Chapter 2.Stormwater Facility and Conveyance Design

This chapter provides information needed to select and design stormwater management facilities and conveyance features that meet the requirements of Chapter 1. It includes the following sections:

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2.1 Site Planning

As presented in Chapter 1, the City of Portland requires stormwater to be managed onsite to the maximum extent feasible before it is discharged to an offsite disposal location. This is achieved by limiting impervious area and by directing stormwater to facilities designed to manage stormwater.

Successful design of stormwater facilities and conveyance features requires careful planning. This section introduces several overarching goals for integrating stormwater requirements into a comprehensive site plan and outlines the overall process for creating a stormwater management plan. This section provides guidance and recommended steps in preparing a stormwater plan that can meet City requirements and standards. Following the guidance in this section will help project designers meet the sizing requirements in Section 2.2, the design standards in Section 2.3, and the submittal requirements in Section 2.4.

2.1.1 Design Goals

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

Goal 1: Create an Informed Project Team

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

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

Goal 2: Maximize Permeability, Minimize Offsite Discharge

Creating a site design with less impervious area reduces the stormwater volumes and flow rates, which can ultimately result in smaller stormwater management facilities and lessen downstream impacts. Options include clustering the development to limit the building footprint, as well as impervious area reduction techniques (see Section 2.3.1 for guidelines and specifications). Maximizing permeability at every opportunity requires the integration of many decisions at all levels of the project, from site planning to materials selection; these decisions should be made with stormwater management in mind.

Goal 3: Use Stormwater as a Design Element

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

The drainage system can be integrated into development plans to provide multiple project benefits:

- Improve site aesthetics.
- Provide recreational opportunities.
- Maximize land values.
- Improve project marketability.
- Help meet landscape and screening requirements.
- Provide wildlife habitat.
- Provide environmental education for employees, visitors, and the public.

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

Plans that integrate stormwater facilities with the other development objectives can yield a series of small landscaped areas that meet other project objectives, rather

than creating one large, fenced pond at the end of the conveyance system. Stormwater facilities, such as ecoroofs, swales, planters, and basins, can be landscaped with plants that are attractive.

2.1.2 Steps in the Design Process

Once the project goals and objectives are established and the concept is complete, the following steps are recommended for designing a stormwater management system. Depending on the type of development or improvement proposed, a combination of the following steps may be required. A detailed explanation of each step is provided on the following pages.

STEPS IN THE DESIGN AND PERMIT PROCESS

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

For development initiated projects (land use, early assistance, public works permitting, building permits, or other development-related permitting), a number of these steps are required in order to demonstrate compliance with City approval criteria. Steps 1 through 6 must be completed to ensure that Bureau of Environmental Services (BES) approval criteria, early assistance, and land use review requirements can be met through the Bureau of Development Services (BDS) processes. Steps 1 through 9 must be completed to ensure that BES approval criteria and requirements can be met through the BDS process for building permit (or other private development permit) review, including private stormwater facility or conveyance feature construction inspection. Steps 1 through 9 must be completed to ensure that BES approval criteria can be met through the Public Works Permit process for development-related proposals in the public right-of-way, including any required public works inspections.

If an underground injection control (UIC) facility is proposed, Steps 1 through 5 also allow the project designer to prepare for Oregon Department of Environmental Quality (DEQ) rule authorization or Water Pollution Control Facility permit application. Once DEQ decision is rendered, the project designer can proceed with Steps 6 through 9.

Projects by public agencies will complete all steps throughout the design and construction process for public improvements.

Note: Every project is different, and it is not within the scope of this manual to specify what permits or reviews are required. For development related projects, applicants are encouraged to visit the Bureau of Development Services' Development Services Center to identify comprehensive project review and permit requirements.

Development initiated stormwater improvements

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

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

Step 1: Evaluate the Site

The first step in designing a stormwater management system, including stormwater management facilities and conveyance features, is to document and evaluate existing site conditions.

PortlandMaps

A variety of site-specific information is available online through www.PortlandMaps.com. The completeness of the records available will vary, but may include historic plumbing permits, zoning information, historic or recent permit information, and proximity of sewer and stormwater infrastructure to development projects.

Identify existing site features that could be protected or incorporated into the site. Identify existing natural or manmade drainage features, including open channels, ditches, ponds, depressions, wetlands, fish bearing and non-fish bearing streams, lakes, and rivers. Include riparian areas and other significant vegetation, including mature trees. Identify limits of development and access, as related to disturbance of soils, vegetation, and water quality sensitive areas.

Delineate tree canopy on and around the site as per Title 11. Where and when desirable or required by tree preservation and mitigation standards, conserve or plan to supplement existing tree canopy, especially conifers.

Identify surface and groundwater features that will affect the facility design, including size of drainage area/basin, topography and slopes, geologic formations, and seasonal groundwater levels. Document the distance to drinking water wells, wellhead protection areas, and other groundwater areas of concern.

Identify existing utilities, including all public and private storm, sanitary, and combined sewers, as well as water lines. Identify existing conveyance features, including culverts and outfalls. Identify drainage flows across the property from upland areas to downstream receiving waters. Existing and proposed utility placement should be addressed during design; existing utilities may need to be relocated. Potholing to verify depth, cover and location may be required. In the public right-of-way, utilities should be generally located outside or underneath any stormwater facilities. If existing or proposed utilities must cross perpendicularly through the stormwater facility, the utility location should avoid areas of plant growth (soil, vegetation). If existing or proposed utilities must be parallel to the facility, the utility location should have sufficient clearance outside of the facility walls or street curbs and gutters. Approved placement of utilities and stormwater facilities in the public right-of-way will be coordinated during the Public Works Permit or Street Opening Permit process under PBOT authority.

Identify potential drainageways and associated drainage reserves. BES' determination of an onsite drainageway and placement of a drainage reserve does not depend on water being present, only on factors that demonstrate the presence of water during previous wet seasons. Placement of a drainage reserve may be based in any combination of these factors; not all the factors must be present. In making the determination, BES staff will evaluate the following factors:

- Topography.
- Existing and proposed infrastructure (e.g., culverts, right-of-way ditches, outfalls).
- Soil type and erosion/incision.
- Channel substrate.
- Evidence of drift lines, waterborne sediment deposits, or sorting.
- Soil saturation within 18 inches of the surface.

- Vegetation characteristic of riparian, streambank, or wetland habitats.
- Visual topographic or vegetative connection to nearby wetlands, streams, seeps/springs, and sensitive natural areas.
- Maps, photographs, or historical permit records.
- Identification of any municipally owned stormwater controls structures or management facilities along the drainageway or at its inlet.
- Visible flowing or ponding water.
- Volume and velocity of existing drainage on, upstream of, and downstream of the site (including groundwater flows).

See Section 1.3.4 for requirements for drainage reserve protection. In addition to drainage reserve requirements, BDS implements Title 24.50 requirements which may require identification of floodplain width.

Private systems may need to be decommissioned and public service provided. Locate existing sumps, drywells, cesspools, and septic systems. Contact BDS Records & Resources at 503-823-7660 for plumbing as-builts and access to building plans on private property. Contact BES System Development Assistance at 503-823-7761 for as-builts of public infrastructure in the right-of-way.

Consider land use, traffic area and circulation, drainage patterns and routes of conveyance, and other water quality concerns with respect to contributing drainage basins. Plan to keep stormwater management facilities a safe distance from operations that involve hazardous materials or solid waste.

Research existing soil conditions, particularly infiltration potential and whether contamination exists onsite. Determine hydrologic soil group, soil drainage class, and potential for erosion. (Refer to site evaluation maps in Appendix C.) Examine boring and/or infiltration test results from nearby drywells or sumps to support the feasibility of infiltration.

Step 2: Confirm Current Requirements

This is the appropriate time to confirm all required City of Portland reviews and permits, as well as all other permit requirements—e.g., National Pollutant Discharge Elimination System construction site and discharge permits, DEQ UIC authorization, and other applicable requirements.

In addition to confirming stormwater management requirements, identify:

- Setbacks (see Table 2-1 and Figure 2-1).
- Easements.
- Drainage reserve requirements and encroachment requirements and other protected areas.
- Presence of any federally listed threatened or endangered species.
- Cut and fill quantities.
- Other site restrictions by consulting all applicable state and federal standards and requirements.

Other site restrictions include, but are not limited to, environmental zones, wellhead protection areas, greenway overlays, plan districts, seep/spring or other environmental tracts, floodplain development restrictions and requirements, tree conservation and tree root protection areas, landscape and/or screening requirements, and all other zoning or density requirements.

Identify any contaminated media, current or historical site activities that may impact stormwater facility design, or other site uses that may trigger source control requirements as provided in the City's Source Control Manual.

Collect and confirm existing reports, tests, or studies required for site development—e.g., Phase I and Phase II environmental site assessments and geotechnical reports.

If the site conditions and/or the development proposal are complex, contact BDS to initiate an early assistance meeting or pre-application conference with City staff to discuss conceptual site plan ideas. Certain land use review types may require a Pre-Application Conference. Contact BDS or the BES land use section for assistance. Contact the Stormwater Early Assistance Team at 503-823-7761 for more information.

STORMWATER FACILITY SETBACKS

Setbacks for private stormwater facilities are derived from the State of Oregon plumbing and building code and represent best practices for ensuring safety of nearby structures or features. BES will enforce these setbacks unless an alternative is approved through BDS plumbing code appeal.

Setbacks are measured from the center of a drywell or from the outside edge of a surface stormwater facility to the adjacent boundary, structure, or facility (see Figure 2-1). All setback distances provided are minimums that can be increased at the discretion of City of Portland staff. Under typical conditions, setbacks assume that the stormwater facility is either level to or at a lower elevation than the finished floor elevation of any nearby structures. If an applicant proposes to encroach in a setback, the applicant must provide a signed and stamped geotechnical report that demonstrates that the proposal will meet the intent of the building and/or plumbing code requirements as part of an approved plumbing code appeal. An alternative facility design may be required to meet conditions of appeal approval.

Plumbing Code Appeals

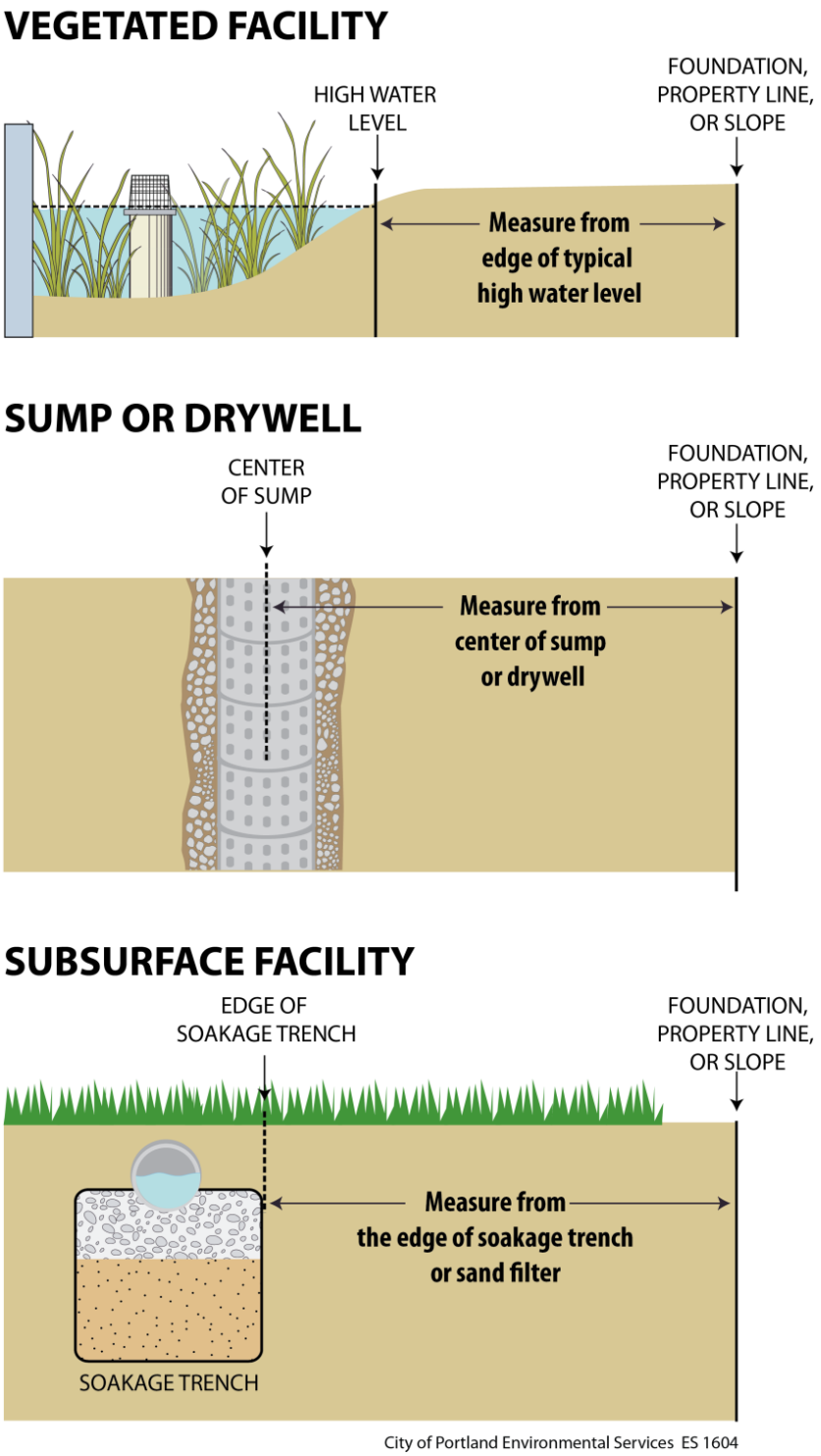
Information about BDS plumbing code appeals can be found online at www.portlandoregon.gov/bds. To submit a plumbing code appeal, please check the BDS website for instructions or contact the appeals secretary at 503-823-7335.

Table 2-1. Summary of Stormwater Facility Setbacks

Type of Stormwater Facility	Setback from	Distance in Feet
Permeable pavers, pervious asphalt, or pervious concrete.	Property line or foundation. A liner may be required where located within 5 feet of infrastructure.	0
Lined facilities	Foundation	0
Lined facilities less than 30 inches above lowest adjacent grade	Property Line	0
All infiltration facilities	Property Line	5
All infiltration facilities	Any foundation	10
All infiltration facilities	Upslope from any drainfield	100
Swales and basins	Slopes 10% or greater	100
Trenches and drywells	Slopes 20% or greater	100
All infiltration facilities require geotechnical report and engineering	Slopes 20% or greater	<100
UIC	Slope greater than 10’ high & steeper than 2h:1v	200
UIC	Drinking water well	500 (or 2-yr time travel)

Stormwater facilities may have typical setbacks. See facility-specific setback information in Section 2.3.4.

Figure 2-1. How to Measure Stormwater Facility Setbacks



Step 3: Characterize Site Drainage Area, Runoff, and Hierarchy

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

Determine if the project will use the Simplified, Presumptive, or Performance Approach (see Section 2.2 for a complete description of each) to size the stormwater management facilities. This is important because it establishes the type and number of infiltration tests that will be required. Begin to gather the information needed for the stormwater management submittals (see Section 2.4 for submittal requirements.)

Conduct soil infiltration testing, as specified in Section 2.3.6. Infiltration testing is also discussed in Section 2.2.

Determine where stormwater will be discharged and what hierarchy level will be used.

Formulate how the stormwater management plan will meet the system-specific requirements of this manual, including infiltration and discharge, pollution reduction, flow control, and conveyance.

Work with BES staff to determine what upstream and downstream cumulative activities will impact the proposed project.

Work with BES staff to determine if the capacity of the downstream receiving system (natural or manmade) must be characterized.

If necessary, plan to safely route upstream flows across the site both during and after construction.

Determine if additional drainageway protection is necessary beyond the standard drainage reserve requirements. Determine if a drainage reserve encroachment would be required or could be avoided with careful site planning. See Section 1.3.4 for drainage reserve requirements and Section 2.3.4 for Drainageways, Drainage Reserves, and Encroachments design information.

Develop preliminary calculations that estimate how much stormwater will be created, how much can be infiltrated onsite, and how much, if any, will be discharged offsite.

Step 4: Develop a Conceptual Design

This step includes stormwater facility selection and preliminary sizing.

Select the appropriate facility type, location, and size for each proposed facility (see Section 2.2) detail specifications, especially minimum and maximum dimensions and setback requirements.

Develop a preliminary site grading plan. The grading plan should avoid impacts to drainageways and floodplains. It is essential for impervious surfaces to be graded to drain toward the stormwater facilities. The facilities must also be depressed to allow sheet flow into the area. Clearly supplement the grading plan with appropriate cross-sections and detailed drawings.

Some situations, such as steep slopes and high sediment loads, may limit facility options. Steep slopes will typically require more complex engineering. Plan to implement onsite erosion and sediment controls to reduce the amount of sediment getting into the stormwater or drainageways. Excessive sedimentation can significantly degrade water quality, impact fish and wildlife habitat, and damage a facility and require costly repairs. Pretreatment may be necessary to protect vegetated facilities. If a facility will be used for erosion control during construction, it must be constructed before general grading occurs and rehabilitated after construction.

Determine if hydrologic and hydraulic models specified in the City's Sewer and Drainage Facilities Design Manual are necessary to size public conveyance facilities. Correlate calculations between the conveyance infrastructure and the stormwater facility sizing.

Develop preliminary design calculations that demonstrate how the proposed plan will meet the pollution reduction, flow control, and infiltration and discharge requirements, including which category of the stormwater hierarchy (Section 1.3.1) the project will achieve. If a land use review or early assistance is required, the conceptual plan will be reviewed by BES.

Step 5: Develop a Landscape Plan

Once the preliminary sizing is complete, attention to the proposed soils and vegetation is necessary. See Section 2.4.1 for landscape submittal guidelines, plant lists and specifications. See Section 2.3.6 for soil specifications.

At this step, it is appropriate to consult with a qualified landscape professional. Proper soil and plant selection is critical to the success of a facility and must not be left unspecified.

Stormwater management facilities should be integrated with the other project landscape areas. Select plant species and develop a planting plan. Consider the use of native plants where appropriate. Urban conditions may require hardier species.

Native plants are required in drainageways for any proposed encroachments. Improvements to drainageways or drainage reserves should be phased to protect existing vegetation and support new vegetation.

Schedule plantings so they are well established before concentrated flows are routed to a facility. If possible, plan to wait 3 to 6 months before routing water into a facility. If this is not possible, establish approved erosion control measures before routing stormwater to a facility.

Step 6: Complete a Stormwater Management Plan

Complete final plans and any required submittal items. See Section 2.2 for a more complete description of requirements and Section 2.4 for submittal requirements.

Plans and specifications must be prepared or closely supervised by a certified design professional licensed in the State of Oregon.

Confirm that all design criteria are met. Confirm that volume storage within a facility is adequate. Complete grading plans and construction documents, including inlet and outlet locations, elevations, and sizes. Ensure that landscape construction and erosion control techniques are well described. Ensure adequate maintenance access to all stormwater facilities.

Step 7: Prepare an Operations and Maintenance Plan

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

Outline the scope of activities, schedule, and responsible parties for inspecting and maintaining the stormwater management system, including stormwater facilities and related stormwater conveyance features, both during the maintenance warranty period (if applicable) and over the long term. Vegetation management, inlet clearing, weed control, sediment removal, trash and debris removal, and seasonal irrigation are some of the primary maintenance activities to be addressed.

Facilities that will come into the City's ownership and operation are subject to specific policies and guidance (see Section 3.2).

Step 8: Submit Final Plans and Obtain Permits

Development proposals will submit all final plans and drawings to the City of Portland for review, final approval, and permitting of the project. Various permits may be required including, but not limited to, a public works permit for construction in the right-of-way, a site development permit, a tree permit, or a plumbing permit. Provide additional information to City staff reviewing the application, as requested, to expedite the review process. Once permits are approved and issued, call for locates and begin construction.

Public improvements designed and constructed by public agencies will be reviewed by BES. Depending on the scope of the project, Street Opening Permits from the Portland Bureau of Transportation may be required.

Step 9: Construct and Inspect

The construction and inspection processes vary for private and public stormwater improvements.

Public Improvements. Once design plans for public facilities are approved and permitted, the Public Works Permit applicant (Permittee) must schedule a preconstruction meeting with all relevant city construction inspection teams to coordinate and evaluate all stormwater components of the project before construction. Initial inspection coordination is established at this meeting. Inspections throughout the project are coordinated by the City inspector and the contractor or general manager. Meetings with design engineers, contractors, and construction review teams are integral to ensuring that all stormwater facilities are constructed according to the development goals, project plans, and current design specifications.

Private Improvements. BES performs construction inspections on private property within the development permitting process. The number, type, and sequencing of inspections required for proposed stormwater management systems will vary by a number of factors, including phasing of construction, type of development, and type and number of stormwater facilities. The inspection requirements will be determined during plan review. Vegetated stormwater facilities will usually require multiple inspections throughout the construction phase. Instructions on requesting inspections will be provided during plan review and permit issuance. The building permit applicant is encouraged to contact BES prior to building the facility to schedule preconstruction meetings or to verify inspection requirements. For more information on inspections of onsite stormwater management facilities, contact the BES Development Review Hotline at 503-823-7761.

2.2 Sizing Methodologies

This section presents three methodologies for sizing stormwater management facilities and conveyance features: the Simplified Approach, Presumptive Approach, and Performance Approach. Stormwater facilities and conveyance features sized with the Simplified and Presumptive approaches comply with the City's conveyance/capacity, flow control, and pollution reduction requirements (see Section 1.3.7). When the Performance Approach is used, it is up to the project designer to demonstrate that those requirements are met.

Project designers must select the Simplified, Presumptive or Performance approach to design stormwater facilities. Each approach has a unique plan review and approval process that establishes a review and approval track for the project. The final selection of a project design approach is subject to City approval. BES may require use of a different approach upon review of site conditions and technical constraints. For example, if a public improvement has specific project goals to meet approved system or facility plan outcomes, then regardless of size, the Performance Approach may be more appropriate. Similarly, if a development proposal at a small site would like to propose facilities that require analysis under the Presumptive Approach, the Presumptive Approach would be required. Use of some stormwater facility types require use of a specific design approach. A combination of approaches may be used for a single project, but the review and submittal requirements will be that of the more intensive approach.

For every project, the impervious area includes the total proposed impervious area, including, but not limited to, buildings and structures, streets and frontages, and driveway aprons and sidewalks.

The ***Simplified Approach*** is available for projects with less than 10,000 square feet (0.23 acre) total new or redeveloped impervious area on private property, including but not limited to roofs, patios, parking areas, and driveways. (See Section 2.2.1 for more information.) This approach is most appropriate for small-scale residential development, typically with limited professional design services available. It is not allowed for use on large, complex projects or on projects that have multiple catchments that, when combined, exceed 10,000 square feet of new or redeveloped impervious area. It is not allowed on projects that include private streets, in the public right of way, or that would require a Public Works Permit.

