the rock as extending the full length of the final segment (i.e., less than ¼ the length of the facility). The user has the option to enter their own value for the rock area instead of using the PAC-calculated value.

Total Rock Storage (for configurations B, C, D, E, and F)

The rock storage area depends upon the volume and porosity of the rock storage.

$$CAPACITY_{rock} = A_{rock} \times D_{rock} \times \mathrm{P}_{rock}$$

Rock Storage Below Underdrain (for configurations C, D and F)

The rock storage below the underdrain is the pore space within the rock that can hold water below the invert elevation of the underdrain. Water in this portion of rock storage cannot discharge via the underdrain but, if the facility is unlined, can infiltrate to the subsurface.

$$CAPACITY_{rock} = A_{rock} \times Height_{underdrain} \times \mathrm{P}_{rock}$$

Rock Storage Above Underdrain (for configurations C, D, and F)

The rock storage above the underdrain is the rock pore space that can hold water above the underdrain’s invert elevation. Water in this part of the rock may discharge via the underdrain or, for unlined facilities, may infiltrate to the subsurface.

$$CAPACITY_{rock\ above\ underdrain} = A_{rock} \times (D_{rock} - Height_{underdrain}) \times \mathrm{P}_{rock}$$

A.5.2.3 Facility Routing Calculations

The facility routing calculations involve many steps, which are summarized in this portion of the appendix. The PAC uses the routed post-development stormwater runoff from the six scenarios (i.e., the water quality storm event, the ½ the 2-yr, 24-hr storm event, and the 2-, 5-, 10-, and 25-yr, 24-hr storm events) as inflow to the stormwater facility. The PAC calculates everything in 10-minute time steps.

Backup is summarized as described below.

- Surface Backup: If the inflow rate exceeds the blended soil filtration rate, stormwater will back up within surface storage up to the top of the overflow pipe (for configuration E only, it will then overtop the lowest overflow pipe until the rock storage is full, then (if backup is still occurring) it will continue to backup to the top of the higher overflow pipe).
- Subsurface Backup: If the flow entering the layer with rock (or for configuration A, the flow that filtered through all of the blended soil) exceeds the sum of the bottom area's infiltration rate and any underdrain's peak discharge rate, stormwater will begin to backup, first within the rock gallery (if there is a rock gallery), then (if backup continues) within the blended soil, and finally (if backup is still continuing) within surface storage.

Inflow to the Stormwater Facility

The PAC does not count direct rainfall on the facility; only stormwater runoff from the catchment's impervious area is routed through the facility. The volume of inflow to the stormwater facility during each time step equals the volume of stormwater runoff reaching the stormwater facility during each time step.

$$In_{facility(t)} = Runoff\ Volume_{(t)}$$

Surface Storage

Before the storm begins, the PAC assumes the surface storage is empty. Therefore, at the beginning of the first time step, the cumulative volume of stormwater in surface storage is zero. At the beginning of all subsequent time steps, the cumulative volume of stormwater in surface storage is equal to the cumulative volume of stormwater in surface storage at the end of the previous time step. As time proceeds during each 10-minute time step, stormwater inflow enters the surface storage and stormwater exits the surface storage by filtering through the blended soil (unless prevented by backup from below) and, if the surface storage capacity is exceeded, by outflowing through the overflow. Any amount that cannot infiltrate into the blended soil (either due to the blended soil infiltration rate, or backup within the rock and blended soil) or outflow through the overflow pipe remains in the surface storage at the end of the time of the time step.

$$STORED_{surface(t)} = STORED_{surface(t-1)} + IN_{facility(t)} - IN_{media(t)} + BACK_{storage(t)} - PIPE_{(t)}$$

Surface Overflow

The surface storage has a maximum capacity; any volume of backup into surface storage that exceeds the surface storage capacity exits the surface storage as overflow. Overflow from the discharge pipe only occurs if the backup within surface storage exceeds the capacity of the surface storage. If the backup within the surface storage is less than this capacity, then no overflow occurs.

$$OVER_{(t)} = \text{greater of } \begin{cases} 0 \\ STORED_{surface(t)} - CAPACITY_{surface} \end{cases}$$

Overflow into Pipe E - Configuration E Only

For configuration E only, there are two overflow pipes. The lower overflow pipe (called overflow “E”) directs stormwater to the rock gallery below the blended soil (bypassing filtration). Stormwater flows into overflow E only if the backup within surface storage exceeds the capacity of the surface storage of overflow E. If the backup within the surface storage is less than this capacity, then stormwater does not enter overflow E.

$$MAXOVERFLOWE_{(t)} = \text{greater of } \begin{cases} 0 \\ STORED_{surface(t)} - CAPACITY_{surfaceE} \end{cases}$$

Overflow E can only direct overflow into the rock gallery if there is room in the rock or the blended soil next to the rock for this overflow. If there is no room in the rock or the blended soil next to the rock, it continues to build up in the surface storage.

$$OVERFLOWE_{(t)} = \text{smaller of } \begin{cases} AVAILABLE_{rock(t)} + AVAILABLE_{mediabyrock(t)} \\ MAXOVERFLOWE_{(t)} \end{cases}$$

Outflow from Surface into Overflow Pipes

The PAC calculates the sum of the outflow from the pipes ($PIPE_{(t)}$).

Facilities with Configurations A, B, C, D, and F

Facilities with configurations A, B, C, D, and F have only one overflow pipe. Therefore, the total pipe outflow is simply the outflow from the overflow pipe.

$$PIPE_{(t)} = OVER_{(t)}$$

Facilities with Configuration E

Facilities with configuration E have two overflow pipes. Therefore, the total pipe outflow is the sum of outflow from both pipes.

$$PIPE_{(t)} = OVER_{(t)} + OVERFLOWE_{(t)}$$

Flow into the Blended Soil

The volume of stormwater that enters the blended soil during each time step depends upon 1) the quantity of inflow and stormwater within surface storage, 2) the maximum volume that the blended soil can infiltrate during the time step, and 3) the amount of backup in the facility. For the purposes of calculation only, the PAC divides the blended soil into layers and, for rock facilities, also into sections. The two sections of blended soil in rock facilities are divided by an imaginary line extending from the top of the rock parallel to the facility bottom: blended soil below this line is referred to as the blended soil next to the rock, blended soil above this line (even if not directly above the rock) is referred to as blended soil above the rock. For rock facilities, only the blended soil above this line is then further divided into layers. For facilities without rock, all of the blended soil is divided into layers.

Flow into the Blended Soil Prior to Considering Backup

The PAC first calculates inflow without considering backup; the PAC accounts for backup later. If the sum of the surface storage at the beginning of the time step and inflow during the time step is less than the maximum volume that the blended soil can infiltrate, then all of the stormwater within surface storage at the beginning of the time step and all of stormwater inflow during the time step infiltrates. Otherwise, the maximum volume that the blended soil can infiltrate, infiltrates.

$$In_{soil(t)} = \text{the smaller of} \quad \begin{cases} In_{facility(t)} + Stored_{surface(t-1)} \\ MaxIn_{soil(t)} \end{cases}$$

The maximum volume of stormwater that can enter the blended soil during a time step is based upon the infiltration rate of the blended soil and the area over which stormwater can infiltrate into the blended soil. For planters, the area over which stormwater can infiltrate into the blended soil is always the same (i.e., the bottom area of surface storage). For basins and sloped facilities, the area over which stormwater can infiltrate into the soil increases as the depth of water within surface storage increases.

For simplicity, this PAC, like the previous PAC, calculates the maximum infiltration rate based upon the water's surface area when the stormwater in surface storage is at 75% of the full depth. (For planters, the water's surface area is always the bottom area of surface storage, regardless of the depth.) Since the blended soil infiltration rate is 6 in/hr and there are six 10-minute time steps in one hour, the blended soil infiltration rate is 1 inch (or 1/12 of a foot) per 10-minute time step. The water's surface area (at 75% full) multiplied by 1/12 of a foot yields the maximum volume of inflow to the blended soil per time step.

$$MaxIn_{soil(t)} = \frac{A_{75}}{12}$$

Flow through the Blended Soil

The PAC assumes the blended soil infiltration rate is 6 in/hr. Since there are six 10-minute time steps in one hour, the blended soil infiltration rate is 1 inch per time step. The infiltration rate is based on the rate of drop at the surface (i.e., one inch of stormwater drops every ten minutes *at the surface*), which is different from the drop of stormwater within the blended soil. The surface storage porosity is assumed to be 1 (i.e., 100% of the space in surface storage is available for water, ignoring the space the plants take up) and the blended soil storage porosity is assumed to be 0.1 (i.e., 10% of the space in the blended soil is available to hold water). A volume of water that fills 1-inch of surface storage is equal to a volume of water that fills the pore spaces of 10-inches of blended soil. In other words, a 1-inch depth of stormwater infiltrating from surface storage into the blended soil fills the pore space of a 10-inch depth of blended soil when the blended soil infiltration rate is 6 in/hr.

Stormwater flow through the blended soil is complicated by many factors. The PAC assumes that as stormwater infiltrates through the blended soil, it fills the pore space evenly starting from the top of the blended soil column and working its way down over time to the bottom of the blended soil column. The PAC divides the blended soil above the rock (or if there is no rock, above the bottom of the facility) into stacked layers, with each layer being the depth that stormwater filters through in a 10-minute time step.

$$\#Layers_{soil} = \frac{(D_{soil} - D_{rock})/12}{\frac{(Blended\ Soil\ Infiltration\ Rate)}{No.of\ Times\ Step\ per\ Hour}/Porosity_{soil}}$$

Given the standard blended soil infiltration rate of 6 in/hr, a 10-minute time step (six time steps per hour), and a blended soil porosity of 0.1, a full blended soil layer is 10 inches. The equation for the number of 10-inch layers in a given depth of blended soil simplifies to the following:

$$\text{Using the default PAC parameters: } \#Layers_{soil} = \frac{(D_{soil} - D_{rock})}{12} \times 0.1$$

If the number of blended soil sections is a whole number, then each layer has the same thickness (i.e., 10 inches using the default PAC parameters). Otherwise, the final layer is less thick (i.e., less than 10 inches using the default PAC parameters). The fraction of the final layer is calculated by dividing the thickness of the final layer by the thickness of a full layer.

$$Fraction_{layer} = \#Layers_{soil}\ rounded\ up\ to\ the\ nearest\ whole\ \# - \#Layers_{soil}$$

$$\text{Using default PAC parameters: } Fraction_{layer} = \frac{Final\ Layer\ Thickness\ (inches)}{10}$$

Top Layer

The PAC assumes stormwater from surface storage initially enters the top blended soil layer. The volume of stormwater runoff entering the facility may vary from time step to time step, but is assumed to enter at a constant rate during each individual time step.

If the blended soil is thick enough to contain a full blended soil layer (i.e., using the default PAC parameters, the blended soil is 10-inches or more above the rock for facilities with rock or 10-inches or more above the bottom for facilities without rock), then the layer has the capacity to hold all of the water that infiltrates into it from the surface during the 10-minute time step.

If the number of blended soil layers is less than 1 (i.e., the blended soil is less than 10 inches in depth using the standard blended soil assumptions), then the blended soil does not have enough capacity to hold all of the water that infiltrates into it from the surface during a 10 minute period. Stormwater that infiltrates early in the time step will pass entirely through the blended soil (unless there is backup) while the portion that infiltrates later in the time step will still be in the blended soil at the end of the time step. The amount stored within the blended soil during a given time step is assumed to be the amount entering the blended soil during the time step multiplied by the fraction of a time step that the blended soil can hold.

$$Stored_{soil\_layer(t)} = In_{soil(t)} \times Fraction_{soil\_layer}$$

*In the above equation, the Fraction of the soil layer is 1 if the top layer is thick enough to contain a full blended soil layer or a positive number less than 1 if the top layer is not thick enough to contain a full blended soil layer.

Multiple Layers

If there are multiple blended soil layers, during the next 10-minute time step, what infiltrated into the blended soil in the top layer, infiltrates into the layer of blended soil below it and so on until the stormwater enters the final layer. The final layer takes all of the stormwater from the layer above it that it can hold. If the number of blended soil layers is a whole number, the final layer can hold all of the water that infiltrated from the layer above (i.e., using the default PAC parameters, the blended soil is 10-inches or more above the rock for facilities with rock or 10-inches or more above the bottom for facilities without rock). Otherwise, the final layer can hold only a fraction the amount that infiltrated from the layer above.

$$STORED_{bottom\ soil\ layer(t)} = STORED_{2nd\ soil\ layer(t-1)} \times Fraction_{soilsection}$$

*In the above equation, the Fraction of the soil layer is 1 if the final layer is thick enough to contain a full blended soil layer or a positive number less than 1 if the final layer is not thick enough to contain a full blended soil layer.

Storage of Stormwater in the Blended Soil

The blended soil layers are based on the depth of the blended soil above the rock gallery for facilities with a rock gallery (configurations B, C, D, E, and F) and are based on the depth of the blended soil above the bottom of the facility for facilities without a rock gallery (configuration A). The sum of the stormwater stored within all of the blended soil layers from the final layer to the top layer is added to determine the total blended soil storage above the rock gallery, for facilities with a rock gallery, or above the bottom of the facility, for facilities without a rock gallery.

$$STORED_{soil(t)} = \sum_{final\ section}^{top\ section} IN_{soilSCT(t)}$$

Available Blended Soil Capacity

The available blended soil capacity is the pore space in the blended soil that is not currently storing water. It is calculated by subtracting the amount of water stored in the blended soil by the maximum amount the blended soil can store.

$$AVAILABLE1_{soilaboverock(t)} = CAPACITY_{soilaboverock} - STORED_{soil(t)}$$

$$AVAILABLE1_{mediaSCT(t)} = CAPACITY_{soilSCT} - STORED_{soilSCT(t)}$$

The storage capacity of each layer of blended soil depends upon whether the blended soil contains only one blended soil layer or multiple blended soil layers. If the blended soil contains only one blended soil layer, the storage capacity is equal to the total storage capacity of the blended soil.

Multiple Layers

If the blended soil contains multiple blended soil layers (i.e., if it takes more than one time step for water to flow through the blended soil), the storage capacity of the final layer may be different than the layers above it. The PAC calculates the average capacity of a layer, by dividing the total capacity by the number of layers. Note that the number of layers is a whole number, rounded down so as not to contain any fractional final layer.

$$CAPACITY_{soilSTDSCT} = \frac{CAPACITY_{soil}}{Rounded\ Down\#Layers_{soil}}$$

The storage capacity in the final layer of blended soil may be a full time step or a fraction of a time step. For example, if it takes 1.8 time steps for stormwater to flow through 18 inches of blended soil to the rock, then the final layer is 0.8 time steps or 80% of a time step. In the below equation, the fraction of the soil layer is 1 if the final layer is thick enough to contain a full blended soil layer or a positive number less than 1 if the final layer is not thick enough to contain a full blended soil layer.

$$CAPACITY_{soilFINALSCT} = CAPACITY_{soilSTDSCT} \times Fraction_{soilFINALSCT}$$

Flow out of the Blended Soil

The PAC calculates flow out of the blended soil first by calculating the flow out of the blended soil assuming there is no backup and then by subtracting any backup. If there is no backup, the volume of stormwater that flows out of a blended soil layer during the time step equals the volume of stormwater that flowed into that layer of blended soil during the previous time step.

$$OUT(1)_{soilSTDSCT(t)} = IN(1)_{soilSTDSCT(t-1)}$$

$$OUT(1)_{soilFINALSCT(t)} = IN(1)_{soilFINALSCT(t-1)}$$

There may not be room for the flow from the blended soil if the combined available rock storage capacity, orifice capacity, and subsurface infiltration capacity is too small. If it is too small, then backup will prevent the flow from exiting the blended soil. The actual flow out of the blended soil is the flow that would occur without backup minus what is prevented from flowing out of the soil by the backup.

$$OUT_{soil(t)} = OUT(1)_{soil(t)} - BACK_{soil(t-1)}$$

Flow into the Rock Gallery

The PAC assumes the maximum rate of flow into the rock gallery is equal to the maximum rate of flow into the blended soil plus the volume of water contained in the blended soil next to the rock above the underdrain.

$$MaxInflowV_{rock} = MaxInflowV_{soil} + V_{soil\ to\ rock\ above\ underdrain}$$

Infiltration to Subsurface

The facility base area (set equal to the surface area at the top (or only) overflow elevation) is multiped by the percentage of the base area that infiltrates (i.e., the percent that is unlined) to calculate the area for subsurface infiltration. The PAC uses ½ the test infiltration rate as the infiltration rate for all infiltration tests except for the double-ring infiltrometer test. The double-ring infiltrometer test results are used as the infiltration rate since this test is typically more accurate.