The ***Presumptive Approach*** is required for sites larger than 10,000 square feet, such as medium- to large-scale residential and commercial projects on either private or

public property. The Presumptive Approach is required for private streets and for any project in the public right-of-way (see Section 2.2.2 for more information). It can also be used to size facilities on smaller projects where the more detailed hydrologic calculations will allow the design professional to size a facility more accurately by taking tested infiltration rates and other more specific design factors into account. This approach requires design by a licensed engineer or qualified design professional.

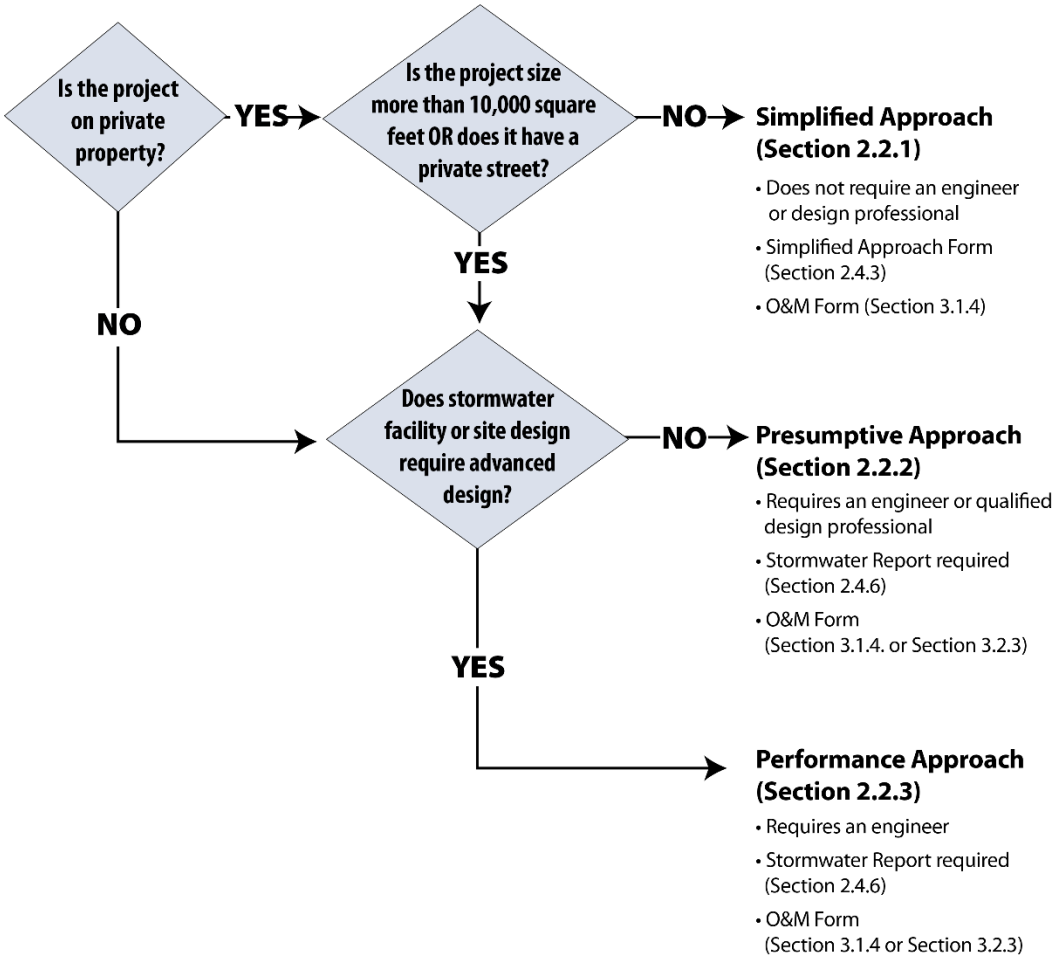
The ***Performance Approach*** is required for projects with unique circumstances that require analysis that goes beyond the capabilities or specifications of the Simplified and Presumptive approaches. It may be used to address a range of circumstances, including, but not limited to:

- Size a performance-based facility (wetlands, ponds, grassy swales, sumps, drywells, etc. See Figure 2-5 for complete list.).
- Install an approved manufactured stormwater treatment technology that meets the City's pollution reduction requirements.
- Propose an alternate design methodology or facility specification.
- Address unique site conditions.

The Performance Approach requires design by a licensed engineer. Detailed engineering calculations must be provided as evidence of the proposed design's performance with respect to the stormwater requirements provided in Section 2.2.3.

Figure 2-2 provides an overview of the three design approaches and their specific requirements.

Figure 2-2. Summary of Design Approaches



Site design, site conditions, or facility choices may require use of a more advanced sizing methodology. Each sizing methodology has limitations and conditions that must be met.

2.2.1 Simplified Approach

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

With the Simplified Approach, vegetated surface facilities include:

- Rain gardens
- Swales
- Planters
- Basins
- Filter strips

Subsurface infiltration facilities include soakage trench and drywells. All of these facilities are designed to receive and manage stormwater runoff from adjacent impervious surfaces.

Impervious area reduction techniques (ecoroofs, pervious pavement and tree credit) are also allowed under the Simplified Approach, but those techniques cannot receive stormwater runoff from adjacent impervious areas. Impervious area reduction techniques that are designed to receive runoff from other impervious areas must be designed under the Performance Approach (see Section 2.2.3).

All vegetated surface facilities and ecoroofs designed with the Simplified Approach require an overflow to an approved discharge location. Total onsite infiltration is achieved when overflows are directed to a subsurface infiltration facility, including, but not limited to, drywells and soakage trenches.

Simplified Approach Infiltration Testing

The Simplified Approach requires at least one infiltration test to be conducted before selecting and sizing stormwater management facilities (see Section 2.3.6 for the Simplified Approach Infiltration Test instructions and requirements). The Simplified Approach Submittal Requirements have instructions on how to submit the

infiltration testing information on the Simplified Approach Form (both found in Section 2.4.3).

BES does not require correction factors be applied to the tested infiltration rate when using the Simplified Approach Infiltration Test. A tested infiltration rate of 2 inches per hour or greater requires onsite infiltration. A tested infiltration rate of less than 2 inches per hour requires the use of a partial infiltration or lined facility with overflow to an approved discharge location. Exceptions apply depending on site conditions and the approved discharge location. See Section 2.3.2 for a description of facility configurations. If the tested infiltration rate is greater than 4 inches per hour, the designer should consider the use of the Presumptive Approach where well-draining soils can be factored in to more accurately design the stormwater facility.

Simplified Approach Submittal Requirements

As part of their building or other development-related permit application, applicants using the Simplified Approach must submit a completed Simplified Approach Form along with other documentation requirements listed in the Simplified Approach Submittal Requirements (Section 2.4.3). An Operations and Maintenance Form and the appropriate Operations and Maintenance Plan(s) must also be included. On sites with steep slopes or shallow groundwater, BES may require a geotechnical report in order to evaluate the suitability of the proposed facility and its location. BES staff may also require an encased falling head or a double-ring infiltrometer infiltration test under the Presumptive and Performance Infiltration Testing Requirements to verify that the Simplified Approach is appropriate.

2.2.2 Presumptive Approach

The Presumptive Approach allows the designer to factor in site-specific data to determine the size and configuration of the stormwater facility for swales, basins, and planters. It is approved for sites of any size. Like the Simplified Approach, the Presumptive Approach allows impervious area reduction techniques, vegetated surface facilities, and subsurface facilities. The Presumptive Approach also includes hybrid facilities. See Section 2.3 for a complete overview of facility types, configurations, and design requirements.

The Presumptive Approach Calculator (PAC) allows designers to size basins, swales, and planters with consideration of native infiltration rates and other unique site conditions of the project. See below for a discussion of the PAC.

Vegetated surface facilities available with the Presumptive Approach include swales, planters, and basins, all of which are designed to receive and manage stormwater

runoff from adjacent impervious surfaces. Under the Presumptive Approach, swales, planters, and basins can be designed as infiltration, partial infiltration, hybrid, or lined facilities.

Hybrid facilities can be designed under the Presumptive Approach. They combine the benefits of vegetated surface facilities with those of subsurface infiltration facilities to provide pollution reduction, flow control, and full or partial infiltration that meets specific stormwater hierarchy requirements (see Section 2.3.2 for a complete description of hybrid facilities).

Presumptive Approach Infiltration Testing

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

- Open pit falling head.
- Encased falling head.
- Double-ring infiltrometer.

A qualified professional must exercise judgment in the selection of the infiltration test method (see Section 2.3.6 for the number and location of tests required). Depending on site conditions and the proposed facility location, the City may adjust the required number of tests. If the location and/or orientation of the proposed facility are revised during the design process, retesting will be required, unless otherwise approved by the City.

The Presumptive Approach requires in all cases that correction factors be applied to the tested infiltration rate to determine the design infiltration rate. See Section 2.3.6 for the correction factors that apply.

For the Presumptive Approach, a tested infiltration rate of two inches per hour or greater requires onsite infiltration. A tested infiltration rate of less than two inches per hour allows the use of a partial infiltration or lined facility depending on site conditions. Exceptions apply depending on site conditions and the approved discharge location. See Section 2.3.2 for a description of facility configurations.

Presumptive Approach Calculator (PAC)

The City developed a standardized sizing calculator for vegetated surface facilities, named the Presumptive Approach Calculator (PAC). The PAC allows design professionals to size stormwater facilities based on site-specific data, such as native soil infiltration rates and above and below ground storage capacity. The PAC will

calculate if the proposed project design meets the stormwater hierarchy category requirements for flow control and pollution reduction.

If the design professional proposes to deviate from the recommended ranges in the PAC, the proposal must be submitted under the Performance Approach. Appendix A.4 includes the technical framework behind the PAC and includes allowed and recommended ranges for data entry fields.

Presumptive Approach Calculator

The Presumptive Approach Calculator is an online calculator accessed through Portland Online. The PAC requires design professionals to have a portlandoregon.gov account. The PAC allows design professionals to save projects to their account and share design information through import/export functionality.

The PAC can be accessed at www.portlandoregon.gov/bes/pac.

Presumptive or Performance Approach Required for Streets

The Presumptive Approach or Performance Approach is required for sizing vegetated stormwater facilities in the public right-of-way and private streets.

The open pit falling head infiltration test may be used for sizing street facilities, but depending on the development proposal and the existing site conditions, the City may require the double-ring infiltrometer test (see Section 2.3.6 for infiltration test specification and the location of minimum number of tests required).

Trees, planted in accordance with the City of Portland Urban Forestry requirements, may be used as an impervious area reduction technique in the public right-of-way and on private streets. Refer to Section 2.3.4 for more information.

Stormwater Management Typical Details are available specifically for public streets (see Section 2.3.5). These typical details are commonly referred to as "Green Street Details," they are tailored to circumstances commonly found in the right–of-way. Vegetated stormwater facilities for streets are often affected by street design criteria and are subject to certain dimensional limitations. Green Street Details can also be used for private streets or private parking lots as appropriate.

Presumptive Approach Submittal Requirements

Design professionals using the Presumptive Approach must submit a Stormwater Management Report as part of their permit application along with other documentation requirements listed in the Presumptive Approach Submittal Requirements (see Section 2.4.4 and Section 2.4.6). An Operations and Maintenance

Form and the appropriate Operations and Maintenance Plan(s) must also be included.

2.2.3 Performance Approach

Engineers or qualified design professionals using the Performance Approach must demonstrate how the proposed design meets the *Stormwater Management Manual's* stormwater management and conveyance requirements. Engineers or qualified design professionals who have developed stormwater management facilities or plans that do not meet the requirements of the Simplified Approach or Presumptive Approach as listed previously must submit plans under the Performance Approach. Performance Approach submittals may include impervious area reduction techniques, vegetated surface facilities and subsurface facilities that vary from the specified design requirements. Performance Approach designs will be reviewed by technical staff under the direction of the Chief Engineer or designee.

The Performance Approach may be used to:

- Size a performance-based facility (ponds, grassy swales, etc.).
- Propose an alternate design methodology or facility specification, such as conveying runoff from impervious area to ecoroofs or pervious pavement.
- Address unique site conditions.
- Use the Presumptive Approach Calculator using values outside of recommended ranges (see Appendix A.4 PAC Technical Framework for recommended and required ranges).
- Use a manufactured stormwater treatment technology approved by BES for meeting pollution reduction requirements.
- Apply a new or emerging design technology, such as manufactured stormwater treatment technologies not approved for use in the City of Portland.

Facilities must be designed using the hydrologic analysis methods below. If these hydrologic analysis methods are not used, BES must pre-approve the alternative method before the plans and calculations are submitted. Regardless of how the hydrologic calculations are performed, all hydrologic submittals must include data necessary to facilitate BES's review. The engineer or qualified design professional must demonstrate how the site-specific stormwater management and conveyance requirements will be met, as appropriate.

Hydrologic Analysis Method Resources

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

The Natural Resource Conservation Service "Urban Hydrology for Small Watersheds" (NRCS TR-55) method may be applied to small, medium, and large projects. This is also one of the recommended methods for completing hydrologic analyses necessary for designing flow control facilities when not using the Simplified Approach.

The US Army Corps of Engineers "Hydrologic Modeling System" (HEC-HMS) method may be used on medium and large projects.

The Environmental Protection Agency's Storm Water Management Model (EPA-SWMM) method may be used on medium and large projects.

Infiltration and Discharge

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

Flow Control

BES will use the SBUH to check design calculations for flow control facilities. The design professional may also use NRCS TR-55, HEC-HMS, or SWMM to demonstrate compliance with flow control standards.

Pollution Reduction

The City will accept a design proposed for pollution reduction requirements if the engineers or qualified design professionals demonstrates the following:

- Facilities must perform at the required efficiency: 70 percent total suspended solids (TSS) removal from 90 percent of the average annual runoff (see Section 1.3.4) and is capable of reducing Total Maximum Daily Load (TMDL) pollutants of concern (if applicable). Documented performance is required and must include published data, with supporting cited research, demonstrating removal of target pollutants at required levels.

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

Flow Rate-Based Facilities

With the exception of facilities sized using the Simplified and Presumptive approaches, BES will use the Rational Method, with rainfall intensities presented in Section 1.3.4, to verify flow rates used to size rate-based pollution reduction facilities. Through a continuous simulation model using Portland rainfall data, BES has verified that these intensities treat 90 percent of the average annual runoff volume. The design professional may also use SBUH, NRCS TR-55, HEC-1, or SWMM to demonstrate treatment of 90 percent of the average annual runoff volume.

Flow Volume-Based Facilities

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

Combination Rate/Volume-Based Facilities

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

Conveyance

For public culverts, outfalls, storm-only sewers and other drainage facilities, refer to the City's Sewer and Drainage Facilities Design Manual for acceptable hydrologic analysis methods for stormwater conveyance in the public right-of-way.

Performance Approach Submittal Requirements

Under the Performance Approach, the engineers or qualified design professionals must demonstrate that the proposed management plan meets or exceeds all of the City of Portland's stormwater requirements. Engineers or qualified design

professionals using the Performance Approach must submit a Stormwater Management Report as part of their permit application, along with a complete site plan, construction drawings, and details. An Operations and Maintenance Form and an Operations and Maintenance Plan must also be included.

See Section 2.4.5 and Section 2.4.6 for complete information about the submittal requirements for the Performance Approach.

2.3 Stormwater Facility and Conveyance Design

This section provides detailed requirements, specifications, and details for designing the stormwater facilities and conveyance features included in this manual.

2.3.1 Types of Stormwater Facilities and Conveyance Features

Impervious Area Reduction Techniques

Ecoroofs, pervious pavement, and trees are impervious area reduction techniques that can affect which design approach is required and reduce the overall square footage of impervious area that requires stormwater management (see Section 2.3.4 for facility requirements and specifications). For example, if a project designer has a project with 11,000 square feet of impervious area, and site conditions allow for 3,000 square feet of pervious pavement, the project designer can reduce the impervious area to 8,000 square feet and use the Simplified Approach, as long as all other requirements for the Simplified Approach are met. Ecoroofs, pervious pavement, and trees intercept rainfall directly and are not allowed to receive stormwater runoff from other areas.

Vegetated Stormwater Facilities (VSF)

Swales, planters, and basins can be used to meet the Simplified, Presumptive, or Performance approach. Sizing calculation requirements will depend on the size of impervious surface managed and the corresponding approach.

Downspout extension and rain gardens are vegetated facilities that can be used to meet the Simplified approach. They are particularly suited for residential development and retrofits.

Filter strips, grassy swales, and ponds are vegetated facilities that meet limited stormwater management requirements. Filter strips are allowed under the Simplified Approach for impervious area under 500 square feet. If filter strips are proposed for use with over 500 square feet of impervious area, the Performance Approach is required. Ponds and grassy swales are allowed only under the Performance Approach.

Subsurface Infiltration Facilities

Soakage trenches, drywells, and sumps can also be used in combination with impervious area reduction if vegetated surface facilities cannot manage all of the impervious area. Under certain circumstances, subsurface infiltration facilities may be allowed without vegetated surface facilities.

Other Facility Types

Non-vegetated and structural stormwater management facilities, such as rainwater harvesting and detention tanks, require review and approval under the Performance Approach.

Manufactured Stormwater Treatment Technologies

Manufactured Stormwater Treatment Technologies (MSTT) can be used to meet pollution reduction requirements when discharging to stormwater-only systems. Manufactured stormwater treatment technologies from the approved list must be used with the Performance Approach. Other manufactured stormwater treatment technologies that are not on the list may be used in specific applications but must be submitted to BES as a Performance Approach for site-specific review and approval. Depending on discharge location, flow control may also be required. The engineer or qualified design professional is responsible for ensuring that any approval conditions for the specific MSTT are met.

Stormwater Conveyance Features

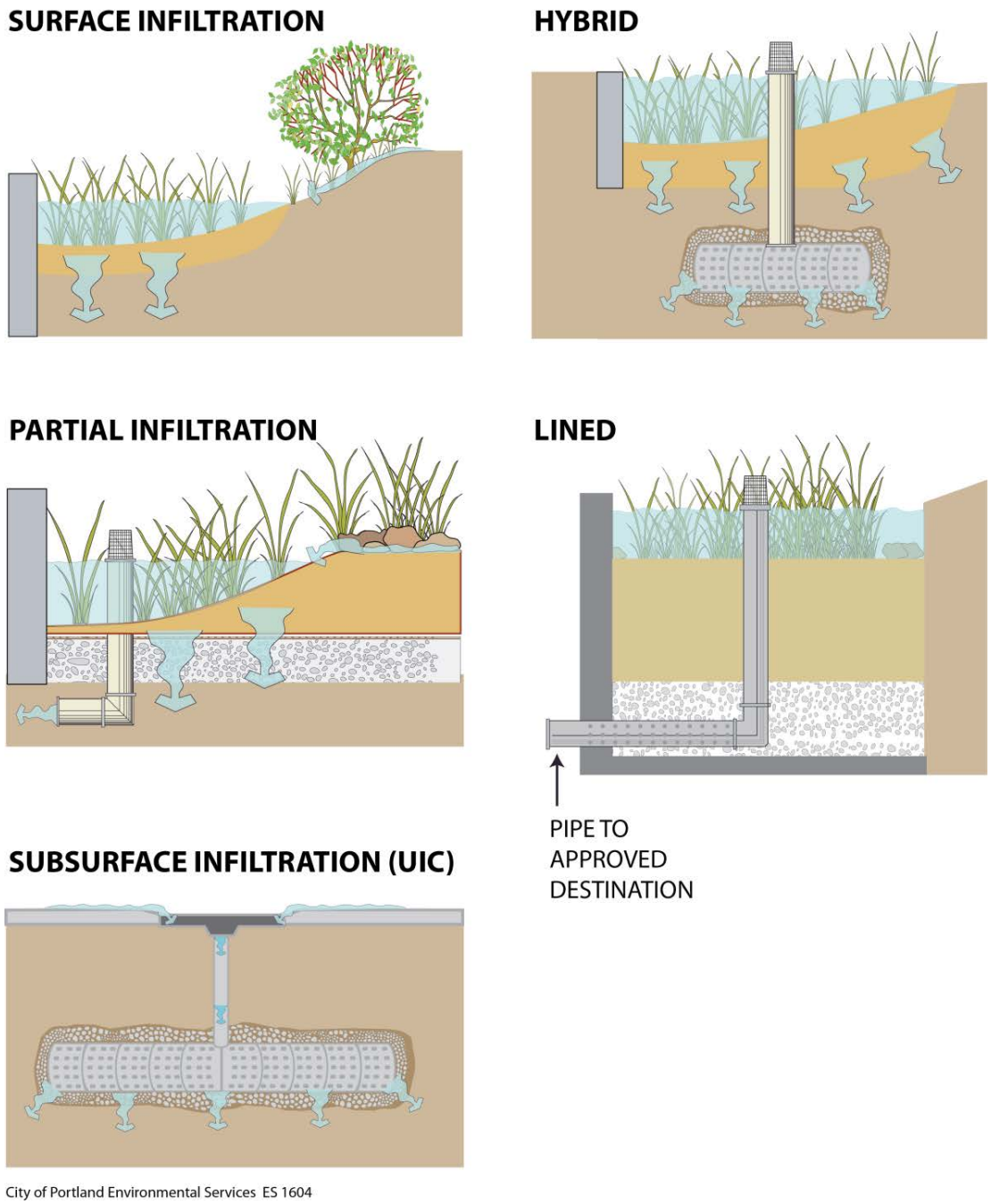
Conveyance features include drainageways, culverts, and outfalls that are used to transport stormwater. Conveyance features safely move a certain amount of stormwater to, from, and through a site in ways that protect water quality. Stormwater is conveyed to rivers through public and private storm sewers and outfalls, from streams and drainageways that pass through private ownerships and receive runoff from public right-of-way. Adequate conveyance capacity is critical for minimizing upstream, downstream or site impacts. Drainage reserve requirements preserve the capacity of stormwater conveyance on private property.

2.3.2 Stormwater Facility Configuration

Stormwater management facilities can be vertically configured five ways (see Figure 2-3):

- Surface infiltration.
- Partial infiltration.
- Subsurface infiltration.
- Hybrid facilities (both surface and subsurface infiltration).
- Lined facilities (does not infiltrate).

Figure 2-3. Vertical Stormwater Facility Configurations



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Surface infiltration facilities achieve infiltration in the upper layer of the ground surface and can include facilities such as swales, planters, and basins. Infiltration facilities manage the 10-year design storm and require a tested infiltration rate of at least 2 inches per hour. Facilities that achieve total onsite infiltration do not require an offsite discharge location and therefore meet Category 1 or Category 2 requirements of the Stormwater Hierarchy (see Section 1.3.1).

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

Subsurface infiltration facilities achieve infiltration below the ground surface and include facilities such as sumps, drywells, and soakage trenches. Subsurface infiltration facilities are subject to DEQ's UIC regulations (see Section 1.3.3).