For the double-ring infiltrometer test: $InfiltrationRate = Tested\ Infiltration\ Rate$

For all other infiltration tests: $Infiltration\ Rate = Tested\ Infiltration\ Rate/2$

$$MaxInflowV_{subsurface} = \left(A_{bottom} \times \frac{\%unlined}{100}\right) \times Infiltration\ Rate/(12 \times 6)$$

Configuration A

The PAC compares the volume exiting the blended soil with the volume that can infiltrate to the subsurface. It uses the smaller value as the infiltration to the subsurface.

$$IN_{subsurface} = \text{the smaller of } \begin{cases} OUT_{soil(t)} \\ MaxInflowV_{subsurface} \end{cases}$$

Configuration B

The PAC compares the volume of the water in the rock storage and the blended soil next to the rock storage plus the volume exiting the blended soil above the rock with the maximum that can infiltrate to the subsurface. It uses the smaller value as the infiltration to the subsurface.

$$IN_{subsurface} = \text{the smaller of } \begin{cases} OUT_{soil(t)} + STORED_{rock\ and\ soil\ by\ rock} \\ MaxInflowV_{subsurface} \end{cases}$$

Configuration D

Configuration D is lined and has no infiltration to the subsurface.

Configurations C, E, and F

For configurations C, E, and F, the PAC compares the volume of the water in the rock storage and the blended soil next to the rock storage plus the volume exiting the blended soil above the rock with the maximum that can infiltrate to the subsurface. It uses the smaller value as the initial estimate of the infiltration to the subsurface.

This initial estimate is used as the infiltration to the subsurface if the depth of water in the rock gallery does not exceed the invert elevation of the underdrain. If the depth of water in the rock gallery exceeds the invert elevation of the underdrain, this initial estimate must be adjusted to account for the underdrain outflow. This is because some of the water above the invert of the underdrain will exit via the underdrain.

The PAC estimates the fraction of the water above the underdrain that exits via the underdrain and the fraction that exits via subsurface infiltration. To do this, the PAC calculates both the maximum amount that could exit via the underdrain and the maximum amount that could infiltrate to the subsurface. Since none of the stored stormwater below the invert elevation of the underdrain will exit via the underdrain, all of the volume below the invert elevation of the underdrain is counted toward the maximum amount that could infiltrate to the subsurface. The PAC calculates the ratio of the maximum volume that can exit via the underdrain to maximum volume that can infiltrate to the subsurface minus the volume of stormwater within the facility below the invert elevation of the underdrain.

$$Ratio = \frac{MAXUNDERDRAINFLOW}{MAXINFILTRATION_{subsurface} - VOLUME_{below\ underdrain}}$$

Underdrain Outflow

The maximum outflow from the underdrain in a given time step is based upon the amount of stormwater stored within the rock above the invert elevation of the underdrain plus any amount of stormwater that can reach the rock in a given time step. The maximum outflow from the underdrain depends upon whether the underdrain has an orifice. If there is no orifice, the underdrain is assumed to not restrict the outflow.

Orifice

If the underdrain has an orifice, the outflow is restricted by the orifice. The smaller the diameter of the orifice, the smaller the flow out of the underdrain.

$$Orifice\ Area\ (ft^2) = \pi \left[\frac{Orifice\ Diameter\ (in)}{2 \times 12}\right]^2$$

$$UnderdrainFlow = 0.6 \times Orifice\ Area \times \sqrt{64.4 \times Head}$$

The underdrain flow depends upon the head of water in the facility, which is calculated as the depth of water in the facility minus headloss through the blended soil. The head is the sum of the depth of water above the orifice that impacts flow. The head is calculated from the invert of the underdrain up. The depth of water in the rock storage above the invert elevation of the underdrain is always counted toward the head. The depth of water in a given layer of the blended media is only counted toward the head if the rock storage is completely full and all of the blended media layers below it are completely full. The depth of water in surface storage is only counted toward the head if both the rock gallery and the blended soil are completely saturated. If the rock gallery and the blended soil are not saturated, then water in surface storage is considered to be perched, and not impacting the flow on the underdrain. Headloss through the blended soil is small and is estimated as the depth of water in the blended soil that counts toward the head multiplied by the ratio of the estimated underdrain outflow rate to the media infiltration rate.

If the facility is unlined (i.e., configurations C, E, or F), some of this water may infiltrate into the subsurface instead of outflowing through the underdrain. Therefore, the PAC estimates the portion of this volume of stormwater infiltrates into the subsurface and subtracts out the portion the infiltrates to the subsurface.

Table A-15. Allowed and Recommended Ranges

Description	Unit	Recommended Values	Possible Values (if outside recommended values)
Infiltration Testing Procedure	N/A	Open Pit, Encased, Double-Ring Infiltrometer, N/A	
Tested Native Soil Infiltration Rate	in/hr	0.01-100.00	
Hierarchy	N/A	1, 2a, 2b, 2c, 3	
Impervious Area	ft^2	1-999,999	
Pre-Development Time of Concentration	min	5-45	
Post-Development Time of Concentration	min	5-45	
Pre-Development Curve Number	N/A	65-81	1-99
Post-Development Curve Number	N/A	98-99	1-99
Catchment too small for flow control	N/A	Checked (for yes) or unchecked (for no)	
Facility Category	N/A	Planter (Flat), Basin (Flat), Sloped Facility	
Facility Configuration	N/A	A,B,C,D,E,F	
Facility Location	N/A	Public right-of-way or Parcel	
Facility Shape	N/A	Rectangular, Amoeba, User-Defined	
Is there an Orifice	y/n	yes, no	
If there is no Orifice, Why?	N/A	Water quality only facility; facility meets flow control without an orifice; catchment area too small	
Diameter of Orifice	in	Blank (if no orifice), $^3/_8$, ½, $^5/_8$, ¾, $^7/_8$, 1, 1 $^1/_8$, 1 ¼, 1 $^3/_8$, 1 ½, 1 $^5/_8$, 1 ¾, 1 $^7/_8$, 2, 2 $^1/_8$, 2 ¼, 2 $^3/_8$, 2 ½, 2 $^5/_8$, 2 ¾, 2 $^7/_8$, 3, 3 $^1/_8$, 3 ¼, 3 $^3/_8$, 3 ½, 3 $^5/_8$, 3 ¾	
Coefficient of Orifice	N/A	0.6 (constant)	
Bottom of Surface Area	ft^2	1-99,999	
Bottom Width	ft	1.00-999.00	
Overflow Height	in	1.0-9.0 for public right-of-way 1.0-18.0 for parcels	1.0-36.0
Blended Soil Depth or Blended Soil plus Rock Depth	in	For configuration A: 1-12; for all other configurations: 12-36	Configuration B: 1.0-60; all other configurations: 6.0-60.0

Description	Unit	Recommended Values	**Possible Values** (if outside recommended values)
Rock Area	ft^2	1-33,333	1-99,999
Rock Width	ft	1.00-999.00	
Rock Storage Width	ft	1.00-999.00	
Rock Storage Depth	in	Configuration B: 1.0-18; all other configurations: 6.0-18.0	Configuration B: 1.0-60; all other configurations: 6.0-60.0
Rock Porosity	%	0.3	0.1-1.0
Height of Underdrain	in	1.0-24.0	1.0-36.0
Percent of Facility Base that Infiltrates	%	1-100	
Blended Soil Filtration Rate	in/hr	6 in/hr (constant)	
Blended Soil Available Pore Space	%	0.1 (constant)	
Side Slope (left and right)	_h:1v	2.0-99.0	
Surface Area at the Overflow	ft^2	1-99,999	
Freeboard Depth	in	1.0-20.0	
Surface Area at Overflow E	ft^2	1-99,999	
Depth to Overflow E	in	1-34	
Perimeter Length of Bottom Area	ft	1-99,999	
Segment Length	ft	1.00-99.00	
Check Dam Width	in	0.1-99.0	
Slope	ft/ft	0.01-0.20	
Right Side Slope (h/v)	ft/ft	0.0-99.0	
Left Side Slope (h/v)	ft/ft	0.0-99.0	
Downstream Depth (Overflow Height)	in	1.0-36.0	
Bottom Surface Width	ft	0-99.00	
Landscape Width	ft	1.0-999.0	

Appendix B. Recommended Guidance for Water Crossing Structures, and Outfalls

This Appendix is intended to provide guidance in designing stormwater outfalls and water crossing structures that minimize impacts to watershed health.