Hybrid facilities combine a vegetated infiltration facility with a subsurface infiltration facility. They achieve both surface infiltration and subsurface infiltration through bypassing flows greater than the water quality storm directly to a gravel layer below the facility growing medium or to a subsurface infiltration facility. By providing a direct connection to subsurface infiltration, the designer can take advantage of higher native infiltration rates, if they exist, or utilize the below-grade storage to reduce the size of the facility. Hybrid facilities are also subject to DEQ's UIC regulations (see Section 1.3.3).

The hybrid facility is a configuration type that is appropriate for sites with well-draining soil but with space limitations. They are not allowed on projects using the Simplified Approach sizing. Under the Simplified Approach, a surface facility can overflow to a subsurface facility, but the sizing methodology does not take the infiltration of the surface facility into account. Under the Presumptive or the Performance Approach, a hybrid facility can be designed to maximize infiltration at the surface and in the subsurface.

Lined facilities include an impervious or lined bottom and do not infiltrate. They are appropriate for sites that have restrictive site conditions including steep slopes, landslide risk, high groundwater, facilities located on structures, soil or groundwater contamination, and may also be appropriate next to structures or property lines to

protect foundations, basements, and adjacent properties. Lined facilities include a surface overflow and/or an underdrain in the gravel layer where treated flow is routed to an approved discharge location as specified in Category 3 or 4 of the Stormwater Hierarchy (see Section 1.3.1).

Shared facilities

Stormwater that is generated from impervious area on a property (privately or publicly owned) must be managed on the property, while stormwater generated from within the public right-of-way must be managed in the public right-of-way. Deviating from this horizontal configuration of stormwater management facilities is considered a **"shared" stormwater management facility**. "Shared" facilities, those that are designed to manage stormwater runoff from property and the public right-of-way, may be considered at the discretion of BES if the proposed facility meets stormwater and transportation system needs and if at least one of the following criteria is met:

- Public street improvements require the construction of a public stormwater management facility, and there is an opportunity for a private facility to accept public runoff that cannot be managed effectively in the public right-of-way.
- Private stormwater management facilities are not feasible to be constructed on private property, and there is sufficient area in the public right-of-way to construct a facility that can manage stormwater from both the street and the private property.

The property owner must share in the ongoing operations and maintenance costs and/or responsibility in proportion to the property's stormwater contribution. Shared facilities in the public-right-of-way will require review and/or permits from the Portland Bureau of Transportation and require an O & M plan to be recorded on the deed of all participating properties.

Discharge configuration

Stormwater management facilities may be required to discharge offsite depending on the facility type and site conditions. The configuration of the overflow discharge may vary based on stormwater facility type, type of stormwater system discharging to, or site design (see Figure 2-4).

A piped overflow is typically set at an elevation above the growing medium and provides a safe overflow where flow exceeds the design capacity of the facility. Overflows are required for a variety of specific facility types when not designed for complete onsite infiltration or when infiltration requirements cannot be met (see

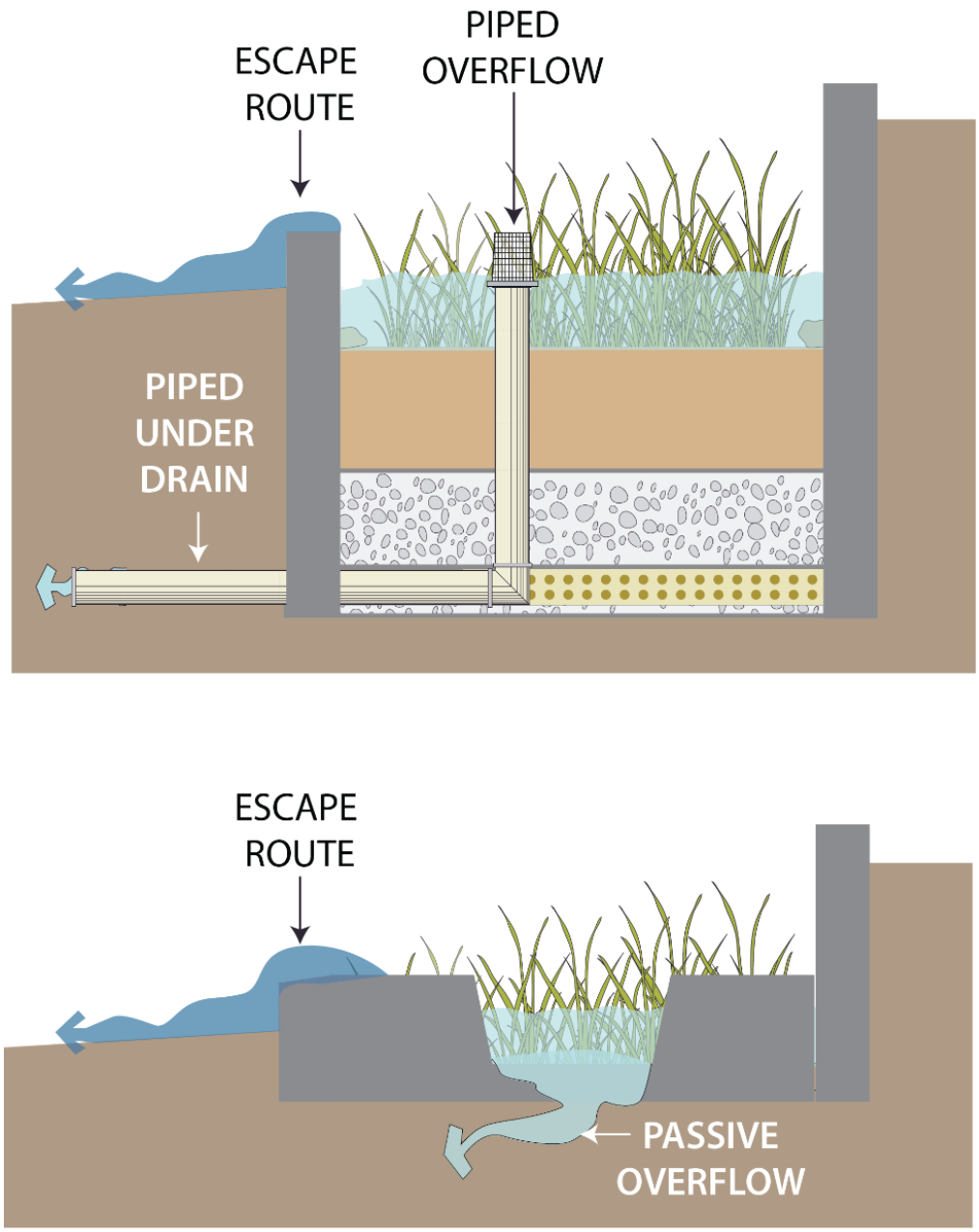
Section 2.3.5 for typical piped overflow configuration details). A piped overflow requires a connection to an approved discharge location. A weep hole to a public street curb (also referred to as a curb outlet) may be allowed with PBOT approval.

A passive overflow is typically set at an elevation above the surface of the growing medium, such as a notch in a planter wall to direct the overflow to an approved discharge location. In the right-of-way, this may be a notch in the curb directing overflow to the gutter.

A piped underdrain is typically set at an elevation below the growing medium (or rock storage, if used) to drain stormwater flows that pass through the growing medium and cannot be infiltrated onsite. A piped underdrain requires a connection to an approved discharge location.

An escape route is a requirement for all projects to delineate where flows will be routed to maintain public safety and prevent property damage in the event the facility fails or flows exceed the facility design capacity. Identifying an escape route is in addition to identifying an offsite discharge overflow method. Depending on site conditions, this may include an overflow structure or storage in a parking lot, street, or landscaping areas. Escape routes from stormwater facilities cannot be directly piped to public storm sewer or combined sewer systems. Project designers must describe where the flow will be routed on a basin site plan to illustrate where flood conditions or ponding is expected to occur. If an appropriate escape route cannot be identified, then the project designer will be required to design to at least the 100-year design storm.

Figure 2-4. Stormwater Facility Discharge Configurations



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2.3.3 Standard Landscape Requirements

This section addresses the landscape requirements that apply to the design and construction of all vegetated stormwater facilities, both private and public (see the individual facility descriptions in Section 2.3.4 for facility-specific and private/public facilities requirements).

Site Preparation and Grading

Existing vegetation to be saved must be clearly marked and securely protected. If native plants are present, they should be salvaged and stored for replanting once construction is complete. Unwanted vegetation in the facility area should be removed during site preparation with equipment appropriate for the type of material and site conditions.

The location of all areas of future stormwater facilities should be clearly marked before site work begins. All stormwater facilities should be fenced or covered to protect them from damage or misuse during construction. Fencing is required around all infiltration facilities to prevent soil compaction during construction. The subgrade in proposed infiltration areas must not be compacted. At least 6 inches of native material must be maintained above the proposed bottom of the facility until construction is scheduled for the facility. No vehicular traffic, material storage, or heavy equipment is allowed within 10 feet of the infiltration facility area after site clearing and grading have been completed, except that needed to excavate, grade, and construct the facility. Lined facilities must be covered with plywood or other sheeting to prevent misuse, such as temporary storage of construction debris. No stormwater facility area should be used for dumping concrete or other construction waste, mixing grout, cleaning tools, or washing paint brushes.

Follow all tree protection requirements of Title 11.

Location of all stockpiles must be indicated, including erosion protection measures per the City's Erosion and Sediment Control Manual. The erosion and sediment control plan set should show the fencing layout for vegetation to be protected and the location of stormwater facilities.

Once the facility area is graded, all native subsoil must be scarified before installing the specified stormwater facility growing medium. No disturbance should occur within the drip line of existing trees. After scarifying, no other construction traffic should be allowed in the area, except for planting and related work. All construction and other debris must be removed before the growing medium is placed. Furthermore, the soil must not be exposed during wet weather conditions and must be covered with the growing medium within 1 day of being exposed.

Surface drainage must be prevented from entering the facility during construction until the facility is fully installed and the contributing catchment area is constructed. Proposed facility areas must be protected from sedimentation during construction. The contractor is responsible for protecting the facility from erosion before water is allowed to enter the facility. Appropriate erosion control measures, as required by the City's Erosion and Sediment Control Manual, must be used.

Access

The design must consider safe access for maintenance of the facility and of adjacent buildings or infrastructure. Stormwater facilities must be accessible for monitoring and maintenance. Paths, gates, and covers must be safe to access. Where structural surfaces are needed to support vehicles, access routes must be of sufficient width to allow vehicle passage and constructed of gravel or other permeable paving surfaces where possible. Public facilities must have access routes sufficient to be accessed by vehicle and must be located adjacent to the public right-of-way wherever feasible. If a facility is accessed only by the public right-of-way, plan for a safe parking space for maintenance vehicles, as well as traffic disruptions caused by maintenance activities.

Geosynthetic Liner and/or Waterproofing

Where infiltration is not safe or not allowed, stormwater facilities must be designed to be water-tight. A liner and corresponding attachment details or single-pour concrete may be required depending on the location. Consult a structural engineer if the facility may impact an adjacent foundation. Slow infiltration rates do not require liners.

Liners may also be used to protect structures or prevent infiltration immediately adjacent to roadways. Partial lining (half-liners or curtain liners) may be required depending on a number of factors. This would not be considered a "lined" facility configuration because it is not designed to be water-tight.

Pipes, Inlets, Outlets, and Storm Sewers

Pipe may be necessary for conveying stormwater from roofs and impervious surfaces to stormwater facilities, inside facilities for ensuring that water moves through, and from the facility to the approvable discharge location. See individual facility overviews and details for requirements, and any plumbing code as required.

Drain Layer

A drainage layer (sometimes referred to as rock storage or a rock gallery) may be required below the growing medium of a vegetated facility. The intent of this layer is to retain or detain and convey stormwater. See individual facility overviews and

details for requirements, as they are different depending on sizing approach and facility type.

Geotextile or separation lens (if required or approved)

Typically a separation layer is required between the drainage layer and the growing medium, usually a geotextile fabric or a gravel lens. This keeps the layers distinct and allow for good conveyance.

Anywhere a geotextile is used in a critical application, a geotechnical professional should specify it for that application.

Check dams

Check dams are required in some vegetated stormwater facilities to allow water to pool. Check dams can increase infiltration into the ground and help provide flow control prior to offsite discharge. They also slow flow to remove coarse sediment and prevent erosion. They must be constructed of durable, nontoxic materials such as rock, brick, concrete, rot resistant wood, or wood composite. Integrate these materials into the grading and install them perpendicular to the flow path of stormwater.

Growing Medium

Growing medium supports plants and micro-organisms that improve the function of stormwater facilities. Growing medium may include stormwater facility blended soil, blended topsoil, three-way mix, or native soils. See individual facility design criteria and details for requirements in private and public facilities.

Soil analysis for all growing media is required for all public facilities and may be required for private facilities. Soil analysis is not required for single-family residential sites. The source of growing medium must be provided.

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

Vegetation

Plants are critical to the performance of vegetated stormwater facilities and therefore must be selected for the appropriate soil, hydrologic, and site-specific conditions. The planting design must minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis. Plantings should also be designed to minimize the need for mowing, pruning, and irrigation.

For facilities located in environmental zones, drainageways or drainage reserves, or for BES-maintained facilities located outside of the public right-of-way, all plants within the facility area must be appropriate native species from the latest edition of the Portland Plant List. No plant species on the Nuisance Plants List or Required Eradication List contained in the Portland Plant List are allowed.

Structural components such as chain link fence, concrete bulkheads, outfalls, rip-rap, gabions, large steel grates, pipe, blank retaining walls, vault lids, and access roads should be screened from view by vegetation. The quantities and spacing of plant material required for each facility should provide sufficient screening. Attention should be paid to site conditions that may require adjustments to the planting plan, including the need for additional trees and shrubs. The intent of this requirement is not to dictate a specific solution such as a linear hedge. Designers are encouraged to integrate the facility landscaping with the screening objective. As a guide, landscape regulations for screens are provided in Landscaping Standards L2, L3, or L4 as specified in City Code Chapter 33.248.

See Section 2.4.1 for the Landscape Submittal Requirements. See individual facility design criteria in Section 2.3.4 and details for density and size requirements in private and public facilities. Refer to Section 2.3.5 for planting templates appropriate for public and private streets.

Because portions of vegetated facilities areas are designed to accommodate inundation through the wet periods of the year, it is imperative for the designer to delineate the wet zone, Zone A, and develop a planting plan in accordance with the level of inundation/saturation. The moderate to dry Zone B surrounds Zone A and is likely to be inundated much less frequently than the lower portions of the facility. For the purposes of this manual in determining landscaping requirements, the delineation between Zone A and Zone B must be the elevation of either the outlet elevation or the top of the check dam, whichever is lower. Planting plans must be specific to the designated zones.

Depending on when stormwater will be routed to the facility, planting should preferably occur in the dormant season. For best results, planting should occur between February 1st and May 1st or between October 1st and December 1st.

Plants must be healthy and vigorous.

Mulch

Mulch can protect soil from compaction and erosion and may aid in holding moisture in the soil and suppressing weeds. Mulch should be weed-free and applied to cover all soil between plants. It should not be over-applied.

Manure mulching and high-fertilizer hydroseeding are prohibited in stormwater facilities.

Irrigation

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

Pollution Prevention

Projects must be designed to minimize the need for toxic or potentially polluting materials such as herbicides, pesticides, fertilizers, or petroleum-based fuels within the facility area before, during, and after construction. Use of these materials creates the risk of spills, misuse, and future draining or leaching of pollutants into facilities or the surrounding area.

Materials that could leach pollutants or pose a hazard to people and wildlife should not be used as components of a stormwater facility. Some examples of these materials are chemically treated railroad ties and lumber, recycled crushed asphalt, and galvanized metals. Many alternatives to these materials are available.

Standard Landscape Requirements for Streets

See Section 2.3.5 for right-of-way stormwater facilities planting templates and Section 2.4.1 for plant lists. Typically, plants are specified in #1 containers and planted 12 inches on center. No medium to large shrubs are allowed in a stormwater facility next to a public street. Vegetation in stormwater facilities located in the public right-of-way constructed through a public works permit must be covered by a 2-year maintenance warranty period as described in Chapter 3.

Planting is only allowed between February 1st and May 1st or between October 1st and December 1st. Planting outside of these times is only allowed with permission from Watershed Revegetation Program (503-823-2365).

The landscape requirements for private streets are implemented by the Bureau of Development Services.

Watershed Revegetation Program

Public Works Permit applicants (Permitees) may choose to enter into an optional agreement for vegetation services with BES's Watershed Revegetation Program during design and construction. This agreement is offered so that permit applicants can benefit from BES's professional expertise in establishing and maintaining stormwater management facility landscapes that treat public stormwater.

The Watershed Reveg Program can:

- Prepare a planting plan and plant establishment treatment schedule to meet the requirements of the *Stormwater Management Manual*.
- Reveg inspects stormwater facility blended soil for final grade and depth requirements.
- Source and acquire all plant material, and plant according to the plans. The City may interchange plant sizes and species due to nursery stock availability.
- Work with the permit holder to ensure that project implementation follows the permit, construction documents, design intent, and field conditions.
- Ensure prompt delivery of services with adequate coordination with other contractors.
- Provide all necessary labor and other miscellaneous work incidental to completion of planting, unless otherwise specified in the agreement.
- Install project signage, if appropriate.

Permittees can obtain more information directly from the Watershed Revegetation Program by calling 503-823-2365. See Section 3.2 for services that Watershed Revegetation Program can perform during the 2-year maintenance warranty period.

2.3.4 Facility and Conveyance Design Criteria

This section provides the specific design requirements for each stormwater facility or conveyance feature listed in Figure 2-5. It also includes specific information regarding submittal requirements and construction considerations. Variations that exist between the Simplified, Presumptive, or Performance approaches and variations between public right-of-way and property are identified.

Figure 2-5. Stormwater Facility and Conveyance Features by Design Approach

	Simplified Approach for Private	Presumptive Approach for Private	Presumptive Approach for Streets	Performance Approach
Impervious Area Reduction Techniques				
Ecoroof	•			•
Pervious Pavement	•			•
Tree Credits	•	•	•	•
Vegetated Stormwater Facility				
Downspout Extension	•			
Rain Garden	•			
Swales	•	•	•	•
Curb Extensions			•	•
Planters	•	•	•	•
Basins	•	•	•	•
Filter Strips	•			•
Grassy Swales				•
Ponds				•
Subsurface Stormwater Facility				
Sand Filters				•
Soakage Trenches	•			•
Drywells	•			•
Sumps				•
Other Stormwater Facility Types				
Manufactured Stormwater Treatment Technologies				•
Rainwater Harvesting				•
Structural Detention Facilities				•
Stormwater Conveyance Features				
Drainageways and Drainage Reserves	Requirements not sizing approach dependent			

2.3.4.1. Ecoroof

Ecoroofs reduce impervious area and provide stormwater management.

Facility Description

An ecoroof is an impervious area reduction technique which decreases stormwater management requirements on the project site. Also called a green roof, an ecoroof is a lightweight vegetated system consisting of waterproofing material, a growing medium, and low growing, drought tolerant plants. Ecoroofs reduce post-developed peak runoff rates to near-pre-developed rates and reduce annual runoff volume by at least 50 percent. Ecoroofs also help mitigate runoff temperatures by keeping roofs cool and retaining most of the runoff during dry periods.

The roof structure must be strong enough to hold the additional weight of the ecoroof. The load-bearing capacity of the roof must be evaluated by a licensed professional, and the design must comply with building code requirements.

The design must be self-sustaining, meaning the design goal must be to minimize inputs after the first couple of years. This is in contrast to roof gardens which require more maintenance and irrigation.

Design Requirements

Sizing: Ecoroofs replace impervious area at a 1:1 ratio. They cannot receive runoff from other impervious areas except as reviewed and approved by BES under the Performance Approach.

Slope: The maximum allowable roof slope is 25 percent, unless the applicant provides documentation of runoff control on steeper slopes.

Access: The design must provide safe access for maintenance of the ecoroof and roof fixtures.

Waterproofing: All conventional commercial materials may be used, although a root barrier may be required for asphaltic materials. No portion of the waterproof membrane may be exposed to sunlight in order to maximize the life of the ecoroof.

Flashing: The design should minimize the use of copper or galvanized metal fittings which can introduce pollutants to the runoff.

Root barrier: A root barrier is sometimes required in addition to waterproofing material. Root barriers impregnated with pesticides, metals, or other chemicals which may leach into stormwater are not allowed, unless the applicant can provide documentation that leaching does not occur. If a root barrier is used, it must extend under any gravel ballast, under the growing medium, and up the side of any vertical elements. Some waterproofing materials also act as a root barrier.

Drainage and overflow: A method of drainage must be provided. The drainage layer may include geotextile fabric, gravel, or be the growing medium itself particularly on steeper, fast-draining ecoroofs. Ecoroofs are not a full stormwater disposal system and need a conventional drainage system to manage excess runoff from the roof during periods of sustained or heavy rainfall. The applicant must provide roof drains that connect to an approvable discharge location.

Growing medium: A minimum of 4 inches of growing medium is required for the vegetated portions of the ecoroof. The medium must support the chemical, biological, and physical needs of the plants. Designers are encouraged to use a medium with significant water-holding capacity to maximize stormwater retention. The medium should be an unconsolidated mixture of mineral aggregate such as screened pumice and sandy loam, and organic matter such as aged compost or fiber

compost. Other blends will be approved by BES on a case-by-case basis. Incorporation of chemical additives such as fertilizers and fungicides is not allowed. A depth of less than 4 inches may be allowed if the applicant demonstrates through the Performance Approach that applicable Chapter 1 requirements are met.

Vegetation and coverage: Drought-tolerant plants (per the ecoroof plant list in Section 2.4.1, Green Roof Plants by Snodgrass & Snodgrass, and/or equivalent) must achieve 90 percent coverage within two years. At least 50 percent of the ecoroof vegetation must be evergreen species. Ecoroof vegetation should be:

- Drought-tolerant, requiring little or no irrigation after establishment.
- Self-sustaining, without the need for fertilizers, pesticides, or herbicides.
- Able to withstand heat and cold.
- Very low-maintenance, needing little or no mowing or trimming.
- Perennial or self-sowing.
- Fire-resistant.

A mix of sedum/succulent plant communities is recommended because these plants possess many of the attributes listed above. Although herbs, forbs, grasses and other low groundcovers can provide stormwater and aesthetic benefits, plants that require irrigation beyond what is allowed in this section for survival are not permitted.

Mulch: Gravel mulch or an alternative mulch is recommended to retain moisture and protect exposed soil from erosion.

Non-vegetated components: Non-vegetated components may comprise up to 10 percent of the ecoroof while still counting toward the total ecoroof area, though the non-vegetated area should be kept to a minimum. If additional non-vegetated area is necessary to meet fire code requirements, the 10 percent maximum may be exceeded only by that required area. Rooftop features which cannot be considered non-vegetated components of an ecoroof include: mechanical equipment and solar panels (unless vegetation is extended beneath elevated units), elevator overruns, penthouses, and skylights. Runoff from portions of the structure that penetrate the ecoroof (e.g. elevator overruns and penthouses) must meet the provisions of this manual. Examples of non-vegetated components that can be counted within the 10 percent include:

- Decking or porous materials such as gravel or pavers which are placed over sand or another substrate for the purpose of providing access to the ecoroof and other rooftop components.
- Ballast along parapets or mechanical units.
- Other non-vegetated components may be allowed subject to BES review.

Ballast (optional): Gravel ballast is sometimes placed along the perimeter of the roof and at air vents or other vertical elements. It is sometimes used to provide maintenance access, especially to vertical elements that require regular, periodic maintenance. In many cases little, if any, ballast is needed.

Header/separation board (optional): A header or separation board may be placed between gravel ballast and adjacent elements such as soil or drains, but pressure-treated lumber is prohibited. In many cases a header is not needed, and designers are encouraged to use just one header if a header is needed.

Protection boards or materials (optional): These materials protect the waterproof membrane from damage during construction and over the life of the system and are usually made of soft fibrous materials. They often are not needed, depending on the membrane selected.

Habitat design (optional): BES encourages designs that benefit urban wildlife. Diversifying design elements such as soil type and depth is good for habitat: variable soil types and depths create microclimates, allowing varied species to use the ecoroof. For instance, small areas of sand, gravel or native topsoil benefit ground-nesting pollinators. Another element of a habitat-friendly ecoroof is varied vegetation. Large plant species provide additional structure, flower shapes, and bloom times, which in turn attract varied wildlife. Drought- tolerant native species are most effective at attracting native pollinators. Small areas of woody material and rock create microhabitats, encouraging more species (these elements must be secured to the roof or placed in locations where there is no risk of movement). A summer water source can be included such as a basin to collect condensate from rooftop units. Ecoroofs designed for habitat allow for areas with denser vegetation and areas with minimal vegetation. See typical details for an example of habitat-friendly ecoroofs.

Bird-friendly design (optional): Portland published a Resource Guide for Bird-friendly Building Design in July 2012. BES recommends reducing or eliminating building features with the potential to increase bird-strike mortality. In particular, glass and lighting near an ecoroof (e.g., an ecoroof on a podium level adjacent to a taller portion of the building) should comply with the guide recommendations. The vegetation will attract migratory birds as a source of habitat and food (insects and other prey for feeding). The U.S. Green Building Council introduced a pilot Bird Collision Deterrence LEED credit (Pilot Credit 55) in 2011, providing an incentive for projects that are pursuing LEED certification.

Title 33 Ecoroof Criteria

Ecoroofs that are proposed to meet a provision of Portland City Code Title 33 (Planning and Zoning) and must meet all of the design and maintenance standards in this chapter, and operations and maintenance standards in Chapter 3. Because ecoroofs are designed to manage area at a 1:1 ratio and are not designed to manage runoff from adjacent areas, the applicant should be aware that an ecoroof proposed to satisfy Title 33 standards may not on its own be sufficient to meet all of the requirements of this manual. In such cases, the project team must address stormwater management requirements for the remainder of the structure's roof by other means, e.g. through separate stormwater facilities or by expanding the ecoroof to 100% roof coverage.

Floor Area Ratio (FAR) Bonus: In some areas, Portland City Code Title 33 may award bonus floor area to projects that include an ecoroof (e.g. Gateway Plan District, Mixed Use Zones). Where called for in Title 33, BES will issue a certification letter through the City's land use review process once the applicant has provided sufficient materials to confirm that the ecoroof complies with the standards of this manual. In order to receive a BES letter of certification prior to issuance of a land use decision, the applicant should submit all of the materials listed below with the land use application.

Ecoroof Requirement: Portland City Code Title 33 may require an ecoroof for projects located in specific areas or zoning designations. BES will not issue a letter of certification for ecoroofs that are required by Title 33, but 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.

For ecoroofs proposed to meet either regulatory provision presented above, the following materials must be submitted to BES for review:

- Planting plan and plant list with detailed square footage breakdown.
- Cross sections, typical details, and related specifications. Include a cross section and description of waterproof membrane and root barrier system.
- Specification for the plant cover and method for vegetation application.
- Drainage plan.
- Soil specification, including weight and depth.
- Operations and maintenance plan.
- Planned water use and/or irrigation system.

Typical Details: See Section 2.3.5 (SW-100's) for ecoroof typical details.

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

2.3.4.2. Pervious Pavement

Two types of pervious pavement: pervious concrete (foreground) and pervious pavers (background). Pervious pavements reduce impervious area and provide stormwater management.

Facility Description

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

Pervious asphalt, pervious concrete, and permeable pavers can be used in practically all pedestrian areas as well as residential driveways and commercial parking lots. Pervious asphalt and concrete will be approved on private streets and public roadways on a case-by-case basis. For all streets, the pavement design must be prepared by a registered professional engineer.

Pervious Asphalt and Concrete. Pervious asphalt and pervious concrete are similar to conventional asphalt and concrete in structure and form, except that the fines (sand and finer material) have been removed. The top lifts are thicker than traditional pavements to provide the required stability. When properly handled and installed, porous paving has a high percentage of void space (approximately 17 to 22 percent).

Pervious asphalt consists of an open-graded coarse aggregate cemented together by asphalt cement. The Oregon Department of Transportation (ODOT) has approved a pervious asphalt mix for use on public highways and freeways, and refers to it as an open-graded ½-inch or ¾-inch asphalt mix design.

Pervious concrete is a structural, open-textured pervious concrete paving surface consisting of standard Portland cement, fly ash, locally available open-graded coarse aggregate, admixtures, fibers, and potable water.

Permeable Pavers. There are many types of permeable pavers on the market. Many manufacturers make specific pavers for pervious applications. Brand names and specifications must be supplied with permit applications.

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

Design Requirements

Additional stormwater from other impervious areas, such as rooftops, may not be directed to a pervious pavement system under the Simplified Approach. Pervious pavements must not be located over cisterns, utility vaults, underground parking, or other impervious surfaces.

Soil Suitability: A minimum distance of five feet to seasonally high groundwater is required. Where the tested infiltration rate is less than 2 inches/hour, the pavement section must sheet-flow to an adequately sized filter strip (500 square foot limit for pavement), or the pervious pavement subsurface rock may be sized for necessary detention. If an underdrain is proposed for collection, the conveyance must lead to a vegetated facility sized to treat the entire pervious paved area.

Setbacks: There are no required setbacks, but impermeable liners between base rock and adjacent foundations are highly recommended. A liner may be required for

areas located within 5 feet of structures or infrastructure. See Exhibit 2-1 for more information on setbacks.

Sizing: Sizing requirements vary by design approach.

Simplified Approach: Pervious pavement and permeable pavers replace impervious surfaces at a 1:1 ratio.

Performance Approach: Pervious pavement designed under the performance approach must be designed to directly infiltrate all stormwater from the pavement surface into a crushed rock storage layer, which must contain enough void space to store the 10-year, 24-hour storm and infiltrate it into the subgrade in less than 30 hours.

Slope: Where slopes are greater than 5 percent, the design must be engineered to specifically address under-pavement water retention. If the slope of the area is 10 percent or greater, pervious pavement is not allowed.

Subgrade: Pervious pavement must not be constructed over fill soils. The area to be paved should be leveled and lightly compacted with a plate compactor to include a slight grade away from foundations. Subgrade must not be subject to truck traffic. The subgrade should not be constructed or compacted during wet conditions.

Geotextile fabric: Subgrade geotextile for separation may be desired between subgrade (native soil) and aggregate base (gravel layer), but is not required. Specify per geotechnical professional or manufacture.

Aggregate base: 6-inch minimum of washed, crushed 2- to ¾-inch or No. 57 rock.

Top lift: See Figure 2-6. Pervious Pavement Requirements for the top lift depth requirements for private property under the Simplified Approach. Asphalt and concrete must have at least 15 percent air voids in the completed top lift. Concrete must be 2400 to 2500 psi in 28 days. Pervious pavement requirements for public or private streets must be engineered. Public streets must also meet current City Standard Specifications.

Figure 2-6. Pervious Pavement Requirements

	Concrete (inches)	Asphalt (inches)	Paver (inches)	Engineering Required?	Compaction Required?
Residential Driveway or Pedestrian Only	4	2.5	2 ⅜	No	No

Typical Details: See Section 2.3.5 for typical details for pervious pavement.

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach. When considering permeable pavement for the public right-of-way, private streets, and parking lots, the project must be designed under the Performance Approach. Permeable pavement in the public right-of-way is approved on a case-by-case basis at the discretion of the City of Portland's Chief Engineers, and must be designed by a registered professional.

When considering pervious pavement for private streets, the applicant must meet the specifications of the BDS's private street administrative rule. A site development permit is required for private street construction.

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

Construction Considerations

It is imperative during design and construction to establish protection for the pervious pavement subgrade from over-compaction. The subgrade should not be constructed or compacted during wet conditions. The design professional must show how the project will be sequenced to avoid traffic on the subgrade of the proposed paved area, and how the paving will be protected from construction traffic, and sediment accumulation after installation.

Construction sequencing should avoid heavy truck traffic and sediment on the paving. A pervious pavement protection plan may be required in order to protect the surface from compaction during construction.

2.3.4.3. Tree Credits

Trees intercept rainfall and reduce runoff.

Facility Description

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

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

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

Trees are allowed as an impervious area reduction technique on both private property and in the public right-of-way under specific criteria and with provisions. The specifications that follow were developed to maximize the use of trees to mitigate stormwater impacts and to support the implementation of Title 11 (Trees). The City Forester maintains authority over trees in the public right-of-way. BES will inspect trees on private property during installation and during post-construction operations and maintenance visits, and the property owner is responsible for maintenance. Title 11 requirements apply to all trees.

Design Requirements

Site applicability: The tree credit can be used for all sites. For sites with over 1,000 square feet of impervious surface to manage, no more than 10 percent of the impervious area can be mitigated through the use of trees. Exceeding this allowance in the right-of-way will be considered on a site by site basis under staff discretion.

New tree sizing: New broadleaf trees on private property must be at least 1.5 caliper inches at the time of planting, and new coniferous trees must be at least 5 feet tall OR meet Portland City Code Title 11 requirements, whichever is greater, to receive credit.

New tree setbacks: New trees must be planted within 10 feet of impervious surfaces. One hundred square feet of credit is given for new broadleaf trees, and 200 square feet of credit is given for new coniferous trees (see minimum tree sizes below).

Street trees planted less than 10 feet from a water line (or other water infrastructure such as a water meter) require the installation of a tree root barrier, per Standard Drawing P-581.

Existing tree sizing and setbacks: Credit also applies to existing trees kept on a site if the trunk is within 25 feet of impervious surfaces and are at least 1.5-inch caliper or larger. Caliper is the diameter of the tree measured 6 inches above the ground surface or root ball. The tree credit for existing trees is tiered based on caliper (see Figure 2-7).

Figure 2-7. Stormwater Credit for Existing Trees

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

Tree selection: The trees selected must be suitable species for the site conditions and the design intent. Nuisance trees cannot receive stormwater tree credit. BES may require a certified arborist's report to verify suitable tree selection and preservation. See Section 2.4.1 for plant species information.

Trees on private property: Proposed trees are reviewed by BDS staff. This area should be marked on plans and protected during construction.

Street and public trees: By City ordinance, the City Forester is authorized to set standards for tree sizes planted on publicly owned lands and public rights-of-way. A permit is required from Urban Forestry to plant, prune, or remove trees in the public right-of-way. See Title 11 requirements regarding street trees and other public trees.

Other considerations: Trees planted to meet stormwater facility planting requirements cannot also receive impervious area reduction credit. New or existing trees counting towards environmental zone mitigation cannot receive tree credit. Tree credits may not be allowed if site circumstances or system limitations exist.

Typical Details: See Title 11 Code for tree requirements relating to development situations. See Section 2.3.5 (SW-300's) for typical details relating to incorporating trees into vegetated stormwater facilities in the public right-of-way.

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach. Trees to be given credit as an impervious area reduction technique must be clearly labeled as such, with the size (as provided in the Bureau of Development Services Tree and Landscaping Manual – Plant Materials) and species included. Approximate setbacks from property lines and structures must be shown. Temporary irrigation measures must be shown, if applicable. 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. Trees proposed for stormwater credit will need to be included in the required O&M Plan. BES will require BDS approval and may require a survey and certified arborist report to verify suitable tree selection or tree preservation for any trees designated for stormwater tree credit.

Construction Considerations

Protection of existing trees during construction must meet Title 11 requirements. Alternative protection may be proposed via the performance path in Title 11 and is approved by BDS staff. The applicant will have to provide documentation required by the code to ensure the tree will remain healthy after construction and for the life of the tree.

2.3.4.4. Downspout Extension

Downspout extensions route runoff from roof areas to adjacent landscape.

Facility Description

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

Design Requirements

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

Setbacks: Downspouts typically discharge 2 feet from slab on grade and structures with crawl spaces and 6 feet from all foundations with basements. The point of discharge typically are set back 5 feet from property lines and 10 feet from all neighboring structures or buildings and retaining walls over 36 inches in height. Splash blocks are not considered part of the downspout extension and are included for erosion control and flow dispersal only. See Table 2-1 for more information on setbacks.

Sizing and grade: The landscape area utilized for disposal of stormwater must be at least 10 percent of the roof area that drains to each downspout. The grade of the landscape area must gently slope away from the foundation and neighboring properties and allow stormwater to spread out over the required 10 percent infiltration area. Setback requirements must be retained over the entire infiltration area.

Materials: Durable, gutter-grade materials such as aluminum, steel, copper, vinyl, and plastic downspouts can be utilized for extensions. Downspouts need to be secured to the structure and connections securely fastened together with appropriate materials (i.e., sheet metal or similar screws). Flexible downspout extensions are not approvable materials. Rain chains must be securely fastened to the structure and the ground in a vertical alignment and must meet setback standards in order to be approved. Splash blocks, rock, or flagstone must be utilized for erosion control and flow dispersal at the location of discharge. Downspouts can be directed to drain onto grass without additional erosion control measures.

Other Considerations: Downspouts must not be directed to drain onto or over impervious areas, including walkways, driveways, and patios or onto neighboring properties, including public sidewalks and streets. Downspouts and gutters may be regraded, piped, or redirected in order to convey water to a safe infiltration area. Downspouts need to drain directly to landscape areas intended for infiltration.

Landscaped areas above buried oil tanks or adjacent to retaining walls over 36 inches high cannot be utilized as infiltration areas.

Typical Details: See Section 2.3.5 for typical details for downspout extensions on private property under the Simplified Approach (SW-100's).

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach. An applicant for downspout extension approval must submit a site plan that notes downspout locations and roof drainage areas and that clearly illustrates roof area limitations, setbacks, and infiltration area requirements can be met. Alternate onsite disposal methods such as soakage trenches will be required upon inspection for sites that cannot meet applicable downspout extension setback and landscape requirements.

Construction Considerations

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

2.3.4.5. Rain Garden

Rain gardens are shallow landscape depressions which collect runoff and allow it to infiltrate.

Facility Description

Rain gardens are a method of stormwater management that directs roof and/or paved area runoff to a shallow, flat, vegetated landscape depression amended with compost to allow for onsite infiltration. Rain gardens can meet stormwater requirements for new and redevelopment projects that manage less than 5,000 square feet of roof and paved areas. Site conditions will determine if this is a suitable method for managing stormwater onsite. Property line and building setbacks as well as surface grade and available landscaped areas for infiltration must be considered. Proposed downspout locations and roof/gutter alignments will impact the feasibility of this option, as well as slope, setback, and other site considerations.

Design Requirements

Site Suitability: Rain gardens are suitable for sites that have well-draining soils (>2 inches/hour) and have an overall slope of 10 percent or less. New development and redevelopment projects with less than 5,000 square feet of new impervious area are

eligible to use this method. This requirement also applies to stormwater retrofits or alterations to existing structures.

Setbacks: A ten-foot setback from buried oil tanks or retaining walls over 36 inches high is required for safety considerations. It is also recommended to avoid installation over water service lines. The deepest point of a rain garden should be at least 10 feet from all structures. Each downspout or rain drain entering the rain garden must be at least:

- 2 feet from any onsite building foundations without a basement,
- 6 feet from any onsite building foundations with a basement,
- 10 feet from a neighbor's building,
- 5 feet from a property line,

Sizing and grade: The rain garden footprint must be at least 10 percent of the impervious area that drains to each rain garden. The footprint is the area of the rain garden capable of detaining water when full, including facility side slopes.

If site infiltration rates are higher than 2 inches/hour, consider using the Presumptive Approach in order to design a smaller basin.

Each rain garden design needs to include an escape route so that stormwater safely drains in periods of heavy rainfall. Escapes routes can simply be low points in the perimeter of the rain garden that allow excess stormwater to safely drain away from building foundations to a driveway, sidewalk, street, or parking lot and without impact to adjacent properties. Escape routes should be planted or rocked to prevent potential erosion issues.

If an escape route is not available given site conditions, a piped overflow is allowed. Overflows need to have an approved disposal location such as a public storm sewer, adjacent creek, or onsite disposal system such as a drywell.

Dimensions and Slopes: The grade of the rain garden must gently slope away from the foundation and neighboring properties. Setback requirements must be retained over the entire infiltration area. Rain gardens must not be installed at locations on the site where slope is greater than 10%.

Rain gardens will be constructed to a ponding depth of 12 inches with maximum side slopes of 3 horizontal to 1 vertical and a minimum bottom width of 2ft x 2ft. Side slopes of 2 horizontal to 1 vertical may be allowed if erosion control protections are installed, such as vegetative cover and/or larger boulders.

Materials: Water runoff from the roof may be conveyed to the point of discharge in one of the following manners:

- A gutter-grade downspout extension above ground.
- A downspout extension positioned below ground, daylighting into the facility. Where located within the 2-foot or 6-foot setback, the pipe must be watertight. Where located completely below ground, a patio, or a walkway, it must be composed of cast iron or Schedule 40 ABS to comply with the Oregon Plumbing Specialty Code.
- A rock-filled drainage channel ("dry creekbed conveyance swale") lined with moisture-impervious sheeting, such as 30-mm EPDM, where located within the 2-foot or 6-foot setback.

Flexible downspout extensions are not approvable materials. Splash blocks, rock, or flagstone must be utilized for erosion control and flow dispersal where the stormwater enters the rain garden.

Growing Medium: Amend native soils with 3 inches of compost blended into the top 12 inches of native soil.

Vegetation: The entire facility area must be planted with vegetation as per Figure 2-8 . The facility area is equivalent to the total area of the rain garden, including bottom and side slopes, as developed in the sizing calculations. See Section 2.4.1 for suggested plant material.

Figure 2-8. Rain Garden Vegetation - Zone A and B

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
80	Herbaceous plants	100	#1 container	1.25'
OR				
72	Herbaceous plants	100	#1 container	1.25'
4	Small or large shrubs	100	#2 container	1'

If the total project area is over 200 square feet consider adding a tree and reducing the number of herbaceous plants and shrubs.

Mulch: Rain gardens may be topped with 2" of compost cover to enhance soil moisture, prevent weeds and control erosion. Bark mulch or equivalent should only be applied above the high water line.

Typical Details: See Section 2.3.5 for typical details for rain gardens designed under the Simplified Approach (SW-100's).

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach. An applicant for rain garden approval must submit a site plan that notes downspout locations and roof drainage areas and that clearly illustrates roof area limitations, setbacks, and infiltration area requirements can be met. Alternate onsite disposal methods such as soakage trenches will be required upon inspection for sites that cannot meet applicable rain garden setback and landscape requirements.

Construction Considerations

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

Rain gardens need to be located in areas that can accommodate stormwater flows and do not cross walkways or drain onto driveways, patios, or other impervious surfaces. The design should consider landscape grade during construction to ensure the finished landscape grade will allow stormwater to drain safely away from building foundations and property lines.

2.3.4.6. Swales

Swales collect and convey runoff to a discharge location, filtering the runoff, and allowing it to infiltrate.

Facility Description

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

Design Requirements

Soil suitability: Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to be conveyed through the facility. See Section 2.3.6 for infiltration testing procedures.

Simplified Approach: For the Simplified Approach (Section 2.2.1), if the tested infiltration rate is greater than or equal to 2 inches per hour, the simplified swale design meets all requirements. If the tested infiltration rate is less than 2 inches per hour, the swale should be designed as a partial infiltration facility, with an overflow to an approved discharge location.

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

Setbacks: Setback requirements vary by location.

Private property requirements: Infiltration swales are typically set back 5 feet from property lines and 10 feet from building foundations. There are no setback requirements for lined swales. See Table 2-1 for more information on setbacks.

Right-of-way requirements: If a basement is within 10' of an infiltration swale, a partial liner may be required on the basement side of the swale.

Sizing: Sizing requirements vary by design approach.

Simplified Approach: A sizing factor of 0.09 is required.

Presumptive Approach: The Presumptive Approach Calculator allows the designer to size stormwater facilities with respect to native infiltration rates and other unique site conditions of the project.

Performance Approach: Must be engineered to meet site-specific stormwater requirements.

Dimensions and slopes: Requirements vary by location and design approach.

Simplified Approach: The minimum swale width is 9 feet. A 2-foot-wide flat bottom width is required where feasible. The depth is nine inches as measured from the top of the growing medium to the overflow inlet elevation. Maximum side slopes are 3 horizontal to 1 vertical; 4 horizontal to 1 vertical is required immediately adjacent to pedestrian areas. Maximum longitudinal slope is 6 percent. Freeboard for swales must be noted on the plans.

Presumptive approach on private property requirements: The minimum swale width is 9 feet. A 2-foot-wide flat bottom width is required where feasible. Swale depth per Presumptive Approach Calculator. Maximum side slopes are 3 horizontal to 1 vertical; 4 horizontal to 1 vertical is required immediately adjacent to pedestrian areas.

Right-of-way requirements: The minimum swale width is 8 feet. A 2-foot-wide flat bottom width is required where feasible. The maximum ponding depth is 9", unless otherwise approved. See Section 2.3.5 for Green Street typical details for side slope requirements. Maximum longitudinal slope is 6 percent.

Waterproofing/Geosynthetic Liner: Requirements vary by location.

Private property requirements: Liner must be 30-mil EPDM, HDPE, or approved equal.

Right-of-way requirements: Full or partial liners may be required for protecting adjacent water facilities/utilities, on higher classification streets, in locations with hazardous materials or topography considerations, and in wellhead protection areas. The location determines the required liner thickness, see below. All liners must be attached per the Green Street details in Section 2.3.5 Typical Details. Other methods may be considered where impervious or waterproof facilities are required, such as single-pour concrete forms.

- 30 mil HDPE – water main and road protection
- 40 mil HDPE – Columbia Southshore Well Field Wellhead Protection Area

Piping: Requirements vary by location.

Private property requirements: Piping must be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise, a 4-inch pipe minimum is required. Piping installation must follow current Plumbing Code.

Right-of-way requirements: 6-inch or 8-inch ASTM 3034 SDR 35 PVC pipe and perforated pipe are required. Refer to the City's Sewer and Drainage Facilities Design Manual for more information.

Drainage Layer: Requirements vary by location and design approach.

Simplified Approach requirements: 12" depth of ¾" – 1 ½" washed drain rock must be used. Drain rock and growing medium must be separated by a 2- to 3-inch layer of pea gravel.