Appendix B.1 Introduction

Channels, drainageways, streams and rivers are complex systems that provide critical habitat and convey water, sediment, and woody debris. Disturbances to these systems can upset the natural equilibrium by altering natural processes in ways that cause adverse impacts. Construction of culverts and other water crossing structures, and outfalls can cause erosion, bank instability, and habitat degradation. The design and construction of culverts and outfalls should consider site conditions and natural functions to reduce adverse impacts to watershed health.

Encroachments

Drainageway conveyance, including natural or constructed channels, is protected through drainage reserves, which require approval from BES for any encroachments. Culverts and other water crossing structures and outfalls typically require encroachment review. See Chapter 5 for additional information on encroachments.

Other Permits and Requirements

Water crossing structures and outfalls constructed under public works permits that would be owned or managed by the City must meet the requirements of the BES SDFDM and the technical standards of the City of Portland Standard Construction Specifications.

Permits from the US Army Corps of Engineers and the Oregon Division of State Lands may be required for water crossing structures or outfalls. Before a water-crossing structure or culvert may be placed within a drainageway that requires fish passage or other wildlife benefits, Oregon Department of Fish and Wildlife (ODFW) consultation and approval may be required. Additional requirements may be imposed by state and federal agencies.

Appendix B.2 Culverts and Water Crossing Structures

Culverts and other water crossing structures allow water to flow under a road or other constructed obstructions across channels including drainageways. Proper sizing, placement, and design water crossing structures can reduce negative impacts to conveyance, water quality, sediment transport, habitat, and watershed processes.

Adverse Impacts of Improperly Designed Water Crossing Structures

Water crossing structures such as culverts can have significant impacts on the proper functioning of channels by changing the way water and sediment are conveyed. Improperly sized or poorly placed water crossing structures can change hydraulic conditions that alter or interrupt the transport of woody debris and sediments and can change groundwater/surface water interactions. Poorly designed culverts and bridges can induce major channel and bank erosion that can undermine roadways or impede flood flow conveyance, which in turn causes flooding and failure of roadways. Poorly designed culverts can restrict or block wildlife passage and prevent 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 ecological benefits.

Summary of Analysis and Design Methods

This section provides a brief description of hydrologic analysis and design methodologies for selection and design of culverts and other water crossing structures.

Detailed design requirements and procedures are not included here, but can be found in reference documents listed below and cited in this section and Section B.3 .

- Hydrologic analysis requirements for culverts in the public right-of-way or otherwise owned by the City of Portland are provided in the Portland Sewer and Drainage Facilities Design Manual (SDFDM).
- Culvert design guidance for fish passage is provided in the Oregon Department of Fish and Wildlife Fish Passage Criteria and related statutes, the Oregon Road/Stream Crossing Restoration Guide, and the Washington Department of Fish and Wildlife Design of Road Culverts for Fish Passage.
- Permits from the US Army Corps of Engineers and the Oregon Division of State Lands may be required.

B.2.1 Water Crossing Selection

There are many factors to consider when selecting an appropriate water crossing structure. Bridges are generally preferred and may be recommended in certain situations. When a bridge is impractical, culverts that provide continuity of streambed material through the culvert are preferred. Analysis is needed to determine the correct structure for site conditions. Discussion of three water crossing options are summarized below.

Open-Bottom or Natural-Bed Culverts

Open-bottom and natural-bed culverts provide continuity for the streambed material through the culvert and are preferred options, other than a bridge, for maintaining channel geomorphology. Open-bottom or natural-bed culverts are designed to mimic the substrate and flow conditions in the natural streambed above and below the culvert. The culvert alignment, culvert bed grade, and channel bed material should generally be as similar as possible to the adjacent natural streambed. The culvert size is based on geomorphic features and fish passage. Sediment transport continuity and flow conveyance are assumed to be achieved by mimicking the natural channel.

Hydraulic-Only Culverts

Under certain circumstances (e.g., to protect against landslide hazards or along roadside ditches), a closed-bottom culvert sized using only hydraulic analysis may be allowed. This approach to culvert design primarily focuses on creating a hydraulically efficient culvert that provides conveyance of design flows. However, culvert design should analyze sediment transport and be designed to prevent upstream deposition or downstream scour. Hydraulic design culverts may not be allowed in locations requiring fish passage or may require complex design to accommodate fish passage.

Bridges

Typically, bridges are the best choice to protect geomorphic function in a channel. Bridge design needs to meet state and local building, structural, and transportation requirements and needs to consider a variety of items including, but not limited to, bankfull width, flood plain utilization ratio, stream type, bridge performance, and channel meander migration. Bridge design is not covered in this manual. A bridge, rather than a culvert, may be recommended if any of the following apply:

- The active channel is greater than 20 feet wide.
- A roadway width requires a culvert longer than 150 feet.
- The channel gradient is greater than 6%.
- Woody debris movement occurs frequently.

- There is active channel movement.
- Large animals (e.g., coyote or deer) need wildlife passage.
- A culvert could not achieve the hydraulic or hydrologic requirements.
- Endangered Species Act (ESA)-listed fish or other wildlife as identified by ODFW are present.

B.2.2 Culvert Design Information

Design culverts and other water crossing structures to maintain geomorphic function of natural channels, protect habitat, provide fish passage, protect water quality, convey flood flows, maintain continuity of flows up and downstream of the culvert, and minimize negative effects on watershed processes and ecological functions. Water crossing structures require formal engineering calculations and designs.

B.2.2.1 Standard Approaches to Culvert Design

Three standard approaches to culvert design are described below. These are no-slope, stream simulation, and hydraulic-only. The two standard design approaches for open-bottom and natural bed culverts are no-slope and stream simulation. Hydraulic-only culverts are designed to provide efficient passage of flows and typically do not take into account other geomorphic functions like sediment transport or habitat. All culverts require engineering design including hydraulic analysis. See Table B-1 for a summary of criteria to help guide designers at the concept and planning stages.

Table B-1. Culvert Design Approach Guidance

Design Approach	Channel Width (Bankfull Width)	Channel Slope	Channel Stability	Culvert Length	Floodplain Utilization Ratio
No-slope culverts	< 10 ft	<3%	Stable	<75 ft	<3
Stream Simulation	< 15 ft	Any	Moderate or Stable	Additional analysis needed when length:width ratio is >10	<3
Hydraulic Design	Additional engineering methods exist for more complicated situations.				

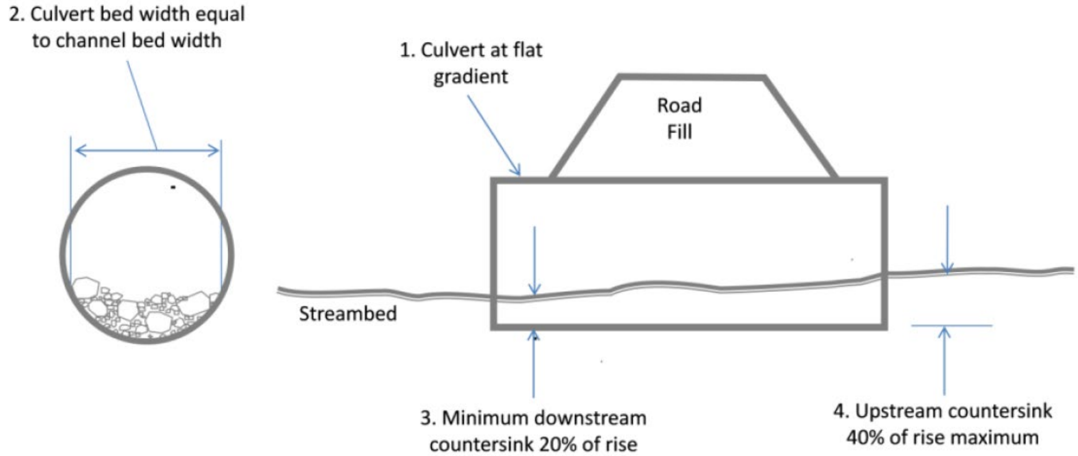
Floodplain utilization rate is defined as the floodprone width divided by the bankfull width. Table summarized from Barnard, R. J., J. Johnson, P. Brooks, K. M. Bates, B. Heiner, J. P. Klavas, D.C. Ponder, P.D. Smith, and P. D. Powers (2013), Water Crossings Design Guidelines, Washington Department of Fish and Wildlife, Olympia, WA.

Open Bottom or Natural-Bed Culverts (No-Slope and Stream Simulation)
Culverts designed with an open-bottom or natural-bed 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. The culvert size is based on geomorphic features and fish passage, sediment transport continuity and flow conveyance are assumed to be achieved by mimicking the natural channel. There are two standard design approaches for open-bottom and natural-bed culverts: no-slope and stream simulation. Both design approaches are described below.

Open Bottom or Natural Bed: No-Slope Culvert Design
The No-Slope Culvert Design Approach is best used at sites where the channel is stable, with a channel width of less than 10 feet and a channel slope of less than 3% and where the floodprone area is less than three times the channel width. The criteria below apply to the No-Slope Culvert Design (See Figure B-1):

- The culvert length must be less than 75 ft.
- The culvert is set at a nearly flat gradient, no more than plus or minus 0.5 percent.
- The width of the bed inside the culvert (not the culvert span) is greater than or equal to the prevailing bankfull width of the stream in the reach where the culvert is located.
- A bed should be placed in the culvert that is composed of material similar to the bed of the adjacent stream or composed of material that better mimics natural conditions.
- Adequate clearance between the culvert bed and crown should be provided to pass expected debris and high flows during flooding events.
- The culvert should not constrict the bankfull flow and is expected to maintain streambed material similar to that found in the adjacent channel.

Figure B-1. No-slope schematic diagram



This shows the four principle components of the design. Illustration from Barnard, R. J., J. Johnson, P. Brooks, K. M. Bates, B. Heiner, J. P. Klavas, D.C. Ponder, P.D. Smith, and P. D. Powers (2013), Water Crossings Design Guidelines, Washington Department of Fish and Wildlife, Olympia, Washington.

Open Bottom or Natural Bed: Stream Simulation Design

The Stream Simulation Design Approach is for sites where the channel stability is moderate or stable, where the channel is moderately confined, with a channel width of less than 15 feet and where the floodprone area is less than three times the channel width.

The culvert shape, dimensions, slope, and bed roughness should be designed to provide flood conveyance capacity and fish passage and not result in any further degradation of water quality. The following conditions apply to the Stream Simulation Design:

- Equilibrium stream slope (stable channel).
- The culvert bed slope should not be greater than 1.25 times the upstream channel's slope.
- Additional analysis is required for culverts with a length-to-width ratio greater than 10.
- A bed should be placed in the culvert that is composed of material similar to the bed of the adjacent stream or composed of material that better mimics natural conditions.
- Adequate clearance between the culvert bed and crown should be provided to pass expected debris and high flows during flooding events.

Hydraulic-Only Design

Under certain circumstances, a closed-bottom culvert sized based on hydraulic efficiency may be appropriate. Culverts designed under this approach should provide passage of the 25-year flow with no surcharge (additional clearance may be required in larger systems or when debris passage is required). Natural bed material is not required but should demonstrate flow conveyance and should be designed to prevent upstream deposition or downstream scour. This may not be allowed in any locations requiring fish passage and may be used in instances to protect against landslide hazards or along roadside ditches, for example.

B.2.2.2 Flood Conveyance Analysis

Demonstrating flood conveyance capacity and performing scour analysis for flood flows is usually required for culvert design. This type of analysis must be performed by a registered professional engineer. Acceptable design approaches include the following:

- Federal Highway Administration Hydraulic Design of Highway Culverts (FHWA 2012).
- Analysis with a hydraulic model such as HEC-RAS.

This analysis should provide water surface profiles, energy grade line, bed shear, and velocities through the structure for the applicable design flows.

Culverts should be sized as follows:

- Convey 25-year design storm flow for full build-out conditions in the upstream drainage basin without surcharging the inlet (i.e., water depth shall not exceed the inside height of the culvert crown).
- Culverts in designated floodways should meet the conveyance criteria in Title 24.50.

Culverts may be required to convey the 100-year flow for streams with a Federal Emergency Management Agency designated floodplain, or if regular high-water conveyance is predicted. If the risk associated with culvert failure is high, a more conservative standard may be required.

In addition, if the culvert is not sized to convey the 100-year peak flow, a route should 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.

B.2.2.3 Common Design Elements

All culvert designs should take into account the following standards and considerations whether they have a natural bed or not.

Horizontal 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. 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. 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 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 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). Calculated slope should approximate the average slope of the adjacent streambed from 10 channel widths upstream and downstream of where the new culvert should be placed.

Grade Control

If the stream channel bed is aggrading (rising) or degrading (incising), grade control structures may be needed up or downstream of the channel crossing. 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 adjust the gradient of the adjacent channel. Grade control structures should also meet all applicable fish passage requirements.

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 may be necessary. Depending on the size of the channel and the peak flow rates that the culvert should 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, regardless of culvert width.

Structural Design

Culverts, bridges and all water crossing structures require engineering design and analysis to ensure they are providing adequate structural strength. Structural designs should take into account the strength of underlying soils, soil cover, traffic loads and other design considerations. Typical culvert materials include the following: metal pipe (arch pipe or closed pipe), pre-cast concrete, and cast-in-place concrete. Selection of the optimal material for a particular site is typically based on cost, site accessibility, construction planning, and structural strength.

Minimum Cover Recommendations

Cover requirements vary depending on the culvert material selected:

- Culverts made of metal should have 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 will vary depending upon the weight of traffic loads or other land use that can be expected atop the culvert.
- Culverts made of reinforced concrete (cast-in-place or pre-cast) can be designed to directly support required traffic loads.

Foundation
The type of foundation necessary depends on the structure selected. A geotechnical engineer should 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. The geotechnical engineer's recommendations should be followed to achieve sufficient structural support for long-term success and prevent differential settlement.

B.2.2.4 Additional Common Design Elements for Open-bottom and Natural-bed Culverts

Culvert Span and Culvert Bed Width
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, or estimated by physical features such as the following:

- A topographic break from vertical bank to flat floodplain.
- A topographic break from steep slope to gentle slope.
- A change in vegetation type.
- A textural change of depositional sediment.
- A textural change of matrix material between cobbles or rocks.
- The elevation below which no fine debris (needles, leaves, cones, seeds) persists.

The minimum culvert bed width should be calculated as 1.2 times the active stream channel width plus two feet. At least three typical cross section widths should be used to calculate an average width. A span of at least 6 feet is typically necessary to enable channel bed construction within a culvert.

Culvert Bed Slope
Installing the culvert bed at a slope significantly less (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 greater (steeper) than the natural gradient may induce instability of the culvert bed material during higher flows. The ratio of the culvert bed slope to the natural channel slope should not exceed 1.25.

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 should include some slope in order to maintain embedded depths and inlet capacity.

Culvert Bed Material

A bed should be placed in the culvert that is composed of material similar to the bed of the adjacent stream or composed of material that better mimics natural conditions. The use of grout or any other substrate binding bed material together is not recommended.

Bed material should be sized based on a sieve analysis of the adjacent natural stream channel. The bed material distribution should be well-graded, non-porous and have approximately 5 to 10% fines. Larger material may be used in moderation to assist in grade retention and to provide resting areas for migratory fish. It is not appropriate to compare sediment size estimates with channel reaches that are controlled by large wood, deeply incised, or not in equilibrium.

Vegetated channels should be designed to match expected natural conditions as determined by the reference reach approach. The design should maintain stability and prevent erosion. Analysis using accepted engineering methods should be used including the stable channel design approach included in the Sewer and Drainage Facility Design Manual or another approach.

Scour Analysis and Embedded Depth

Hydraulic analyses should be performed to ensure structural integrity at high-flows. A scour analysis should be performed to ensure that bed material remains within the culvert during flood flows. Large oversized key boulders that remain in place during the 100-year flow may be used to stabilize the bed. The design should take scour analysis into account when determining the bed material design and proposed embedded depth of countersunk culverts and footings.

Baseflow Channel

Stream channels should include a baseflow channel to support sediment transport and provide fish habitat. The minimum cross-sectional dimensions for the baseflow channel are 1-foot wide by 6 inches deep and are based on confining the summer baseflow. The baseflow channel helps to maintain stream power on the bottom leg of the hydrograph, hence transporting 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.

Culvert Rise and Woody Debris Transport

Adequate clearance between the culvert bed and crown should be provided to pass expected debris during flooding events. Design culverts to provide some transport of woody debris. Select the size of material to pass through a culvert 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 should be calculated and accommodated. The culvert rise can be designed so that sufficient water depth and freeboard occurs during a storm in which the material would be mobile.

A minimum effective rise (from the culvert bed to the height of the culvert crown) of 4 feet is recommended. This will allow for the passage of wood and sediment and favor other natural fluvial processes.