Presumptive approach on private property requirements: Determined by designer and PAC calculations. Options include, but are not limited to drain mat, 3/4" washed rock, or other approved system. Separation between growing medium and drainage layer may be appropriate filter fabric or a gravel lens (pea gravel 2 to 3 inches deep), or as per approved design.

Right-of-way requirements: 1 ½" - ¾-inch round washed drain rock may be required per PAC calculations. Drain rock and growing medium must be separated a 2-inch to 3-inch layer of ¾-inch to No. 4 open graded aggregate. Geotextile fabric is prohibited.

Check dams: Requirements vary by location.

Private property requirements: They generally measure 4 to 10 inches high, depending on the depth of the facility. Width will vary depending on material.

Right-of-way requirements: Place check dams per PAC calculations to maximize volume. See Section 2.3.5 for Green Street typical details (SW-300's).

Growing medium: Requirements vary by location.

Private property requirements: The imported soil must be a sandy loam mixed with compost or a sand/soil/compost blend. It must be roughly one-third compost by volume, free-draining, and support plant growth. The compost must be derived from plant material; animal waste is not allowed. The Stormwater Facility Blended Soil for public facilities is also acceptable, see Section 2.3.6.

If a stormwater management facility is proposed adjacent to property lines or nearby structures, then a lined facility will likely be required. Vegetation planted within water-tight stormwater management facilities cannot compromise the integrity of the facility liner and the facility design must ensure plants will survive. The applicant must coordinate with BES and BDS staff regarding applying BES Stormwater Management Manual requirements, while meeting landscaping requirements. To provide adequate area for plants to grow, vegetation must be planted within a minimum growing medium depth of 24 inches.

Right-of-way requirements: For streets, the Stormwater Facility Blended Soil is specified in Section 2.3.6. The imported growing material must be 18 inches deep, or less, if native soils drain well.

Vegetation: The entire facility area must be planted with vegetation. The facility area is equivalent to the total area of the swale, including bottom and side slopes, as developed in the sizing calculations. See Section 2.4.1 for suggested plant material appropriate for private property and required plant material for the public right-of-way. Swales should be designed so they do not require mowing.

Private property requirements: The entire facility area must be planted with vegetation as per Figure 2-9. (Private) Swale Vegetation - Zone A and Figure 2-10. (Private) Swale Vegetation - Zone B. The facility area is equivalent to the total area of

the swale, including bottom and side slopes, as developed in the sizing calculations. See Section 2.4.1 for suggested plant material appropriate for private property and required plant material required for the public right-of-way. Swales should be designed so they do not require mowing.

Figure 2-9. (Private) Swale Vegetation - Zone A

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
80	Herbaceous plants	100	#1 container	1.25’
OR				
72	Herbaceous plants	100	#1 container	1.25’
4	Small shrubs	100	#1 container	1’

Figure 2-10. (Private) Swale Vegetation - Zone B

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
7	Large or small shrubs	100	#2 container	2’
70	Groundcover	100	#1 container	1’

If the total project area is over 200 square feet consider adding a tree and reducing the number of herbaceous plants and shrubs.

Right-of-way requirements: See Section 2.3.5 for typical Green Street details and planting templates and Section 2.4.1 for Plant List for Public Stormwater Facilities. Plantings adjacent to streets require special attention to line-of-sight and maintenance issues. Vegetation should be planted so it does not block traffic sight lines or require mowing. No medium to large shrubs are allowed. Minimum container size is #1 container. Plants to be spaced per Plant List for Public Stormwater Facilities in Section 2.4.1 and requirements on drawing SW-362.

Mulch: Requirements vary by location.

Private property requirements: Fine to medium hemlock mulch is recommended for swales. It should be placed in the facility only in areas above the high-water line. Care should be given to keeping mulch material out of a stormwater flow path to

avoid any material from clogging inlets or outlets or otherwise escaping the facility. It must be weed-free and applied 2 to 3 inches thick to cover all soil between plants. It should not be over-applied.

Right-of-way requirements: Mulch may be allowed by BES on a case-by-case basis. Mulch will only be allowed on facilities with side slopes that do not have an aboveground overflow drain. Mulch must not inhibit water flow in the flow path, inlets, or outlets. Mulch material must be fine to medium 100% hemlock bark free of dyes and pesticides. Mulch must be applied after beds are clear of weeds and debris, after planting and watering-in of new plants is complete and after the soil surface is brought to a smooth, finished grade. Mulch must be applied in planted areas to an even, uniform depth of 2 inches. Keep mulch off plants, structures, roadways, shoulders, walks, and lawns. Mulch must not cover herbaceous plants or come into contact with the stems of woody shrubs or trees. Mulch surface must be left with a smooth, finished appearance as approved by the City.

Typical Details: See Section 2.3.5 for typical details for swales designed under the Simplified Approach (SW-100's), the Presumptive Approach on private property (SW-200's) and for Green Streets in the public-right-of-way (SW-300's).

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Construction Considerations

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

2.3.4.7. Curb Extensions

Curb extensions are street-side landscape areas which store, filter, and infiltrate stormwater runoff. Photo credit: Henry Ngan.

Facility Description

Stormwater curb extensions are typically used in retrofit situations to manage runoff from developed rights-of-way. They can provide locations for stormwater management when space behind an existing curb line is constrained or inadequate in size.

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

Curb extensions can improve auto, pedestrian, and bicycle safety by narrowing the crossing distance for pedestrians, improving sight lines, and providing a visual presence in the roadway to slow cars approaching intersections.

The presence of utilities, potential loss of on-street parking spaces, and the narrowing of the road are all considerations for curb extension placement and design.

If proposed via Public Works Permit then consult with PBOT early on if these can be allowed/approved.

General Guidelines

Local Service Streets (as defined by the Portland Bureau of Transportation) typically accommodate curb extensions and the design considerations outlined below are directed primarily for this application. Curb extensions can also be accommodated on higher classification streets using similar design considerations. However, significantly more scrutiny and review are required to ensure vehicle and pedestrian safety, safety for maintenance crews, and adequate sizing of the facility for those situations. Additional considerations for higher classification streets may include analysis for future transportation system demands. These demands may call for future travel lanes, bike lanes, or turn lanes that would potentially conflict with a curb extension. Other facility types may be more appropriate for high traffic areas.

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

Since curb extensions occupy space typically used for on-street parking, a technique for mitigating impacts to adjacent property owners is centering surface stormwater facilities between properties (e.g. centered on property lines perpendicular to the facility). Even though this may not be the most efficient location for collection of stormwater, it reduces the impact to one property by spreading it over two. This technique can allow for at least one on-street parking space to be retained on each property frontage. In general, projects should avoid removing parking entirely along frontages without driveways or off-street parking areas.

For mid-block curb extension applications, it is acceptable for stormwater to flow into a facility and then back out (via a passive surface overflow). When a stormwater curb extension is combined with pedestrian ramps at corners, stormwater should be

collected within the facility to the maximum extent practicable. This may include the installation of underdrains and/or overflow inlets within the stormwater facilities. Stormwater must not flow across the base of the pedestrian ramps when exiting the facility.

The development potential of adjacent property should be considered to the maximum extent practical when placing facilities. For example, an undeveloped or underdeveloped lot might require a driveway at a future time, which could conflict with a surface stormwater facility. The Bureau of Development Services should be contacted to determine if a development inquiry or building permit exists for adjacent properties.

Street Design Requirements and Considerations

A curb extension in an existing right-of-way is considered to be an alteration. As a result, the federal law requires a curb extension project improve adjacent corners that do not have pedestrian ramps. See Standard Drawing P-548 of the City of Portland Standard Construction Specifications.

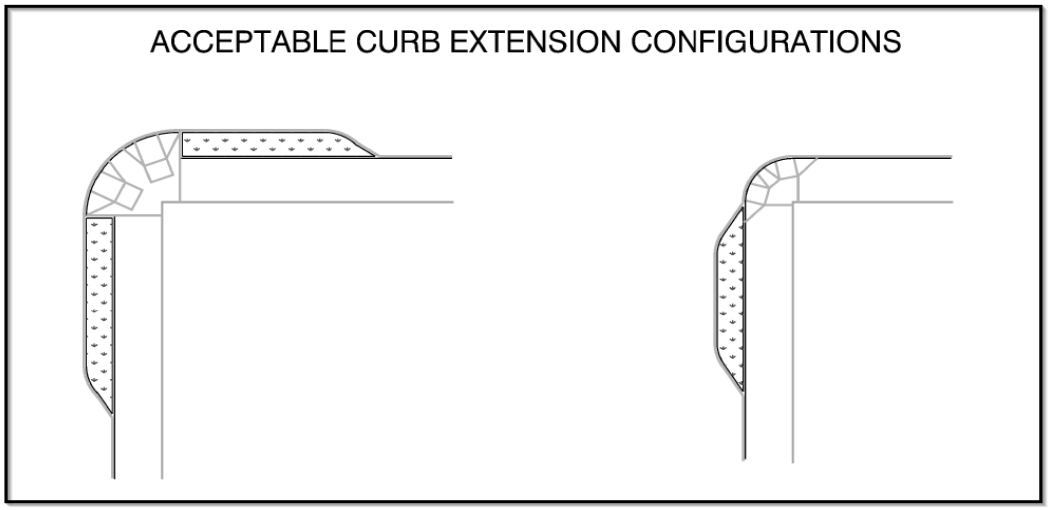
For corner applications, stormwater curb extensions must be placed at the Point of Curvature (PC) or the Point of Tangency of a corner radius or as close to the corner ramp as possible without blocking the pedestrian ramp. Where a curb extension cannot be placed at or very close to the PC of a corner radius, stormwater curb extensions must be moved back approximately 18 feet to allow for a legal parking space.

Stormwater curb extensions proposed on both sides of a street corner must be incorporated into a full curb extension including the corner ramps (See Figure 2-11). Subject to BES approval, a single stormwater curb extension can be placed on one side of a corner without requiring that the corner ramp be incorporated into the extension. The specific geometry requirements for a full corner curb extension are determined by Portland Bureau of Transportation (PBOT) traffic engineers according to site conditions.

Corners with pedestrian ramps must be constructed (see Figure 2-11) in a Pedestrian District or City Walkway per the City's Transportation System Plan. If there is a safety benefit to shortening the crossing distance for pedestrians, and/or if the street is a designated Safe Route to School and on higher classification streets, these requirements will be conveyed by Transportation staff.

For midblock applications, locate stormwater curb extensions at the wing of a driveway or at least 18 feet from a driveway wing to either remove or allow for parking.

Figure 2-11. Acceptable Curb Extension Configurations



The presence of existing fire hydrants and mature street trees will impact placement of curb extensions. Consequently, coordination with the Portland Water Bureau and Portland Parks and Recreation is necessary.

A thickened curb and gutter per City of Portland Standard Construction Specification Drawing P-540 must be used along the street side of all surface stormwater facilities in the public right-of-way.

Typical curb extensions vary in width from 4 to 6 feet as measured from the face of the existing curb to the street-facing face of a new curb. The actual width of the curb extension varies depending on many factors, including but not limited to: existing street width, on-street parking, bike lanes, traffic engineering considerations, and conflicts with utilities, such as water lines. A distance of 20 feet between curbs on opposite sides of the street must be maintained on all local, two-way residential streets per Portland Fire Bureau requirements, unless specific exceptions are approved (see Figure 2-12). See Section 2.3.5 for stormwater curb extension geometry and typical sections (SW-300's).

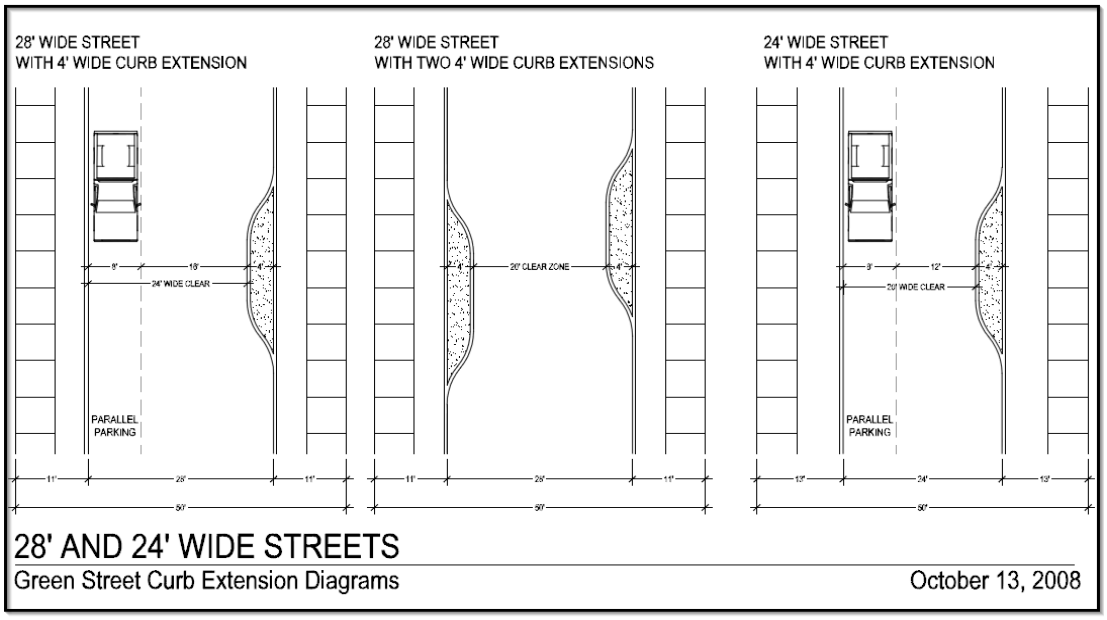
In addition to PBOT and Fire Bureau requirements, existing utility locations may also impact allowable curb extension width. It may be necessary to reduce the width of a curb extension to avoid a utility conflict.

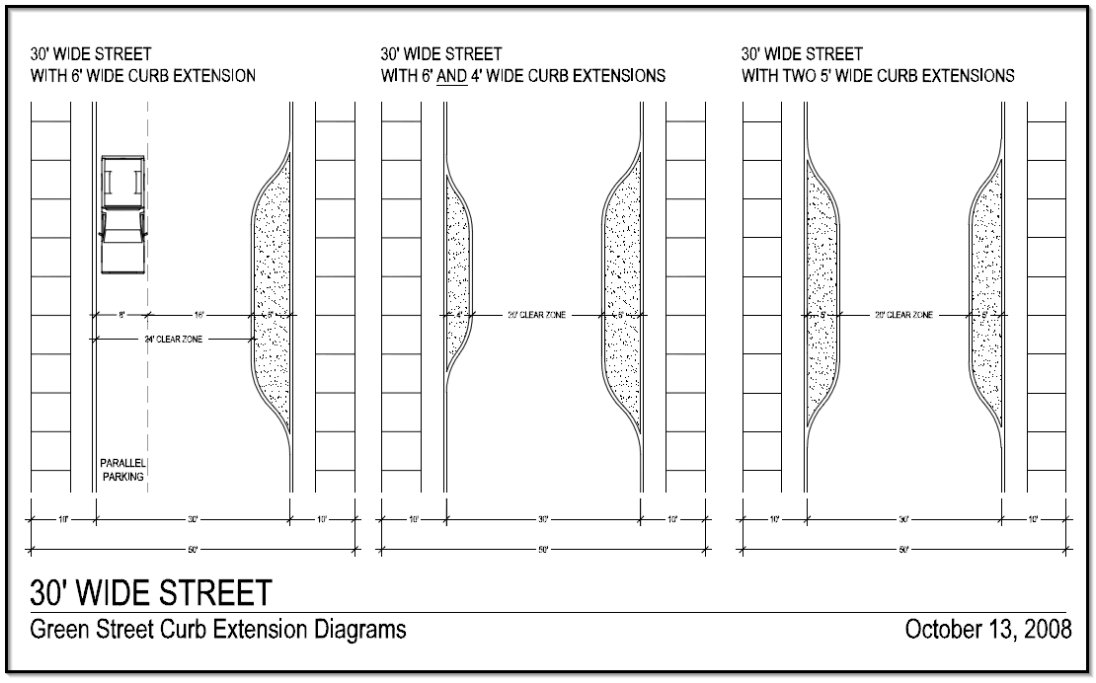
Curb extensions must be designed with a wheel stop at the inlet/outlet of a facility when adjacent to on-street parking. Significant damage to both the facility and a vehicle can occur if a vehicle enters the curb opening of a curb extension. See Section 2.3.5.

Generally, a minimum length of 30 feet is required to accommodate a mid-block curb extension ranging from 4 to 6 feet in width. Any linear length shorter than this should not be considered for a curb extension.

Existing sidewalks with a vertical or horizontal displacement greater than or equal to ½ inch must be repaired at locations where new construction meets old as shown on the City of Portland Standard Construction Specifications Drawing P-554. Many existing sidewalks are old and not able to withstand even minimal adjacent disturbance or construction loads. Since the adjacent property owner is responsible under City Code for sidewalk maintenance and repair, the sidewalk must be restored to a condition as good as the condition that existed before construction. Replacement of fragile sidewalks beyond the minimal requirements allowed by P-554 should be evaluated during the design process by PBOT staff.

Figure 2-12. Street Widths for Curb Extensions





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

Stormwater Requirements

Soil suitability: Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to be conveyed through the facility. See Section 2.3.6 for infiltration testing procedures and requirements.

Setbacks: Infiltration curb extensions are typically set back 10 feet from building foundations. There are no setback requirements for lined curb extensions. See Table 2-1 for more information on setbacks.

Sizing: Surface area and depth of facility vary. The Presumptive Approach Calculator (PAC) allows the designer to size stormwater facilities with respect to native infiltration rates and other unique site conditions of the project. Under the PAC, a curb extension can be designed as a swale or planter facility type depending on site conditions and design needs.

Dimensions and slopes: The minimum curb extension width is 4 feet, and the length will vary. They may vary in ponding depth from 6 to 9 inches measured from the inlet elevation. Maximum longitudinal slope is 6 percent.

Liners: Full or partial liners may be required for protecting adjacent water facilities/utilities, on higher classification streets, in locations with hazardous materials or topography considerations, and in wellhead protection areas. The location determines the required liner thickness, see below. All liners must be attached per the Green Street details in Section 2.3.5. Other methods may be considered where impervious or waterproof facilities are required, such as single-pour concrete forms.

- 30 mil HDPE – water main and road protection.
- 40 mil HDPE – Southshore Well Field Wellhead Protection Area.

Piping: 8-inch ASTM 3034 SDR 35 PVC pipe and 4-inch perforated pipe are required. Refer to the City's Sewer and Drainage Facilities Design Manual.

Check dams: Check dams may be required perpendicular to the flow line to encourage water to pool and infiltrate into the ground. Locate check dams as per Presumptive Approach Calculator to maximize volume. See Section 2.3.5 for Green Street check dam typical details.

Drainage layer: 1 ½" - ¾-inch round washed drain rock may be required per PAC calculations. Drain rock and growing medium must be separated a 2-inch to 3-inch layer of ¾-inch to No. 4 open graded aggregate. Geotextile fabric is prohibited.

Growing medium: For curb extensions, the growing medium is specified in Section 2.3.6. The blended soil must be 18 inches deep, or less if native soils drain well.

Vegetation: The entire facility area must be planted with vegetation. The facility area is equivalent to the total area of the facility, including bottom and side slopes, as developed in the sizing calculations. Curb extensions should be planted so they do not block traffic sight lines or require mowing. See Section 2.4.1 for suggested plant material appropriate for private property and required material for the public right-of-way. See Section 2.3.5 for typical details and planting templates.

Use planter vegetation requirements for flat bottom curb extensions. Use swale vegetation requirements for curb extensions with side slopes.

Mulch: Requirements vary by location.

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

Right-of-way requirements: Mulch may be allowed by BES on a case-by-case basis. Mulch will only be allowed on facilities with side slopes that do not have an aboveground overflow drain. Mulch must not inhibit water flow in the flow path, inlets, or outlets. Mulch material must be fine to medium 100% hemlock bark free of dyes and pesticides. Mulch must be applied after beds are clear of weeds and debris, after planting and watering-in of new plants is complete and after the soil surface is brought to a smooth, finished grade. Mulch must be applied in planted areas to an even, uniform depth of 2 inches. Keep mulch off plants, structures, roadways, shoulders, walks, and lawns. Mulch must not cover herbaceous plants or come into contact with the stems of woody shrubs or trees. Mulch surface must be left with a smooth, finished appearance as approved by the City.

Typical Details: See Section 2.3.5 for typical details for curb extensions designed as Green Streets in the public-right-of-way (SW-300's).

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Construction Considerations

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

2.3.4.8. Planters

Planters infiltrate or treat stormwater; this planter is monolithically poured concrete in a commercial setting.

Facility Description

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

Design Requirements

Soil suitability: Existing infiltration rates and design approach will determine if the facility can be designed to achieve infiltration, partial infiltration, or might be lined. See Section 2.3.6 for infiltration testing procedures.

Simplified Approach: If the tested infiltration rate is greater than or equal to 2 inches per hour, the simplified planter design meets all requirements. If the tested infiltration rate is less than 2 inches per hour, the planter should be designed as a partial infiltration or lined facility, with an overflow to an approved discharge location.

Setbacks: Requirements vary by location.

Private property requirements: Infiltration planters are typically set back 5 feet from property lines and 10 feet from building foundations. No setbacks are required for lined planters where the height above finished grade is 30 inches or less. Lined planters can be used next to foundation walls, adjacent to property lines, or on slopes when they include a waterproof lining. See Table 2-1 for more information on setbacks.

Right-of-way requirements: If a basement is within 10' of an infiltration planter, a partial liner may be required on the basement side of the planter.

Sizing: Requirements vary by design approach.

Simplified Approach: A sizing factor of 0.06 is required.

Presumptive Approach: The Presumptive Approach Calculator allows the designer to size stormwater facilities with respect to native infiltration rates and other unique site conditions of the project.

Performance Approach: Must be engineered to meet site-specific stormwater requirements.

Dimensions and slopes: Requirements vary by location and design approach.

Simplified Approach requirements: The minimum planter width is 24 inches (measured from inside the planter walls). Facility storage depth must be at least 12 inches (from inlet elevation of overflow to top of growing medium), unless a larger-than-required planter area is specified. Planters are flat facilities that must not slope more than 0.5 percent in any direction. A minimum of 2 inches of freeboard (vertical distance between the design water surface elevation and overtopping elevation) must be provided.

Private property requirements for Presumptive Approach: The minimum planter width is 24 inches (measured from inside the planter walls). Facility storage depth must be per PAC calculations. Planters are flat facilities that must not slope more than 0.5 percent in any direction. A minimum of 2 inches of freeboard (vertical distance between the design water surface elevation and overtopping elevation) must be provided.

Right-of-way requirements: The minimum width for a planter is 30 inches. They may vary in ponding depth from 6 to 9 inches measured from the inlet elevation. The maximum longitudinal slope is 6%. If parking is adjacent to the facility, the maximum length is 20 feet.

Planter walls: Requirements vary by location and design approach.

Private property requirements: Planter walls must be concrete unless otherwise approved. For planters that require an impervious bottom, a monolithically poured planter without joins is required.

Right-of-way requirements: See Section 2.3.5 for Green Street typical details for planter wall requirements.

Waterproofing/Liner: Requirements vary by location.

Private property requirements: Lined facilities that require an impervious bottom must be a single-pour concrete box, or approved equivalent.

Right-of-way requirements: Full or partial liners may be required for protecting adjacent water facilities/utilities, on higher classification streets, in locations with hazardous materials or topography considerations, and in wellhead protection areas. The location determines the required liner thickness, see below. All liners must be attached per the Green Street details in Section 2.3.5 Typical Details. Other methods may be considered where impervious or waterproof facilities are required, such as single-pour concrete forms.

- 30 mil HDPE – water main and road protection.
- 40 mil HDPE – Columbia Southshore Well Field Wellhead Protection Area.

Piping: Requirements vary by location.

Private property requirements: Piping must be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise, a 4-inch pipe minimum is required. Piping installation must follow current Uniform Plumbing Code.

Right-of-way requirements: 6-inch or 8-inch ASTM 3034 SDR 35 PVC pipe and perforated pipe are required. Refer to the City's Sewer and Drainage Facilities Design Manual for more information.

Drainage Layer: Requirements vary by location and design approach.

Simplified Approach requirements: 12" depth of ¾" – 1 ½"washed drain rock must be used. Drain rock and growing medium must be separated by a 2- to 3-inch layer of pea gravel.

Private property requirements Presumptive Approach: Determined by designer and PAC calculations. Options include, but are not limited to drain mat, 3/4" washed rock, or other approved system. Separation between growing medium and drainage layer may be appropriate filter fabric or a gravel lens (pea gravel 2 to 3 inches deep), or as per approved design.

Right-of-way requirements: 1 ½" - ¾-inch round washed drain rock may be required per PAC calculations. Drain rock and growing medium must be separated a 2-inch to 3-inch layer of ¾-inch to No. 4 open graded aggregate. Geotextile fabric is prohibited.

Check dams: Requirements vary by location and design approach.

Simplified and Presumptive requirements: Check dams are required for slopes over 0.5%.

Right-of-way requirements: Place check dams per PAC calculations to maximize volume. See Section 2.3.5 (SW-300's) for typical check dam details.

Growing medium: Requirements vary by location.

Private property requirements: The imported soil must be a sandy loam mixed with compost or a sand/soil/compost blend. It must be roughly one-third compost by volume, free-draining, and support plant growth. The compost must be derived from plant material; animal waste is not allowed. The Stormwater Facility Blended Soil for public facilities is also acceptable, see Section 2.3.6.

If a stormwater management facility is proposed adjacent to property lines or nearby structures, then a lined facility will likely be required. Vegetation planted within water-tight stormwater management facilities cannot compromise the integrity of the facility liner and the facility design must ensure plants will survive. The applicant must coordinate with BES and BDS staff regarding applying BES Stormwater Management Manual requirements, while meeting landscaping

requirements. To provide adequate area for plants to grow, vegetation must be planted within a minimum growing medium depth of 24 inches.

Right-of-way requirements: For streets, the Stormwater Facility Blended Soil is specified in Section 2.3.6. The imported growing material must be 18 inches deep, or less if native soils drain well.

Vegetation: Requirements vary by location.

Private property requirements: The entire facility area must be planted with vegetation as per Figure 2-13. The facility area is equivalent to the total area of the planter, as developed in the sizing calculations. The entire surface area of a planter is inundated with water and therefore requires only Zone A plants. See Section 2.4.1 for suggested plant material.

Figure 2-13. Planter Vegetation - Zone A

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
80	Herbaceous plants	100	#1 container	1.25’
OR				
72	Herbaceous plants	100	#1 container	1.25’
4	Small Shrubs	100	#1 container	1’

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

Right-of-way requirements: See Section 2.3.5 for typical Green Street details (SW-300’s) and planting templates and Section 2.4.1 for the Plant List for Public Stormwater Facilities. Plantings adjacent to streets require special attention to line-of-site and maintenance issues. Vegetation should be planted so it does not block traffic sight lines or require mowing. No medium to large shrubs are allowed. Minimum container size is #1 container. Plants to be spaced per the Plant List for Public Stormwater Facilities in Section 2.4.1 and requirements on drawing SW-362.

Mulch: Requirements vary by location.

Private property requirements: 2 to 3 inches deep medium hemlock mulch or approved equal.

Right-of-way requirements: Do not apply mulch.

Typical Details: See Section 2.3.5 for typical details for planters designed under the Simplified Approach (SW-100's), the Presumptive Approach on private property (SW-200's) and for vegetated stormwater facilities in the public-right-of-way (SW-300's).

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Construction Considerations

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

2.3.4.9. Basins

Basins are shallow landscape depressions which treat and infiltrate runoff.

Facility Description

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

Design Requirements

Soil suitability: Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to be conveyed through the facility. See Section 2.3.6 for infiltration testing procedures.

Simplified Approach: If the tested infiltration rate is greater than or equal to 2 inches per hour, the simplified basin design meets all requirements. If the tested infiltration rate is less than 2 inches per hour, the basin should be designed as a partial infiltration facility, with an overflow to an approved discharge location.

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

Setbacks: Requirements vary by location and design approach.

Private property requirements: Infiltration basins are typically set back 5 feet from property lines and 10 feet from building foundations. There are no setback requirements for lined basins. See Table 2-1 for more information on setbacks.

Right-of-way requirements: If a basement is within 10’ of an infiltration basin, a partial liner may be required on the basement side of the basin.

Sizing: Requirements vary by location and design approach.

Simplified Approach: A sizing factor of 0.09 is required.

Presumptive Approach: The Presumptive Approach Calculator allows the designer to size stormwater facilities with respect to native infiltration rates and other unique site conditions of the project.

Performance Approach: Must be engineered to meet site-specific stormwater requirements.

Dimensions and slopes: Requirements vary by location and design approach.

Private property requirements: Minimum bottom width is 2 feet where feasible. Basins designed with the Simplified Approach are 12 inches deep measured from the top of the growing medium to the overflow inlet elevation. Basins designed with the Presumptive Approach vary in depth. Maximum side slopes are 3 horizontal to 1 vertical; 4 horizontal to 1 vertical is required immediately adjacent to pedestrian areas. A minimum of 2 inches of freeboard must be provided.

Right-of-way requirements: Minimum bottom width is 2 feet. A minimum of 2 inches of freeboard must be provided. The maximum ponding depth is 9", unless otherwise approved. See Green Street details in Section 2.3.5 for side slope requirements.

Waterproofing/Geosynthetic Liner: Requirements vary by location and design approach.

Private property requirements: Liner must be 30-mil EPDM, HDPE, or approved equal.

Right-of-way requirements: Full or partial liners may be required for protecting adjacent water facilities/utilities, on higher classification streets, in locations with hazardous materials or topography considerations, and in wellhead protection areas. The location determines the required liner thickness, see below. All liners must be attached per the Green Street details in Section 2.3.5. Other methods may be considered where impervious or waterproof facilities are required, such as single-pour concrete forms.

- 30 mil HDPE – water main and road protection.
- 40 mil HDPE – Columbia Southshore Well Field Wellhead Protection Area.

Piping: Requirements vary by location.

Private property requirements: Piping must be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise, a 4-inch pipe minimum is required. Piping installation must follow current Uniform Plumbing Code.

Right-of-way requirements: 6-inch or 8-inch ASTM 3034 SDR 35 PVC pipe and perforated pipe are required. Refer to the City's Sewer and Drainage Facilities Design Manual for more information.

Drainage Layer: Requirements vary by location and design approach.

Simplified Approach requirements: 12" depth of ¾" – 1 ½"washed drain rock must be used. Drain rock and growing medium must be separated a 2- to 3-inch layer of pea gravel.

Presumptive approach on private property requirements: Determined by designer and PAC calculations. Options include, but are not limited to drain mat, 3/4" washed rock, or other approved system. Liner must be 30-mil EPDM, HDPE, or approved equal. Separation between growing medium and drainage layer may be appropriate

filter fabric or a gravel lens (pea gravel 2 to 3 inches deep), or as per approved design.

Right-of-way requirements: 1 ½" - ¾-inch round washed drain rock may be required per PAC calculations. Drain rock and growing medium must be separated a 2-inch to 3-inch layer of ¾-inch to No. 4 open graded aggregate. Geotextile fabric is prohibited.

Growing medium: Requirements vary by location.

Private property requirements: The imported soil must be a sandy loam mixed with compost or a sand/soil/compost blend. It must be roughly one-third compost by volume, free-draining, and support plant growth. The compost must be derived from plant material; animal waste is not allowed. The Stormwater Facility Blended Soil for public facilities is also acceptable, see Section 2.3.6.

If a stormwater management facility is proposed adjacent to property lines or nearby structures, then a lined facility will likely be required. Vegetation planted within water-tight stormwater management facilities cannot compromise the integrity of the facility liner and the facility design must ensure plants will survive. The applicant must coordinate with BES and BDS staff regarding applying BES Stormwater Management Manual requirements, while meeting landscaping requirements. To provide adequate area for plants to grow, vegetation must be planted within a minimum growing medium depth of 24 inches.

Right-of-way requirements: For streets, the Stormwater Facility Blended Soil is specified in Section 2.3.5. The imported growing material must be 18 inches deep, or less, if native soils drain well.

Vegetation: The entire facility area must be planted with vegetation. The facility area is equivalent to the total area of the basin, including bottom and side slopes, as developed in the sizing calculations. See Section 2.4.1 for suggested plant material appropriate for private property and required plant material for the public right-of-way. Basins should be designed so they do not require mowing.

Private property requirements: The entire facility area must be planted with vegetation as per quantities in Figure 2-14 and Figure 2-15. The facility area is equivalent to the total area of the basin, including bottom and side slopes, as developed in the sizing calculations. See Section 2.4.1 for suggested plant material appropriate for private property. Basins should be designed so they do not require mowing.

Figure 2-14. (Private Property) Basin Vegetation - Zone A

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
80	Herbaceous plants	100	#1 container	1.25’
OR				
72	Herbaceous plants	100	#1 container	1.25’
4	Small shrubs	100	#1 container	1’

Figure 2-15. (Private Property) Basin Vegetation - Zone B

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
7	Large to small shrubs	100	#2 container	2’
70	Groundcover	100	#1 container	1’

If the total project area is over 200 square feet consider adding a tree and reducing the number of herbaceous plants and shrubs.

Right-of-way requirements: See Section 2.3.5 for typical Green Street details and planting templates and Section 2.4.1 for Plant List for Public Stormwater Facilities. Plantings adjacent to streets require special attention to line-of-site and maintenance issues. Vegetation should be planted so it does not block traffic sight lines or require mowing. No medium to large shrubs are allowed. Minimum container size is #1 container. Plants to be spaced per Plant List for Public Stormwater Facilities in Section 2.4.1 and requirements on drawing SW-362.

Mulch: Requirements vary by location.

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

Right-of-way requirements: Mulch may be allowed by BES on a case-by-case basis. Mulch will only be allowed on facilities with side slopes that do not have an aboveground overflow drain. Mulch must not inhibit water flow in the flow path, inlets, or outlets. Mulch material must be fine to medium 100% hemlock bark free of dyes or pesticides. Mulch must be applied after beds are clear of weeds and debris, after planting and watering-in of new plants is complete and after the soil surface is brought to a smooth, finished grade. Mulch must be applied in planted areas to an even, uniform depth of 2 inches. Keep mulch off plants, structures, roadways, shoulders, walks, and lawns. Mulch must not cover herbaceous plants or come into contact with the stems of woody shrubs or trees. Mulch surface must be left with a smooth, finished appearance as approved by the City.

Typical Details: See Section 2.3.5 for typical details for basins designed under the Simplified Approach (SW-100's), the Presumptive Approach on private property (SW-200's), and for Green Streets in the public-right-of-way (SW-300's).

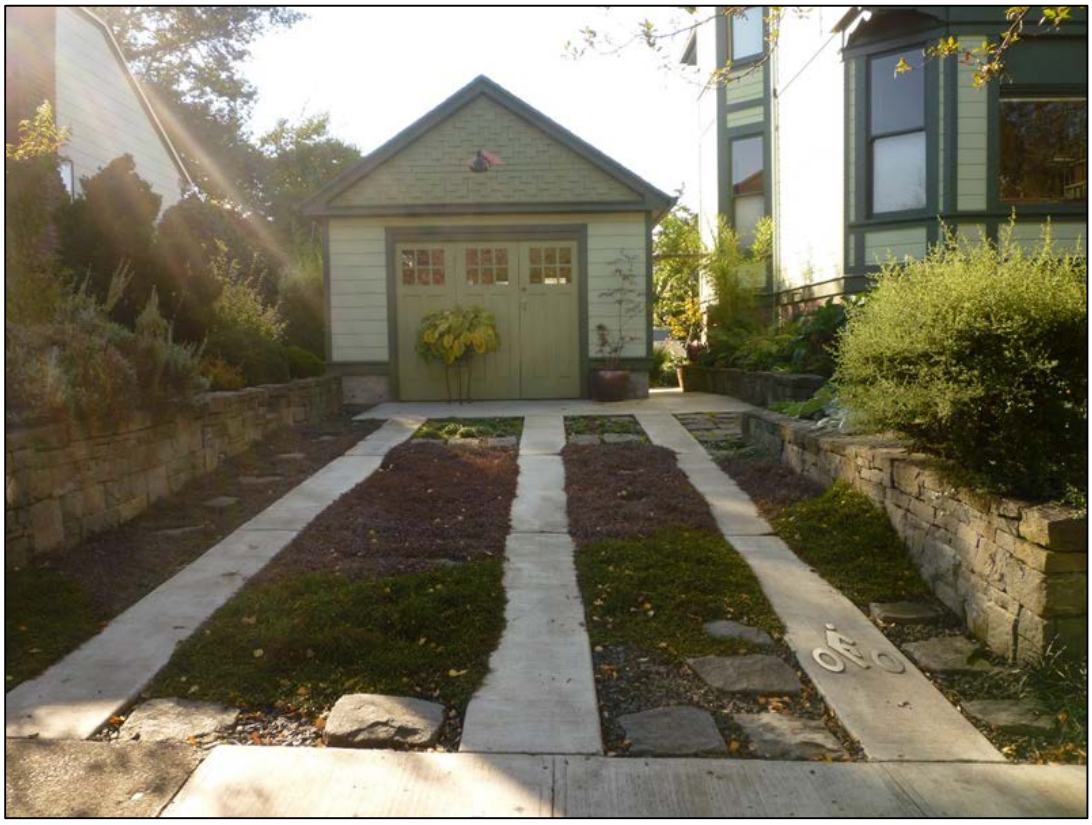
Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Construction Considerations

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

2.3.4.10. Filter Strips



Filter strips are gently-sloped vegetated areas which manage runoff from driveways and walkways, slowing the runoff and allowing it to infiltrate.

Facility Description

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

Driveway center filter strips are used between the drive aisles of residential driveways. They are typically 3 feet wide and placed between two 3-foot-wide paved sections. (The minimum width of a residential driveway is 9 feet, of which the inner 3-foot section could be pervious and used for infiltration as long as all other code requirements are met.) The strip is used exclusively to treat and infiltrate the

stormwater from the impervious area of the drive aisles. The drive aisles must be sloped toward the driveway center filter strip. The driveway center filter strip must be maintained to the required design requirements (including 100 percent landscaping coverage) stated below.

Design Requirements

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

Setbacks: Filter strips are typically 5 feet from the property line; 10 feet from buildings; and 50 feet from wetlands, rivers, streams, and creeks. See Table 2-1 for more information on setbacks.

Sizing: Where the Simplified Approach is applicable, the filter strip is sized at 20 percent of impervious area treated for a maximum of 500 square feet of impervious area to be managed by the filter strip. If the Simplified Approach cannot be used, the Performance Approach will be required for sizing the filter strip, with demonstration of infiltration feasibility.

Dimensions and slopes: Filter strips must slope between 0.5 and 6 percent. Slope of pavement area draining to the strip must be less than 6 percent. Filter strips must have a minimum length of 5 feet, measured in the direction of the flow.

Level spreaders: A grade board or sand/gravel trench may be required to disperse the runoff evenly across the filter strip. The top of the level spreader must be horizontal and at an appropriate height to provide sheet flow directly to the soil without scour. Level spreaders must not hold a permanent volume of runoff. Grade boards can be made of any material that will withstand weather and solar degradation. Trenches used as level spreaders can be filled with washed crushed rock, pea gravel, or sand.

Check dams: If necessary, check dams must be constructed of durable, nontoxic materials such as rock or brick or graded into the native soils. Check dams must be 3 to 5 inches high, and run the length of the filter.

Growing medium: For filters designed with the Simplified Approach or filters on private property, the imported soil must be a sandy loam mixed with compost or a sand/soil/compost blend. It must be roughly one-third compost by volume, free-draining, and support plant growing. The compost must be derived from plant material; animal waste is not allowed. The growing medium must be 12 inches deep for filter strips.

Vegetation: The entire filter strip must have 100 percent coverage by grasses, ground covers, or any combination thereof. See Section 2.4.1 for plant lists.

Typical Details: See Section 2.3.5 for typical details for filter strips (vegetated filters) designed under the Simplified Approach (SW-100's).

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

2.3.4.11. Grassy Swales

Facility Description

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

Grassy swales must be designed and submitted under the Performance Approach (see Section 2.2.3) to meet the site-specific stormwater requirements outlined in Chapter 1.

Design Requirements

Soil suitability: Grassy swales are appropriate for all soil types.

Setbacks: Grassy swales are typically set back 5 feet from centerline of the swale to property lines and 10 feet to building foundations, unless the swale is lined with impermeable fabric. See Table 2-1 for more information on setbacks.

Sizing: The Simplified Approach and Presumptive Approach are not available to size grassy swales. The Performance Approach must be used to meet the below criteria.

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

- Maximum design velocity of 0.9 feet per second.
- Minimum hydraulic residence time (time for Q_{design} to pass through the swale) of 9 minutes.
- A Manning *n* value of 0.25.

A maximum ponding depth of 4" is required to maximize contact with the grass, unless otherwise approved.

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

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

Figure 2-16, Figure 2-17 and Figure 2-18 are derived from the City's Sewer and Drainage Facilities Design Manual to determine minimum required swale length and the swale bottom width given the peak flow rate.

Figure 2-16. Swale Length at 1.5% Longitudinal Slope

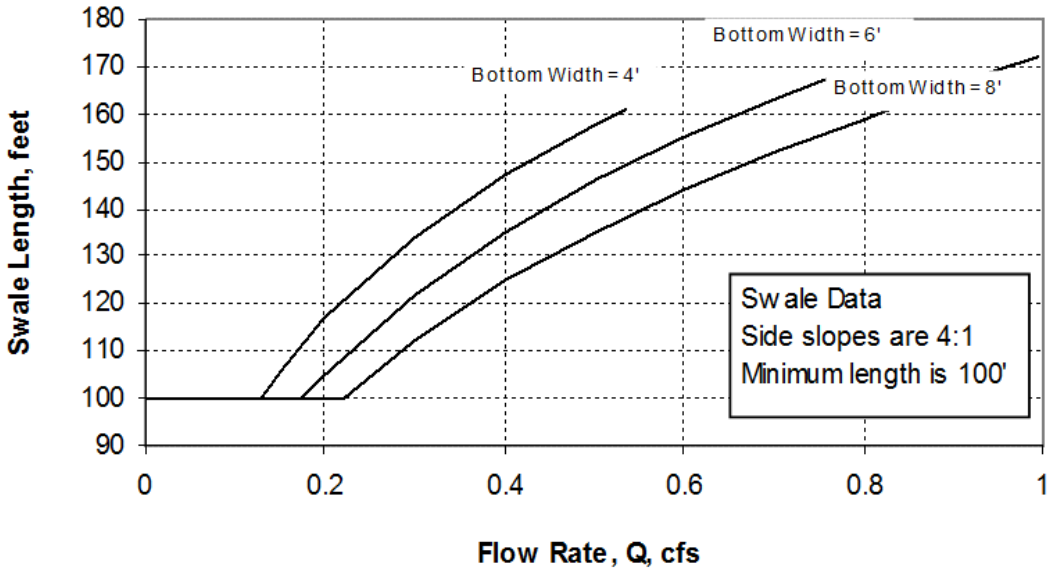


Figure 2-17. Swale Length at 3.0% Longitudinal Slope

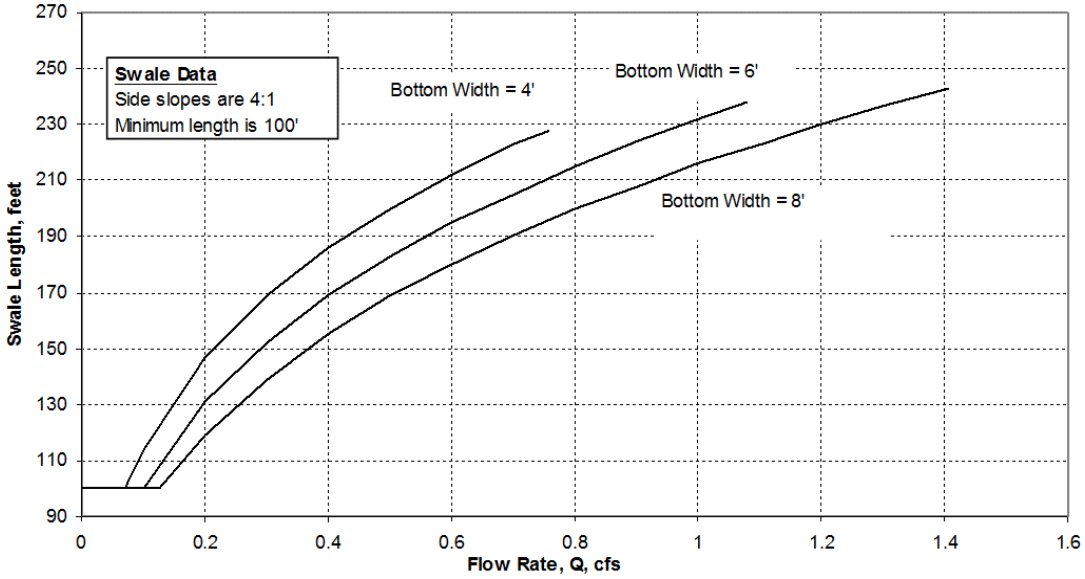
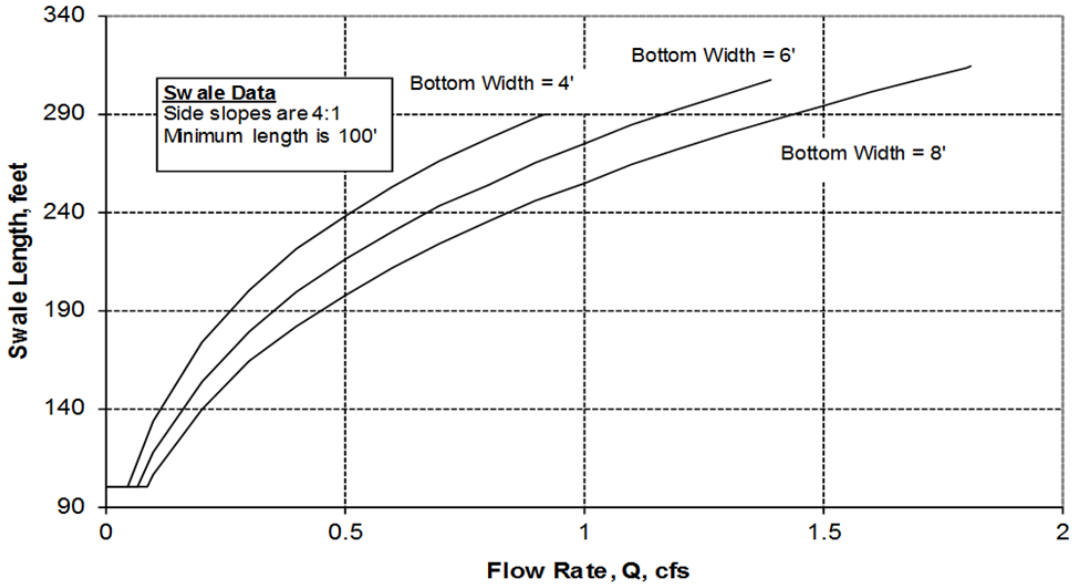


Figure 2-18. Swale Length at 5.0% Longitudinal Slope



Dimensions and slopes: The minimum grassy swale width on private property is 10 feet, with a minimum 2-foot flat bottom. The minimum grassy swale width on public property is 12 feet, with a minimum 4-foot flat bottom. Maximum side slopes for both are 4 horizontal to 1 vertical. The minimum length for both is 100 feet.