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 is necessary, 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 there is a potential for recruitment of wood from a well-vegetated riparian corridor.

Appendix B.3 Outfalls

Outfalls discharge stormwater from an upstream catchment to the separated storm system, including a drainageway, creek, stream or river. Improperly designed outfalls can cause extensive erosion and scour on a bank, or within a receiving waterway and can undermine bank stability.

B.3.1 Outfall Selection

Outfall selection and design is dependent upon local conveyance and energy dissipation requirements. Three types of outfalls are addressed below.

Open channel outfalls discharge stormwater via an open channel (such as a ditch) to a stream, drainageway, or another open channel. Open channel outfalls are good options for sites with existing ditches or channels. The longitudinal slope (in the direction of flow) of the outfall channel should be less than 20 percent.

Piped outfalls discharge stormwater from a piped conduit to a stream, drainageway, or open channel. These are often used at the terminus of a storm sewer piped network. Piped outfalls systems may be required on grades equal to or greater than 20% or if the soil, slope, or space requirements of an open channel or upland dispersion outfall cannot be met.

Upland dispersion (i.e., level spreading) spreads stormwater out over an area outside of the riparian zone and higher in elevation than the receiving stream, drainageway, or open channel. Upland dispersion is a good option for sites where stormwater currently infiltrates. It can be an option for discharges to long slopes, ravines, riparian areas, and other natural areas where concentrated flows, but not dispersed flows, could cause erosion. This method enables stormwater to be used to support habitat functions while also adding stormwater attenuation benefits through uptake by vegetation, decreased flow velocities, and allowing infiltration. The slope(s) onto which the runoff will be dispersed should be stable and have a gradient of 20 percent or less, not have a separate source of concentrate flow, and have room to accommodate a vegetated flow path of at least 50 feet from the proposed dispersion location.

B.3.2 Outfall Design Information

Outfalls should be designed and constructed to provide flow conveyance and minimize impacts to stream channels, drainageways, and watersheds, preventing and reducing erosive conditions and protecting the stability of banks, channels, and ravine slopes. Drainageways may have steep slopes or banks and may have unstable landforms (e.g., slumps). Geotechnical investigation to determine the stability of the stream or riverbank, as reviewed and approved by BES or BDS, may be required prior to approval. The following outfall design criteria are for outfalls smaller than 36 inches in width.

Configuration and placement of the outfall should be designed based on site conditions, such as site slopes, drainage basin size, fish passage status, soil erodibility, receiving channel conditions, slope stability, and existing vegetation.

B.3.2.1 Open Channel and Piped Outfalls: Common Design Elements

Alignment

Orient the outfall at a 30-degree maximum angle from a perpendicular alignment to the receiving channel (with flow oriented in the downstream direction).

Elevation

Locate the outfall discharge above the downstream mean low water level elevation.

Erosion and Scour Control

Design, construct, and maintain the outfall to reduce erosion. Erosion can result when flow passes over sparsely vegetated ground or bare soil and 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 (i.e., the critical shear stress). Protection from erosion can be provided with several techniques including the following:

- Plantings on the channel banks and in the flow path;
- Geotextile fabric lining;
- Low-rise check dams spanning the outfall channel;
- Woody structures installed in the drainageway channel bank; and
- Rock lining (e.g., large riprap, smaller quarry spalls, or streambed boulders).

The design should minimize flow velocities and dissipate energy at the outfall, to 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. Erosion control techniques should not impede fish passage within the receiving water.

Outfall Discharge Protection and Energy Dissipation

Protection of outfalls at the point of discharge to a drainageway, stream, or other waterway maintains channel bank stability and reduces erosion.

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 the specifications outlined in this manual. However, as long as it can be proven to both dissipate energy and protect against erosion and scour, it can be considered acceptable. Depending on the flow velocity and existing site conditions, a variety of approaches can be used to disperse energy and prevent erosion.

Energy dissipation techniques include the following:

- Non-rock dissipaters that are shaped with soils, vegetation, berms, and woody debris;
- Rock outfalls with vegetation incorporated;
- Pipe tee diffusion structures (see Figure B-3); and
- Energy dissipation structures.

While rock is a traditionally used material, the use of plantings and large woody debris are preferred, if feasible.

Non-Rock Dissipator

Non-rock dissipaters that are shaped with soils, vegetation, berms, and woody debris are encouraged. Large woody debris (i.e., woody debris larger than 12 inches in diameter) from long-lived species such as Western redcedar or Douglas-fir is preferred. Large wood can be engineered to deflect flow and dissipate energy as effectively as large rock and provides additional habitat benefits to aquatic and terrestrial ecosystem processes. Logs may be stacked to form outfall wing walls or to shore up banks on either side of an outfall's confluence with a channel. It may also be used to build structural beds on stream banks or slopes where native riparian vegetation should be planted post-construction. Incorporating large wood into outfall designs may also contribute to project impact mitigation, particularly if the project takes place in an area bearing ESA-listed fish or wildlife.

Rock Riprap

With the use of the proper size and gradation, rocks provide energy dissipation as well as protection against soil erosion. Figure B-2 shows an option for outfall energy dissipaters made of rock. All rock protection areas should be interplanted with willow stakes or other appropriate riparian vegetation to increase slope stability, reduce erosion, provide shading and other habitat functions, and improve aesthetics. See Table B-2 for information on using rock for outfall protection.

Figure B-1. Outfall with Rock

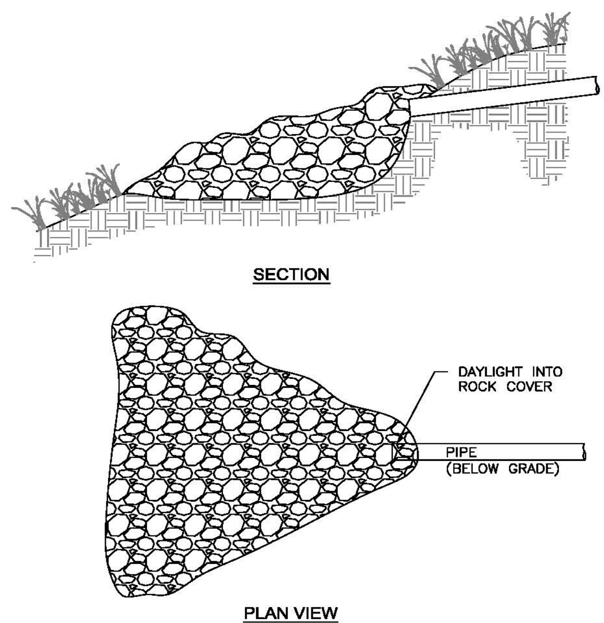


Table B-2. Rock Protection at Outfalls

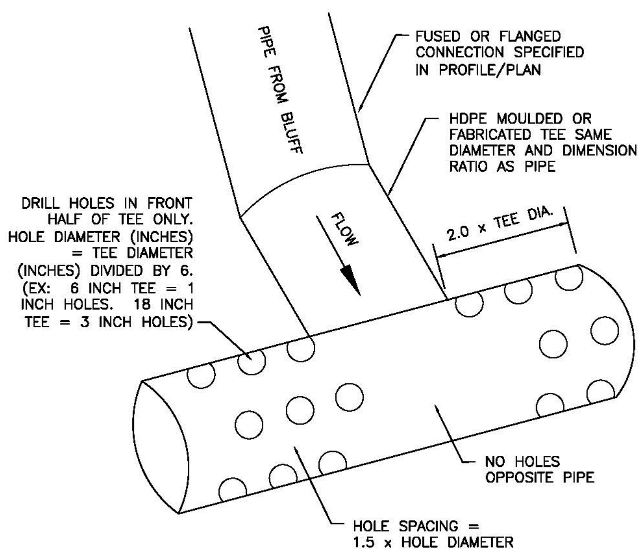
Outfall Diameter	Discharge Velocity at Design Flow	Average Stone Size	Depth	Width	Length	Height
2 inch		1 inch	2 inch	12 inch	24 inch	
4 inch		2 inch	4 inch	24 inch	36 inch	
6 inch		4 inch	6 inch	36 inch	48 inch	
>6 inch	0-5 feet per second	Riprap	2 x max stone size	Diameter + 6 feet	As calculated	Crown + 1 foot
	6-10 feet per second	Riprap	2 x max stone size	Greater of (diameter + 6 feet) or (3x diameter)	As calculated	Crown + 1 foot

Riprap size shall be calculated as ds = 0.25* (V/g) (6 inches minimum), where ds= rip rap size, V = average velocity (ft/s) and g=32.2 ft/s^s.

Energy Dissipation Structures
High velocity flows have significant kinetic energy, which can cause extensive erosion and scour at an outfall or receiving waterway. When flow velocity is high at an outfall, energy should be dissipated, and erosion protection should be in place to protect against scour.

For outfalls with high velocity flows, and high erosion potential more complex energy dissipation structures (e.g., pipe tee diffusers, stilling basins, drop pools, hydraulic jump basins, baffled aprons, bucket aprons) may be needed. These structures should be engineered and are recommended where velocities are greater than 5 feet per second. The use of large, rounded boulders at the outfall outlet may be useful to deflect debris moving downstream away from the outfall. Energy dissipation structures can be constructed out of a variety of materials including wood, boulders and concrete.

Figure B-2. Pipe Tee Diffuser.



Pipe tee diffuser should be designed by a professional engineer using published references. The construction design submittal must identify the design reference.

B.3.2.2 Open Channel Outfalls
To use an open channel outfall, meet the following conditions:

- The soils through which the outfall channel is constructed should be stabilized through approved erosion control measures and may require an official geotechnical report.

- The longitudinal slope (in the direction of flow) of the outfall channel should be less than 20 percent.
- Side slopes shall be a maximum of 3:1. Steeper side slopes may be allowed for channels with rock protection.
- There should be at least 6 inches of freeboard during the 25-year flow.
- The open channel should not pose safety risks at the design flow depth.
- Fish passage should be prohibited into any stormwater facility through an open channel outfall.

Channel Depth and Width
The primary concerns where an open channel outfall merges with a wider and deeper channel are 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 water down the bank of the receiving channel that can cause erosion of the bank or bed of the receiving channel. There should be 6 to 12 inches of freeboard depth above the design storm water surface elevation in an open drainage channel.

Plantings
Incorporate native vegetation 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 vegetation is fully established. Vegetation should be fully established at 90% cover within one year of planting. Reference the Portland Plant List for appropriate vegetation. See Title 11 Tree Code for tree requirements relating to development situations.

Grade and Erosion Control
To minimize erosion and scour, the bottom of the open-channel outfall should be designed at the same elevation as 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) may be required to create a step-pool sequence within the open channel outfall. Appropriate grade control measures depend upon the outfall channel, the receiving waterway, and the site characteristics.

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. Steep (greater than 20 percent slope) elevation drops of greater than 1 foot should be avoided through the use of properly designed and installed grade controls, particularly if upstream fish passage is a consideration. 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 check dams are used to slow velocities in the open channel outfall, a minimum of three check dams are recommended. They should be made of wood or rock, and should be keyed into the open channel bed and banks to prevent the dam from being displaced or bypassed during high flows. Where rock is used, the rock should 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.

B.3.2.3 Piped Outfall

The following are additional design criteria for piped outfalls:

- For slopes steeper than 40 percent, the pipe should be installed on the ground surface to minimize disturbance of what could be an unstable slope.
- Endwalls or flared end sections may be required for exposed outfall pipes greater than 12 inches in diameter.

Outfall Size and Grating

The size of the outfall is determined based on Oregon plumbing code requirements and the design storm size (typically, the 25-year design storm). Publicly accessible outfalls greater than 18 inches in diameter should include grated protection.

B.3.2.4 Upland Dispersion

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 flow path 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 should be created by the flow dispersion.

To use upland dispersion, the following conditions should be met:

- Stormwater discharges are considered low flow (100-year flow < 2 cfs).
- The slope(s) onto which the runoff will be dispersed should be stable and have a gradient of 20 percent or less. An evaluation by a geotechnical

engineer or qualified geologist and approval by the City of Portland Bureau of Development Services may be required.

- The site must have room to accommodate a vegetated flow path of at least 50 feet from the proposed dispersion location to the nearest property line, structure, environmental zone, or steep slope (greater than 40 percent).
- No existing concentrated surface discharge (channels or ditches) should be on the site and no drinking water wells, septic systems, or springs used for drinking water may lie within 100 feet of the proposed dispersion site.

Sizing and siting guidance

A flow dispersal trench can be used to provide upland dispersion, 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. The design criteria for a single flow dispersal trench include the following:

- 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 should use only dispersion trenches to disperse flows.
- Dispersion trenches should be a minimum of 2 feet wide, 2 feet deep, 50 feet long, filled with ¾ - 1½ inch washed drain rock, and provided with a level notched grade board.
- Manifolds may be used to split flows of up to 2 cfs for the 100-year peak flow between up to four trenches (maximum).
- Multiple dispersion trenches should 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.

Appendix B.4 Construction Considerations

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 should expedite completion of construction and minimize potential for adverse water quality impacts.

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 or increase the erosive nature of hillslopes and create conditions conducive to sediment runoff into the conveyance channel.

Every construction project in and around channels is unique and brings specific considerations and requirements necessary to protect watershed function and public health and safety. These guidelines describe only some of the available construction techniques; others may be appropriate in certain situations.

- Project activities should be kept within the regulated work areas only. Equipment should not be allowed to enter any waters of the State or U.S., or the regulated work area except as allowed in permits issued for the project.
- Use low ground-pressure vehicles (such as spider hoes or those approved under Environmental Zoning or Greenway Code allowances) for construction. Demonstrate adequate soil and vegetation protection during construction and restoration. Heavy machinery that produces excessive ground compaction may not be allowed within the drainage reserve during construction.
- For work in the channel or on an active outfall, flow bypass or other forms of dewatering should be accomplished to enable construction in relatively dry conditions. State or Federal permits may apply to dewatering or bypass in the channel.
- Construction should be done in a manner to reduce erosion. If the construction results in bare soil, long-term erosion control should be provided through vegetation coverage and best management practices as required by the Erosion and Sediment Control Manual (Administrative Rule ENB-4.10).

- Replant all disturbed areas associated with culvert, water crossing structure, or outfall construction with native vegetation to help stabilize soils and slopes; this includes construction access roads, equipment landing pads, and other areas upland of the bed and banks.
- For open channel outfalls, complete and stabilize the new channel excavation before making the connection to the receiving drainageway by leaving a plug of native soil or other approved equivalent between the outfall channel excavation and the receiving drainageway until the connection is ready to be made. 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.
- Install piped outfalls on slopes that are 15 percent or greater with erodible soils by hand trenching.
- For culverts with a natural bed, 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 to provide a good seal, and to demonstrate that this seal has occurred.

Additional Construction Considerations

Construction in and adjacent to streams that provide habitat for fish should adhere to prescribed periods for in-water work, as defined in the Oregon Department of Fish and Wildlife Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources. Vegetation removal and brush work should minimize impacts to birds and wildlife, specifically nesting birds, to comply with the U.S. Fish and Wildlife Service's regulatory Migratory Bird Treaty Act.

Appendix B.5 Planting Requirements: Culverts and Outfalls

Replant all disturbance areas with native plants. Within drainage reserves, native plants are required as mitigation in disturbance areas per Chapter 5. For plant recommendations, see the Portland Plant List. Choose plants appropriate for the native plant community type as described in the Portland Plant List. Vegetation should be planted in quantities per Table B-3 and should reach 90 percent vegetation cover within one year. See Title 11 Tree Code for tree requirements relating to development situations and City Code Title 33 for-vegetation requirements related to applicable environmental zoning. For public natural areas with approved master plans or management plans, vegetation requirements may vary.

Table B-3. Planting density for restoration of disturbance areas

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
2	Trees	100	6 ft min height or 1 ½-inch caliper	Per plan
5	Shrubs	100	#1 container or 12-36 inches tall bare root stock	3 ft’
35	Herbaceous plants	100	4-inch pots	12 inches
120	Herbaceous plants	100	Plugs	6 inches

Appendix B.6 Reference Material

Culvert Design

Portland Sewer and Drainage Facilities Design Manual

Oregon Department of Transportation, Hydraulics Manual (2014)

Federal Highway Administration, Hydraulic Design of Highway Culverts (2012)

United States Department of Agriculture, Forest Service; Stream Simulation Design for Culverts (2008)

United States Army Corps of Engineers, Conduits, Culverts and Pipes (1998)

Washington Department of Fish and Wildlife, Implementation and Effectiveness Monitoring of Hydraulic Structures (2015)

Washington Department of Fish and Wildlife, Water Crossing Design Guidelines (2013)

Washington Department of Fish and Wildlife, Stream Habitat Restoration Guidelines (2012)

Fish Passage Design

Anadromous Salmonid Passage Facility Design (2011)The Oregon Road/Stream Crossing Restoration Guide

Washington Department of Fish and Wildlife Design of Road Culverts for Fish Passage.