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

Flow spreader: The grassy swale must incorporate a flow-spreading device at the inlet. The flow spreader must provide a uniform flow distribution across the swale bottom. In swales with a bottom width greater than 6 feet, a flow spreader must be installed at least every 50 feet.

Check dams: Per design.

Growing medium: Blended topsoil must be used within the top 18 inches of the facility to support plant growth, per specifications in Section 2.3.6.

Vegetation: Grasses must be established as soon as possible after the swale is completed and before water is allowed to enter the facility. Unless vegetation is established prior to completion of construction, biodegradable erosion control matting appropriate for low-velocity flows (approximately 1 foot per second) must

be installed in the flow area of the swale before water is allowed to be conveyed through the swale. Figure 2-19 shows vegetation requirements for grassy swales.

Figure 2-19. (Private Property) Grassy Swale Vegetation

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

For the swale flow path, approved native grass mixes are preferable. Seed must be applied at the rates specified by the supplier. Plants must be established at the time of facility completion (at least 3 months after seeding). Trees and shrubs may be allowed in the flow path within swales if the swale exceeds the minimum length and widths specified. See Section 2.4.1 for more information on trees and shrubs that are appropriate.

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

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Construction Considerations

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

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

2.3.4.12. Ponds

Facility Description

Three types of ponds are described in this section: wet ponds, extended wet ponds, and dry ponds, all of which must be designed and submitted under the Performance Approach (see Section 2.2.3) to meet the site-specific stormwater requirements.

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

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

Extended wet ponds are also constructed with a permanent pool of water, but have additional storage above that fills during storm events and releases water slowly over a number of hours. The permanent pool is sized to provide pollution reduction, and the additional storage above (extended detention area) is sized to meet flow control requirements. Pollutants are removed from stormwater through gravitational settling and biological processes. When the sizing criteria presented in this section are used, pollution reduction requirements are presumed to be met. The extended detention must be designed using acceptable hydrologic modeling techniques (see Section 2.2.3 Performance Approach) to meet applicable flow control requirements.

Dry detention ponds are designed to fill during storm events and slowly release the water over a number of hours. Dry detention ponds must be designed using acceptable hydrologic modeling techniques (see Section 2.2.3 Performance Approach) to meet applicable flow control requirements. Additional facilities are required in order to meet pollution reduction requirements, unless the bottom flow path of the pond is designed as a swale according to the swale sizing and design criteria.

Design Requirements

Location and Ownership: All open ponds to be maintained by the City of Portland must be located in a separate open space tract with public sewer easements dedicated to the City.

Open ponds serving more than one tax lot or designed to function as multi-use/recreational facilities must be located in a separate tract (e.g., Tract A), defined easement, or designated open space.

Instream ponds are not allowed.

Soil Suitability: Detention ponds are appropriate for sites with slow draining soils (less than 2"/hour tested) or for facilities that are fully lined. Sites with well-draining soils (at or over 2"/hour tested) should consider the use of an infiltration basin.

Setbacks: Ponds are typically constructed to maintain the following setback distances from structures and other facilities. (All distances are measured from the edge of the maximum water surface elevation.) See Table 2-1 for more information on Setbacks.

- Minimum distance from the edge of the pond water surface to property lines and structures: 20 feet, unless an easement with adjacent property owner is provided.
- Distance from the toe of the pond berm embankment to the nearest property line: one-half of the berm height (minimum distance of 5 feet).
- Minimum distance from the edge of the pond water surface to septic tank, distribution box, or septic tank drain field: 100 feet.
- Surrounding slopes must not exceed 10 percent. Minimum distance from the edge of the pond water surface to the top of a slope greater than 15 percent: 200 feet, unless a geotechnical report is submitted and approved by BES.
- Minimum distance from the edge of the pond water surface to a well: 100 feet.

Access: Access routes to the pond for maintenance purposes must be shown on the plans. Public ponds must provide a minimum 12-footwide access route, not to exceed 10 percent in slope. An eight-foot wide access route is allowed with approval.

Sizing:

- Wet and extended wet detention ponds should be designed for large drainage areas (5 to 150 acres) to help avoid problems associated with long periods of stagnant water.
- For wet and extended wet detention ponds, a water budget must be submitted for review. The water budget must demonstrate that the base flow to the pond is sufficient such that water stagnation/alga matting will not become a problem.
- Wet and extended wet detention permanent pool sizing: The permanent pool (or dead) storage volume, V_{pond}, is equivalent to twice the runoff volume generated by a storm of 0.83 inch over 24 hours (NRCS Type 1A rainfall distribution). This volume can be approximated using the following formula:

  Volume = 2 x (2,276 x Impervious Acreage)

  Where Volume = permanent pool volume, cubic feet and Impervious Acreage = area of impervious surfaces to manage, acres

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

Note: Because of minimum orifice size requirements (2 inches for public facilities, 1 inch for private facilities), detention facilities that rely on orifice structures to control flows for small projects (under 15,000 square feet of impervious development footprint area) are not allowed.

Control structure design: Weir and orifice structures must be enclosed in a catch basin, manhole, or vault and must be accessible for maintenance.

The control structure must be designed to pass the 100-year storm event as overflow, without causing flooding of the contributing drainage area.

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

Orifices: Orifices may be constructed on a “tee” riser section.

The minimum allowable diameter for an orifice used to control flows in a public improvement is 2 inches. Private facilities may use a 1-inch-diameter orifice if additional clogging prevention measures are implemented. The orifice diameter must always be greater than the thickness of the orifice plate.

Multiple orifices may be necessary to meet the 2- through 25-year design storm performance requirements for a detention system. However, extremely low flow rates may result in the need for small orifices (< 1 inch for private facilities, < 2 inches for public) that are prone to clogging. In these cases, retention facilities that do not rely on orifice structures must be used to the maximum extent practicable to meet the site-specific flow control requirements. Large projects may also result in high flow rates that necessitate excessively large orifice sizes that are impractical to construct. In such cases, several orifices may be located at the same elevation to reduce the size of each individual orifice.

Orifices must be protected within a manhole structure or by a minimum 18-inch-thick layer of 1½- to 3-inch evenly graded, washed rock. Orifice holes must be externally protected by stainless steel wire screen (hardware cloth) with a mesh of ¾ inch or less. Chicken wire must not be used for this application.

Orifice diameter must be greater than or equal to the thickness of the orifice plate.

Orifices less than 3 inches must not be made of concrete. A thin material (e.g., stainless steel, HDPE, or PVC) must be used to make the orifice plate; the plate must be attached to the concrete or structure.

Orifice Sizing Equation:

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

where:
Q = Orifice discharge rate, cubic feet per second (cfs)
C = Coefficient of discharge, feet (suggested value = 0.60 for plate orifices)
A = Area of orifice, square feet
h = hydraulic head, feet
g = 32.2 ft/sec2

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

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

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

Rectangular Notched Sharp Crested Weir:

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

where:
Q= Weir discharge, cfs
C = 3.27 + 0.40×H/P, feet
P = Height of weir bottom above downstream water surface, feet
H = Height from weir bottom to crest, feet
L = Length of weir, feet*
* For weirs notched out of circular risers, length is the portion of the riser circumference not to exceed 50 percent of the circumference.

V-Notched Sharp Crested Weir:

$$Q = C_d\,(\text{Tan}\,\frac{\theta}{2})\,H^{\frac{5}{2}}$$

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

Dimensions and slopes: Slopes and depth should be kept as mild as possible to avoid safety risks. Slopes within the pond must not exceed 3 horizontal to 1 vertical.

The maximum depth of the pond must not exceed 4 feet. The 0- to 2-foot depth must be distributed evenly around the perimeter of the pond.

The distance between all inlets and the outlet must be maximized to facilitate sedimentation. The minimum length-to-width ratio is 3:1, at the maximum water surface elevation. This ratio is critical to prevent "short-circuiting," where water passes directly through the facility without being detained for any length of time. If area constraints make this ratio unworkable, baffles, islands, or peninsulas may be installed, with City approval, to increase the flow path and prevent short circuiting.

Minimum freeboard must be 1 foot above the highest potential water surface elevation (1 foot above the emergency overflow structure or spillway elevation).

Dry detention ponds must be divided into a minimum of two cells. The first cell (forebay) must contain approximately 10 percent of the design surface area and must provide at least 0.5 foot of dead storage for sediment accumulation.

Wet and extended wet detention ponds must be divided into a minimum of two cells. The first cell (forebay) must contain approximately 10 percent of the design surface area.

Outlet/overflow: If a riser pipe outlet is used, it must be protected by a trash rack and anti-vortex plate. If an orifice plate is used, it must be protected with a trash rack with at least 10 square feet of open surface area. In both cases, the rack must be hinged or easily removable to allow for cleaning. The rack must be adequately secured to prevent it from being removed or opened when maintenance is not occurring.

All ponds must have an emergency overflow spillway or structure designed to convey the 100-year, 24-hour design storm for post-development site conditions, assuming the pond is full to the overflow spillway or structure crest. The overflow must be designed to convey these extreme event peak flows around the berm structure for discharge into the downstream conveyance system. The overflow must be designed and sited to protect the structural integrity of the berm. This will ensure that catastrophic failure of the berm is avoided, property damage is avoided, and water quality of downstream receiving water bodies is protected.

The subgrade of the spillway must be set at or above the 100-year overflow elevation of the control structure. The spillway must be located to direct overflows safely toward the downstream conveyance system and must be located in existing soil wherever feasible. The emergency overflow spillway must be armored with riprap or other flow-resistant material that will protect the embankment and minimize erosion. Riprap must extend to the toe of each face of the berm embankment. The emergency overflow spillway weir section must be designed for

the maximum design storm event for post-development conditions, using the following formula:

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

where:

L = Length of bottom of weir, feet

Q_{100} = 100-year post-development flow rate, cfs

H = Height of emergency overflow water surface, feet

Berm embankment/soil stabilization: Pond berm embankments must be designed by a civil engineer licensed in the State of Oregon.

Pond berm embankments must be constructed on native consolidated soil (or compacted and stable fill soil) that is free of loose surface soil materials, roots, and other organic debris. Topsoil is required over the consolidated soil to support required plantings.

Pond berm embankments must be constructed by excavating a key equal to 50 percent of the berm embankment cross-sectional height and width, measured through the center of the berm. The berm must be keyed into the native soil by excavating a trench below the berm. This keys the berm into the native soil and prevents it from sliding.

The berm embankment must be constructed of compacted soil (95 percent maximum dry density, Modified Proctor Method per ASTM D1557) placed in 6- to 8-inch lifts with hand-held equipment, or 10- to 12-inch lifts with heavy equipment.

Anti-seepage collars must be placed on outflow pipes in berm embankments that impound water greater than the designed depth of the pond. During construction, exposed earth on the pond side slopes must be seeded with appropriate seed mixture. Establishment of protective vegetative cover must be ensured with appropriate surface-protection best management practices (BMPs) and reseeded as necessary. See the City of Portland's Erosion Control Manual.

Pond embankments must be constructed with a maximum slope of 3H: 1V on the upstream and downstream face. Side slopes within the pond must be sloped no steeper than 3H: 1V. The use of retaining walls in ponds requires preapproval from BES. Retaining walls must not exceed one-third of the circumference of the pond.

Detailed structural design calculations must be submitted with every retaining wall proposal.

Pond berm embankments 6 feet or less in height (including freeboard), measured through the center of the berm, must have a minimum top width of 6 feet, or as recommended by a geotechnical engineer.

Where maintenance access is provided along the top of berm, the minimum width of the top of berm must be 15 feet.

Growing medium: Because pond grading generally requires the topsoil to be removed to form the basin shape of the pond, the resulting top layers of soil must to be amended, or topsoil must be brought back in to ready the soil for planting. Topsoil must be used within the top 12 inches of the facility, or the soil must be amended to support plant growth.

Vegetation: The planting design must minimize solar exposure of open water areas. Trees or other appropriate vegetation must be located around the east, south, and west sides of the facility to maximize shading. Reducing solar exposure has two benefits: it helps reduce heat gain in water before discharging to a receiving water, helping it maintain a healthy and aesthetic pond condition, reducing algae blooms and the potential for anaerobic conditions to develop.

The facility area is equivalent to the area of the pond, including bottom and side slopes, plus the 10-foot buffer around the pond. The emergent plant zone must be at least 25 percent of the total pond water surface area. Minimum plant material quantities are shown in Figure 2-20 and Figure 2-21.

Figure 2-20. Pond Vegetation - Emergent Plants

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
115	Wetland plants	100	6” plugs	1’
OR				
100	Wetland plants	100	6” plugs	1’
4	Small shrubs	100	#1 container	3’
OR				
100% seed coverage				

Figure 2-21. Pond Vegetation - Side Slopes and Buffers

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
1	Evergreen tree	300	Min 6’ height	
OR				
1	Deciduous tree	300	1 ½” caliper at 6” above base	
AND				
4	Large shrubs	100	#3 container	4’

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

For plant selection, see Section 2.4.1.

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

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

For both private and City-maintained facilities where fencing is used, fences must be at least 6 feet high. The six-foot height may not be required in situations where fences are not needed to prevent climbing (e.g., on steep slopes where they are needed to prevent slipping). For City-maintained facilities, a minimum of one vehicular locking access gate must be provided. It must be 12 feet wide, consisting of two swinging sections each six feet wide. At least one pedestrian gate must be provided, with a minimum four-foot width.

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

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

2.3.4.13. Sand Filters

Facility Description

Sand filters, like planters, are structural landscaped reservoirs used to collect, filter, and infiltrate stormwater, allowing pollutants to settle and filter out as the water percolates through the sand and gravel. They can be constructed above, at, or below grade. Depending on site conditions, sand filters can be designed to completely infiltrate all the stormwater they receive, as partial infiltration facilities where only a portion of the flow is infiltrated and overflow is directed to an approved discharge location, or as a fully lined facility. If designed as a subsurface sand filter, the sand filter may be considered a UIC under DEQ regulations (see Section 1.3.3 for more information on UIC requirements).

Sand filters must be designed and submitted under the Performance Approach (see Section 2.2.3) to meet the site-specific stormwater requirements outlined in Chapter 1.

Design Requirements

Soil suitability: Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to be conveyed through the facility. See Section 2.3.6 for infiltration testing procedures. If the tested infiltration rate is less than 2 inches per hour, the sand filter should be designed as a partial infiltration facility, with an overflow to an approved discharge location.

Setbacks: Infiltration sand filters typically have 5-foot setbacks from property lines and 10-foot setbacks from building foundations. No setbacks are required for lined sand filters where the height above finished grade is 30 inches or less. Lined sand filters can be used next to foundation walls, adjacent to property lines, or on slopes. See Table 2-1 for more information on setbacks.

Sizing: Sand filters must be designed to meet the stormwater management requirements as specified in Chapter 1. Sand filters must be designed to pond water for less than 4 hours after each storm event.

Dimensions and slopes: The minimum lined sand filter width is 18 inches, and the minimum infiltration planter width is 30 inches. The minimum sand filter depth is 18 inches. Sand filters are relatively flat facilities that must not slope more than 0.5 percent in any direction. Where the facility is at or above grade, the storage depth must be at least 12 inches between the top of the filter medium and the base of the

overflow, unless a larger-than-required planter square-footage is used. For subgrade facilities, the filter medium must be 30 inches deep, with 8 inches of gravel above and below for conveyance. A minimum of 2 inches of freeboard (vertical distance between the overflow inlet elevation and overtopping elevation) must be provided.

Walls: Walls must be concrete unless otherwise approved. For facilities that require an impervious bottom, a single-pour concrete solution is preferred. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater may not be used.

Waterproofing (if required): If walls are monolithically poured, no additional liner/waterproofing is required. Check state structural requirements for foundations.

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

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

Drainage Layer: Drain rock is required below the sand. For infiltration facilities where drain rock is specified to retain stormwater prior to infiltration, the specification is 1½-to ¾-inch washed drain rock. Where drain rock is specified primarily for detention and conveyance, the specification is ¾-inch washed drain rock. All lined facilities must use ¾-inch washed drain rock. Drain rock and must be separated by geotextile fabric or use a 2- to 3-inch layer of ¾- to ¼-inch washed, crushed rock.

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

For public sand filters, the following additional criteria apply:

- The sand filter must consist of an inlet structure, sand bed, underdrain piping, and liner.

- The inlet structure must spread the flow of incoming water uniformly across the surface of the filter medium during all anticipated flow conditions. This flow must be spread in a manner that prevents roiling or otherwise disturbing the filter medium.
- The sand bed length-to-width ratio must be 2:1 or greater.
- The sand bed filter medium must be certified by a testing laboratory as meeting the gradation specifications in Figure 2-22. The sand bed filter mediums must consist of clean medium to fine sand with no organic material or other deleterious materials.

Figure 2-22. Filter Bed Gradation Specification

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

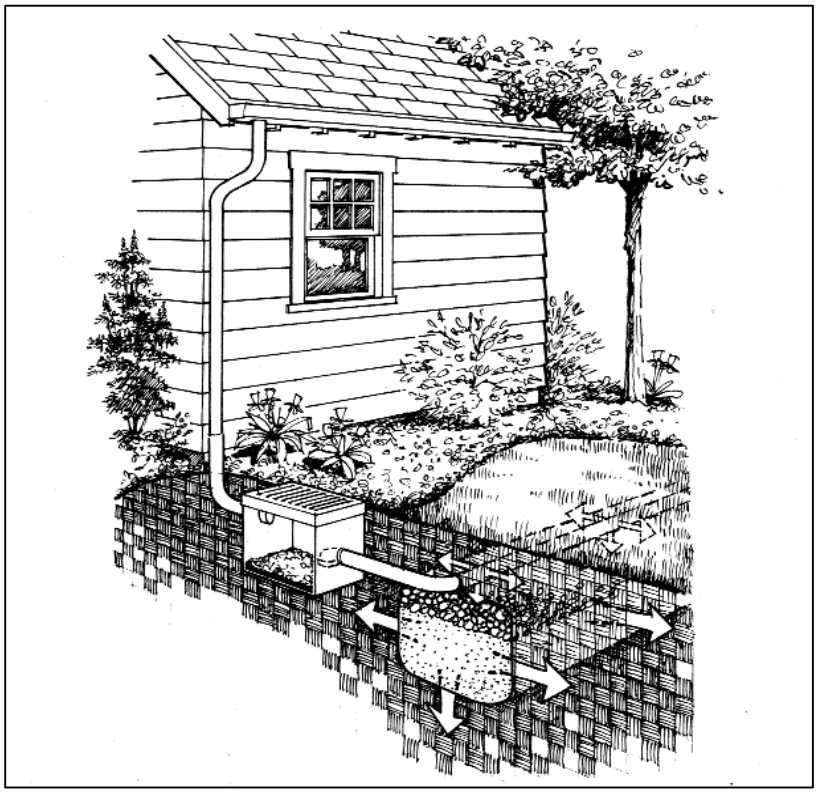
Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Construction Considerations

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

2.3.4.14. Soakage Trenches



Soakage trenches allow water to soak into the ground through underground trenches.

Facility Description

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

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

Underground Injection Control (UIC)

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

For more information about UIC requirements, refer to Section 1.3.3 or visit DEQ's website.

Design Requirements

Soil suitability: Soil conditions are critical to the success of soakage trenches. Submission of infiltration test results is required and must be approved by BES. Infiltration test results must be recorded on the Simplified Approach Form where the Simplified Approach is applicable and otherwise in the Stormwater Management Report (see Section 2.4). Supporting geotechnical analysis is required for slopes of 20 percent or greater, or when requested.

A 2-inch/hour infiltration rate is required at the facility base.

All trenches must be constructed in native soil and must not be subject to vehicular traffic or construction work that will compact the soil, thus reducing permeability.

There must be a 5-foot separation distance from the bottom of the trench to any impervious layer or water table. Soakage trenches are not allowed in areas of shallow groundwater where the separation distance from the bottom of the trench to seasonally high groundwater is less than 5 feet.

Setbacks: Soakage trenches typically have 5-foot setbacks from property lines and 10-foot setbacks from building foundations, unless an appeal is approved by BDS. One hundred-foot setbacks are typical for slopes 20 percent or greater. See Table 2-1 for more information on setbacks. Trenches may not be constructed under current or future impervious surfaces.

Sizing: Sizing requirements vary by design approach. Pore space of the fill material should be 30 percent, with vertical infiltration area only. The trench must infiltrate the entire design storm without overflow. The maximum impervious area to be served by a soakage trench is 10,000 square feet.

Simplified Approach: Soakage trenches are designed with minimum infiltration rate of 2.00 inches per hour. The minimum length is 20', width is 2.5' and depth is 1.5'

Performance Approach: Design by professional per hierarchy requirements. Minimum drawdown time for a soakage trench is 10 hours.

Drainage Layer: A minimum of 12 or 18 inches of open graded washed ¾- to 2½-inch round or crushed rock separated from soil by one layer of geotextile fabric.

Geotextile fabric: Use appropriate filter fabric between the medium and native soils and covering the perforated pipe to prevent clogging.

Piping: The solid conveyance piping from a building or other source must be installed at a ¼-inch per linear foot slope prior to connection with perforated pipe.

A minimum 12-inch cover is required from the top of all piping to the finished grade. All piping within 10 feet of a building must be 3-inch sch. 40 ABS, sch. 40 PVC, or cast iron for rain drain piping serving 1,500 square feet or less of impervious area. For an area greater than 1,500 square feet, 4-inch pipe must be used.