Oregon Requirements for Fish Passage

Oregon Administrative Rules, Chapter 635-412-0005, Fish Passage

Oregon Department of Fish and Wildlife, Fish Passage Website

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Appendix C: Resources and References

This appendix provides references for City program and regulations relating to the design, construction, permitting and maintenance of stormwater management and conveyance facilities. It also provides information on non-City programs and design information that may be helpful in design of stormwater management and conveyance facilities. Weblinks are embedded in the title headings.

C.1. Stormwater Management Manual Contact Information

Stormwater Management Manual website

To request more information on development standards within the Stormwater Management Manual, write to: BESSTormManual@portlandoregon.gov

Stormwater Presumptive Approach Calculator (PAC)

C.2. Permitting and Development Review

Development Services Center (DSC)

Provides expertise and services for all permitting needs and processes. Specific services are listed below.

1900 SW 4th Avenue, 1st Floor

Portland, OR 97201

For hours and availability, visit or call:

- Permitting Services (503) 823-7310
- Planning and Zoning (Zoning questions) (503) 823-7526
- Plumbing, Electrical, Mechanical, Sign Permits (503) 823-7363
- Resource/Records (503) 823-7660
- Permit Status via Voicemail (503) 823-7000 (4)
- Stormwater facility inspection: (503) 823-7000 (1) Request #487

Bureau of Environmental Services, Development Review Hotline

For questions related to project or site-specific development proposals, including guidance on submittal requirements or required inspections.

(503) 823-7761

Bureau of Development Services (BDS) Early Assistance Appointments
Services are available prior to submittal of a land use review or building permit application. These services are intended to provide useful feedback for projects ranging from relatively simple to very large and complex.

Questions: (503) 823-7526

Application form

Application Submittal: Early assistance appointment request forms should be submitted to the Development Services Center

Public Works Permitting Process
For information on improvements in the public right of way.

Site Development Permits
Site development permits are issued for work such as clearing, grading, tree cutting, landslide repair, private streets and groundwork related to new subdivisions, where no building or structure is altered, moved or constructed.

(503) 823-6892

C.3. City Codes

Title 10: Erosion and Sediment Control

Title 11: Trees

Title 17: Public Improvements

Title 21: Water

Title 24: Building Regulations

Title 29: Plumbing, Section 29.30.170

Title 33: Planning and Zoning

C.4. City of Portland Resources

City resources are available for design guidance as well as resources for programmatic support and information.

C.4.1. City Design Resources

BES Auto CAD Files

Sewer and Drainage Facilities Design Manual

Bird Friendly Design

Guidance on practical design approaches to reduce risks to birds, with a focus on exterior glass and lighting design

City of Portland Standard Details and Drawings

City of Portland Standard Construction Specifications

Erosion and Sediment Control Manual

Portland Plant List

Contains a list of Portland's approved native plants and nuisance plants. Nuisance plants are prohibited from being planted and native plants are required in certain environmental zones and drainage reserves.

Rainwater Harvesting Code Guide

Portland's code guide for installing rainwater harvesting systems.

Rainwater Harvesting Resource Guide

This factsheet provides information on the benefits of rainwater harvesting and the various city bureaus that are involved in installing a rainwater harvesting system.

Transportation Design and Construction Standards and Documents

Improvements in the public right-of-way must also meet design and construction standards for transportation elements.

Water Valves Hydrants and Assemblies

Building Codes Division Oregon Smart Guide

C.4.2. City Programs and Bureaus

Clean River Rewards – Stormwater Discount Program

Information on Portland's stormwater utility discount program. Property owners can receive up to a 100% discount on on-site stormwater management charges.

(503) 823-1371

Columbia South Shore Well Field Wellhead Protection Program
Information on the groundwater protection program, regulations, area map and technical assistance.

Combined Sewer Overflow (CSO) Program
Information on Portland's 20-year combined sewer overflow program that was completed in 2011.

Ecoroof Resources
Information on a variety of ecoroof resources in the city of Portland including project examples, technical guidance and how to find an ecoroof professional.

Green Street Steward Program
Information on how community members can participate in the care and maintenance of Portland's green streets.

Maintenance Inspection Program
The City of Portland has a program to inspect stormwater management facilities installed on private property and provide property owners with the Technical Assistance they need to ensure that stormwater management facilities are functioning as intended.

Revegetation Program
The City of Portland has a program that designs, plants, inspects and maintains stormwater management facilities in the public right of way and on public property.

Urban Forestry
Portland Parks & Recreation Urban Forestry's Department manages Portland's forest infrastructure. Information on permits for planting, pruning, and removal of all public and some private trees. The site also provides information on 24-hour tree emergency response.

(503) 823-4489

C.5. Site Evaluation Maps

Portland Maps
This site includes public storm and sewer utility information. Inquirers can search by address to find detailed information about properties. Sewer and environmental information is located under the utilities tab. Tax lot information is located under the assessor and assessor detail tab.

Soil Survey of Multnomah County

Soil Conservation Service, 1982. This document contains soil survey data and soil property data for Multnomah County.

C.6. Additional Resources

Additional programmatic and design resources are available through other states and jurisdictions.

C.6.1. Outside Design Resources

East Multnomah Soil and Water Conservation District – Rain Garden Design and Construction

Environmental Protection Agency National Stormwater Calculator

King County Surface Water Management

King County, Washington, “Surface Water Design Manual”, originally published in 1990 (effective April 24th, 2016)

Oregon Specialty Plumbing Code 2011

Oregon State University, Sea Grant, Oregon Rain Garden Guide

City of Tacoma permeable paving specifications

National Asphalt Paving Association, Porous Asphalt Pavements for Stormwater Management:

National Ready-Mix Concrete Association

Interlocking Concrete Pavement Institute

Port of Portland - Stormwater Design Standards Manual

C.6.2. Outside Programmatic Resources

Clean Water Services

Private Water Quality Facility Management Program

Metro

Portland's regional form of government that oversees regional land use planning, research, natural areas and solid waste and recycling.

Multnomah County Drainage District

The Multnomah County Drainage District prevents flooding through the management of levees, pump stations and drainageways, facilitates recreation within drainage district facilities and maintains habitat friendly environments along the Columbia River and Columbia Slough.

Oregon Department of Environmental Quality (DEQ)

DEQ is Oregon's state agency that regulates the protection of Oregon's land, water and air quality.

Oregon Department of Environmental Quality (DEQ), Underground Injection Control Program (UIC)

Oregon Department of State Lands

Provides information on regulations associated with activities within waters of the state.

Oregon Environmental Council – Low Impact Development Guidance Template

A guidance manual that cities and counties throughout Western Oregon can use to use to reduce stormwater runoff, prevent flooding, and improve the health of our rivers, lakes and streams

Oregon Environmental Council - Stormwater Solutions Report

A report developed to recommend strategies (including policies, projects, and programs) that will reduce stormwater impacts in Oregon's urban areas.

Salmon Safe Certification

A guide for site developers and designers interested in developing environmentally innovative projects that help restore our urban watersheds

U.S. Green Building Council

The US Green Building Council helps advance buildings are designed, constructed and operated through Leadership in Energy and Environmental Design, (LEED). LEED, or is a certification program for buildings and communities that guides their design, construction, operations and maintenance toward sustainability

Washington State Department of Ecology
Stormwater Management Manual for Western Washington

West Multnomah Soil and Water Conservation District – Healthy Stream Program

The Healthy Streams Program provides full funding, project planning and technical assistance to landowners for streamside restoration to improve water quality, wildlife habitat and the condition of the land.

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The City of Portland ensures meaningful access to City programs, services, and activities to comply with Civil Rights Title VI and ADA Title II laws and reasonably provides: translation, interpretation, modifications, accommodations, alternative formats, auxiliary aids, and services. To request these services, call 503-823-7740, City TTY 503-823-6868, Relay Service: 711.

笔译服务！ | Chiaku me Awewen Kapas | अनुवादन तथा व्याख्या | Traducere și interpretariat | Устный и письменный перевод | Turjumaad iyo Fasiraad | Traducción e interpretación | Письмовий і усний переклад | Biên Dịch và Thông Dịch ✆ **503-823-7740**