The pipe within the trench must be either PVC D2729 or HDPE leach field pipe. Perforated pipe must be laid on top of gravel bed and covered with geotextile fabric.

Traps: Lynch-style catch basins are required for soakage trenches to meet the "Discharge to UIC" criteria in Section 1.3.3. Silt traps are optional for all installations and are strongly encouraged because they will lengthen the life of the facility. If installed, the silt trap must be between the dwelling and the trench, a minimum of 5 feet from the dwelling.

Gravel Pits

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

Manufactured Chamber Technologies

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

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

Sizing: Where the Simplified Approach can be used, the chambers must be designed to at least the same requirements as trenches. Pore space of the fill material is assumed to be 0.30. Figure 2-23 shows manufactured chamber technologies dimensions.

Figure 2-23. Manufactured Chamber Technology Dimensions

Impervious Area Ratio	Design Infiltration Rate (in/hr)	Length (in)	Width (in)	Height (in)
1 per 600sf IA*	2.00	~90	34	16 + 6” base rock

Based on standard chamber sizing

Setbacks: Manufactured chambers are typically 10 feet on center from all foundations and 5 feet from property lines. See Table 2-1 for more information on setbacks.

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

Typical Details: See Section 2.3.5 for typical details for soakage trenches designed under the Simplified Approach (SW-100's).

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Construction Considerations

Soakage trench areas must be clearly marked before site work begins to avoid soil disturbance during construction. No vehicular construction traffic, except that specifically used to construct the facility, should be allowed within 10 feet of soakage trench areas.

The bottom of the soakage trench must be level, or clay check dams may be used to prevent water from collecting near the downstream end. Soakage trench and perforated pipe must be installed level and parallel to the contour of the finish grade.

2.3.4.15. Drywells

Drywells allow stormwater to soak into the ground through underground rings (above shows drywell ring being lowered into ground).

Facility Description

The typical drywell is a precast concrete ring in 5-foot-tall sections perforated to allow for infiltration. These facilities are vertical in nature and can range from 5 to 20 feet in depth. Drywells require a minimum of 5 feet of vertical separation between the bottom of the drywell and seasonal high groundwater (see Section 2.3.6 for determining depth to groundwater). Drywells should not be located in dense silt or clay soils, and may only be located in areas with soils suitable for infiltration.

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

Underground Injection Control (UIC)

Drywells are "Class V Injection Wells" under the federal UIC regulations. These facilities must be registered with Oregon DEQ and classified as exempt, authorized by rule, or authorized by permit. Since the UIC Program states that drywells can have a direct impact on groundwater, pollution reduction is required before discharging stormwater into them (unless they are used exclusively for residential roof runoff from two units or less or pedestrian-only plaza areas on private property).

For more information about UIC requirements, refer to Section 1.3.3 or visit DEQ's website.

Design Requirements

Soil suitability: Soil conditions are critical to the success of drywells. An infiltration test or bore-log feasibility test must be performed and the results submitted to BES for approval. The Simplified Approach Form (See Section 2.4.3) must be completed and signed by the applicant, where applicable; otherwise, the sizing and infiltration must be accounted for in the Stormwater Management Report using the Performance Approach and the Rational Method. Drywells should be used only if the soils infiltrate at least 2 inches per hour or with documented approval from BES. Installation of drywells in fill material is not permitted. All drywells must be installed in native soils. Supporting geotechnical evidence is required for all slopes of 20 percent or greater or when requested.

Setbacks: The drywell is typically 10 feet on center from all foundations and 5 feet from property lines. The top of the perforated drywell sections must be located downgrade from foundations and at a lower elevation than local basements. See Table 2-1 for more information on setbacks. Drywells sized using volume as part of the calculation must keep the maximum water surface elevation for the required design storm at least 1-foot below the lowest finished floor elevation (including that of neighboring properties).

If drywell is approved for within building setbacks or under building foundations via plumbing code appeal, it will require design to accommodate 100-year storm event in lieu of an escape route. In addition, system capacity must be protected with sedimentation control devices and the O&M must specify requirements that will protect long-term capacity and escape routes. For infiltration systems proposed underlying structures, a geotechnical report will be required which addresses the

effect of the system on the performance of the foundation as well as the effect of foundations loads on the infiltration system.

Drywells sized using the Performance Approach that have more than the typical 12-inches of rock around the ring must measure setbacks from the edge of the rock gallery or get approval from the geotechnical and structural engineers to place the drywell closer to foundations.

Sizing: Varies by approach.

Simplified Approach: The chart provided in Figure 2-24 must be used to appropriately size the drywell(s) based on the amount of impervious area that each drywell is designed to manage. Dark gray boxes indicate acceptable.

Figure 2-24. Drywell Sizing Chart

Impervious Area (sf)	28" Diameter				48" Diameter			
	5'	10'	15'	20'	5'	10'	15'	20'
1000								
2000								
3000								
4000								
5000								
6000								
7000								
8000								
9000								
10000								
11000								
12000								

Performance Approach Allowable Calculations: Drywells can be sized on a flow-rate basis or a single storm hydrograph-based analysis. Flow-rate based facility design must use the Rational Method and may only count the bottom area when determining infiltration capacity. Hydrograph-based designs should use a time-based model and may account for storage within the drywell and in the associated rock gallery.

In all cases infiltration rates can be calculated using the bottom area of the drywell and rock gallery. Infiltration rates through side-walls may be accounted for if a time-

based model is used for the sizing and a geotechnical engineer determines it is appropriate for the local soils. Fine grained soils can be smeared during construction, this prevents infiltration and may be difficult to control for. Upper layers of soil may have different infiltration rates than deeper soils. These factors must be considered when making the decision to include side-wall infiltration rates.

Traps: Lynch-style catch basins are required for drywells to meet the "Discharge to UIC" criteria in Section 1.3.3. Silt traps are optional for all installations and are strongly encouraged because they will lengthen the life of the facility. If installed, the silt trap must be between the dwelling and the drywell, a minimum of 5 feet from the dwelling.

Manufactured Plastic Drywells

Manufactured plastic "mini-drywells" are made of hard plastic (foam polyolefin) and are very versatile. The excavations for these facilities can be hand-dug, and the drywells can be placed by hand rather than using equipment (as with typical concrete drywells).

Dimensions: Two-foot diameter, two-foot depth, plus one-foot gravel lens below and on the sides.

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

Setbacks: From center:

One unit: Five feet to property line, eight feet to any foundation, and 20 feet to existing cesspools.

Multiple units or in-line units: Five feet to property line, ten feet to any foundation, and 20 feet to existing cesspools.

Typical Details: See Section 2.3.5 for typical details for drywells designed under the Simplified Approach (SW-100's).

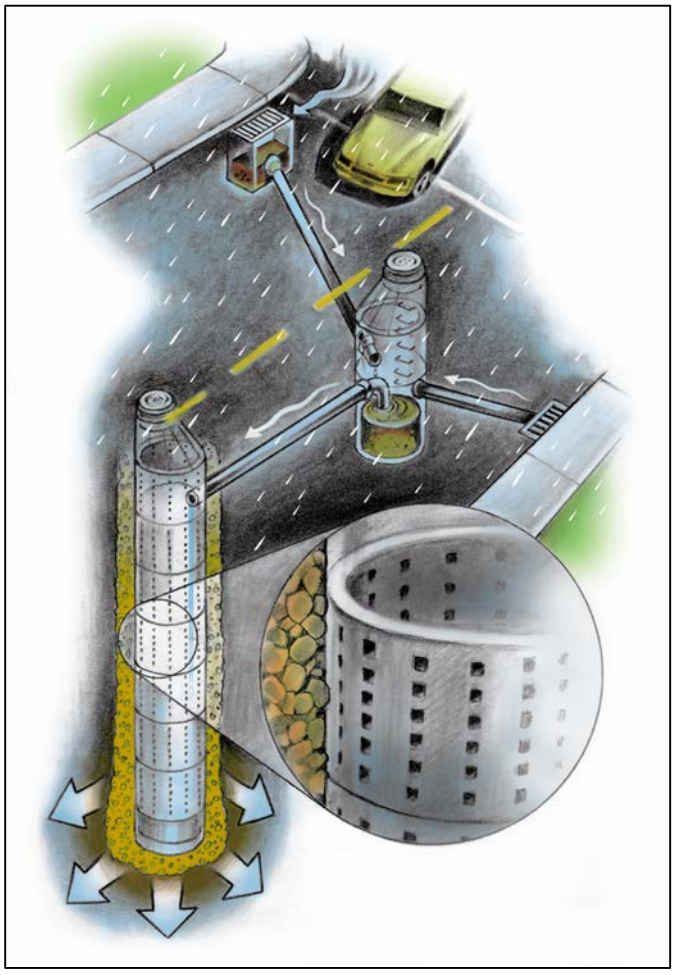
Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Construction Considerations

If smooth excavation tools are used, scratch the sides and bottom of the excavation hole with a sharp pointed instrument and remove the loose material from the bottom of the excavation. This will break-up any smearing that could potentially limit infiltration rates.

2.3.4.16. Sumps



A sump allows stormwater to infiltrate into the ground through underground rings.

Facility Description

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

Underground Injection Control

Sumps are "Class V Injection Wells" under the federal UIC Program. These facilities must be registered with DEQ and authorized by rule or authorized by permit. In the case of City sumps, BES administers the rule authorization process with DEQ.

For more information about UIC requirements, refer to Section 1.3.3 or visit DEQ's website.

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

Sedimentation manholes with oil traps receive runoff from inlets before stormwater enters the sumps. The sedimentation manholes settle out most of the large particulate material that can clog sump drainage holes, which decreases maintenance needs and increases long-term effectiveness. Detailed drawings of a standard sump and standard sedimentation manhole can be found in the City of Portland Standard Drawings and Details P-160 thru P-162.

When constructed according to the standard design procedures, the sump system achieves pollution reduction benefits. The sedimentation manhole reduces pollution through removal of sediment, oils, and grease. Other types of facilities (e.g., swales or planters) may be used to provide pollution reduction instead of sedimentation manholes and may be required in certain circumstances (see Section 1.3.3 for criteria about discharging to UICs).

Sump systems are excluded from use within the following specific areas and land use types within the City:

- Major City traffic streets (including district collectors) in combined sewer areas, or neighborhood collectors in commercially zoned areas (Refer to Transportation Element, Comprehensive Plan, Office of Transportation, 2000).
- Additional requirements may be applicable within designated Wellhead Protection Areas (see Section 1.1.3).

Design Requirements

Soil suitability: Soil conditions are critical to the success of sump systems. The use of sumps will not be approved without supporting geotechnical evidence and a documented sump test to demonstrate they will work in the particular area of interest. The geotechnical evidence must include test sump data to provide information about local underground soil conditions and the potential infiltration capacity of the surrounding soil.

Sizing: Public sump systems must be designed to handle twice the flow from the calculated design storm.

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

Dimensions:

- A maximum of two sumps must be used in series, unless approved by BES.
- The minimum distance between sumps must be 25 feet.
- The desired distance between the sump and sedimentation manhole is 25 feet. This figure is a guideline and depends on site conditions.
- Sumps must not be located in areas with a constant or seasonally high groundwater table or shallow bedrock. The bottom of the sump must be at least 5 feet above the seasonal high water table and at least 3 feet above bedrock.
- Sumps must not be located within 200 feet from the tops of slopes more than 10 feet high and steeper than 2h:1v.
- The sump depth must be 30 feet, unless otherwise approved by BES.
- The sedimentation manhole depth must be 10 feet.

Piping: The diameter of pipe between the sump and sedimentation manhole must be 12 inches. Note: The pipe leaving the sedimentation manhole is fitted with a 90-degree short-radius elbow. See City of Portland Standard Drawings and Details P-160 thru P-162.

See the City of Portland Sewer and Drainage Facilities Design Manual for acceptable pipe material types between the sump and sedimentation manhole.

Typical Details: See City of Portland Standard Drawings and Details P-160 thru P-162 typical details.

Public Sump System Testing

Before being accepted by the City, all public sumps must be tested after construction to ensure they meet or exceed the design capacity. Standard sump notes on the plan set are required to document design rates and sump testing. See Figure 2-26 for plan set standard language.

The City may require the engineer or qualified design professional to supply a sump testing table (see Figure 2-25) to determine if the sump is performing as designed or if an additional sump may be required.

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach.

Figure 2-25. Sump Data Table

Sump Number	Sheet No.	DEQ ID	UIC Registration ID	Min. Percolation Rate Required (GPM)	Hydrant Location for Sump Testing	Testing Flow Rate (GPM)	R/W Drainage Area (sf)

Figure 2-26. Standard Sump Notes for Plan Set

1. Design flows reflect a factor of safety of 2.
2. All sumps must be tested by the contractor as directed and approved by the BES field Inspector.
3. Sump testing must take place after sump construction is complete and before the construction of the sedimentation manhole. Should a sump test fail to verify adequate capacity, an additional sump, constructed in series with the first sump (a maximum of two sumps per system) must be required. Should a test of two sumps in series fail to verify adequate capacity, an alternative public stormwater destination must be required, as approved by BES.
4. Notify BES field inspector and BES Construction Manager at least 48 hours before beginning sump testing. A BES representative must be present during all sump capacity tests.
5. BES will contact the Portland Water Bureau or applicable water district to arrange for sump test water supply and obtain the necessary permits. Upon receipt of hydrant permit, the Contractor can contact BES Materials Testing Laboratory (MTL) and make arrangements to lease sump testing equipment. Contractor can also lease similar testing equipment from any vendor with BES approval.
6. MTL Sump testing equipment is subject to leasing conditions and fees. Note that sump capacity tester is available on a first come – first served basis. The tester and pipe trailers may be rented per day for a maximum of two days per written application. Contact MTL, located at 1405 N River, at (503) 823-2340. Insurance on the MTL leased equipment is required.
7. Provide water flow from fire hydrants to sump being tested using an 8-inch nominal diameter pipe. Deliver clean potable water to sumps. Introduction of sediment is not acceptable and may result in failure of sump capacity test and reconstruction of sump.
8. The test may be completed using flow from one fire hydrant. However, a second fire hydrant may be necessary to complete the sump test.
9. Fill sump with water at an initial rate of 300 gallons per minute (gpm), and record water elevation below sump rim after five minutes. Maintain initial flow rate and continue taking recordings of the water elevation at five-minute intervals until the water surface reaches a constant elevation. Then increase flow rate by 300 gpm, and record the water elevation at the new flow rate as described in the initial process. Continue the sump test by increasing the flow rate at increments of 300 gpm until the sump has reached its maximum capacity.
10. Upon completion of each sump test, compare tested sump capacity flow rate to the minimum flow rate noted in the Plans. Notify Owner immediately if tested flow rate is less than the minimum flow rate listed.
11. Contractor must sign the sump testing results and submit to the BES field inspector.
12. The closest fire hydrant for sump tested is located at the intersections as shown in the Sump Data Table.

2.3.4.17. Manufactured Stormwater Treatment Technologies

Facility Description

The City of Portland maintains a list of approved manufactured stormwater treatment technologies for use under the Performance Approach in meeting pollution reduction requirements when discharging to stormwater-only systems. Use of a vegetated stormwater facility must be demonstrated as infeasible in order for BES to approval use of a manufactured stormwater treatment technology. The list of approved manufactured stormwater treatment technologies is posted on the BES website and includes unit sizing to meet the City's pollution reduction requirements and any required conditions of use.

Manufactured stormwater treatment technologies on BES's approved list must be designed and constructed in accordance with the manufacturer's specifications. Each site plan must undergo manufacturer review before the City of Portland can approve the design for site installation. A letter that certifies that the project has been designed to manufacturer's specifications must be submitted to BES prior to the appropriate design milestone. For public improvements, including Public Works Permits, the letter must be submitted to BES prior to 60% plan review. For installation on private property, the letter must be submitted prior to building permit plan approval.

Manufactured stormwater treatment technologies not on the approved list can be submitted using the Performance Approach for site-specific review and approval. Site specific approval under the Performance Approach is site-specific and does not imply any wider approval or precedent.

Submittal Requirements

In addition to design calculations provided in the Stormwater Management Report (see Section 2.4.5 for Performance Approach Requirements), the following must be submitted with each project proposing use of a manufactured stormwater treatment technology:

- Flow-rate calculations to demonstrate that the MSTT will perform within the approved sizing standards.
- Identification of high flow bypass.
- Facility dimensions and setbacks from property lines and structures.
- Profile view of facility, including typical cross-sections with dimensions.

- All stormwater piping associated with the facility, including pipe materials, sizes, and slopes.
- High-flow or overflow bypass.
- Any necessary documentation to demonstrate compliance with the specific Conditions of Approval for that device.

Construction Considerations

Manufacturers may require use of specific installers and/or techniques. Any manufactured stormwater treatment technology must be installed as per manufacturers' specifications.

2.3.4.18. Rainwater Harvesting

Facility Description

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

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

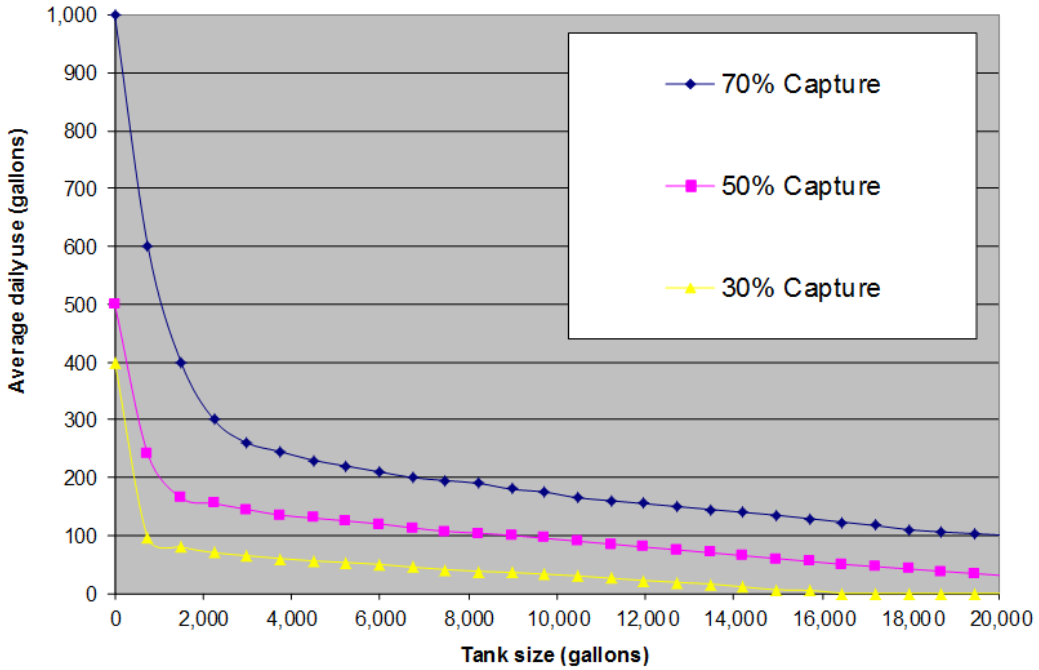
Rainwater harvesting can provide the following stormwater management benefits:

Flow control: In many areas of the City where onsite infiltration is not feasible and the only means of stormwater destination is offsite flow to a combination sewer system, rainwater harvesting can provide volume-reduction benefits. Depending on the size of the water storage facility and the rate of use, a percentage of the annual runoff volume can be reused. Where it is not feasible for rainwater harvesting to meet a development site's full stormwater management obligation, it can be used to manage a portion of the flow and lessen the overall stormwater management requirement.

Design Considerations

Figure 2-27 represents an analysis of a 5,000-square-foot project site with 100 percent impervious surface. The analysis used 8.5 months of 5-minute rainfall intensity data from the Fernwood rain gage in Portland and shows the relationship between water storage volume and average daily water use rate for average annual runoff capture goals of 30, 50, and 70 percent.

Figure 2-27. Rainwater Harvesting Average Annual Stormwater Runoff Capture Rates (5,000 square feet impervious surface)



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

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach. The following information must also be included:

- Pollution reduction facility and efficiency details.
- Hydraulic calculations demonstrating compliance with stormwater management requirements (pollution and flow control).
- Overflow connection to approved stormwater disposal location, per Section 1.3.
- Description of how the facility meets pollution reduction and flow control requirements.

All Plumbing Code requirements must be met and approved through BDS.

2.3.4.19. Structural Detention Facilities

Facility Description

Structural detention facilities such as tanks, vaults, and oversized pipes provide storage of stormwater as part of a flow control system. As with any structure, they must be designed not only for their function as runoff flow control facilities, but also to withstand an environment of periodic inundation, potentially corrosive chemical or electrochemical soil conditions, and heavy ground and surface loadings. They must also be accessible for maintenance. Facilities in this section must be designed using acceptable hydrologic modeling techniques (see Section 2.2.3 Performance Approach) to meet applicable flow control requirements. Additional facilities will be required to meet applicable pollution reduction requirements. Tanks and vaults can be used in conjunction with other detention storage facilities, such as ponds, to provide initial or supplemental storage.

Tanks and vaults typically do not have a built-in design feature for containing sediment, as do multi-cell ponds. Therefore, when tanks or vaults are used for detention storage, either a sedimentation manhole or surface sediment containment pond must be placed upstream of the tank or vault, or the tank/vault must be oversized to allow for the temporary accumulation of sediment. Maintenance is required to periodically remove sediment.

Design Requirements – detention tank, vault, and oversized pipe design

Access: All areas of a tank or vault must be within 50 feet of a minimum 36-inch-diameter access entry cover. All access openings must have round, solid locking lids.

Publicly owned detention tanks, vaults, and pipes are permitted within public rights-of-way. If developments are served with publicly operated and maintained tanks and vaults that are not located within the right-of-way, the tanks/vaults must be located in separate open space tracts with public sewer easements that are dedicated to the City of Portland. All privately owned and maintained facilities must be located to allow easy maintenance and access.

All tanks and vaults must be designed as lined systems.

Sizing: Minimum size for a public detention pipe must be 36 inches. If the collection system piping is designed also to provide storage, the resulting maximum water surface elevation must maintain a minimum 1-foot of freeboard in any catch basin below the catch basin grate. Pipe capacity must be verified using an accepted

methodology approved by the City (see City of Portland's Sewer and Drainage Design Manual). The minimum internal height of a vault or tank must be 3 feet, and the minimum width must be 3 feet. The maximum depth of the vault or tank invert is 20 feet.

Where the tank or vault is designed to provide sediment containment, a minimum of ½ foot of dead storage must be provided, and the tank or vault must be laid flat.

Materials and Structural Stability: For public facilities, pipe materials and joints must conform to the City of Portland Sewer and Drainage Facilities Design Manual. For private facilities, the pipe material must conform to the Unified Plumbing Code.

All tanks, vaults, and pipes must meet structural requirements for overburden support and traffic loadings, if appropriate. H-20 live loads must be accommodated for tanks and vaults under roadways and parking areas. End caps must be designed for structural stability at maximum hydrostatic loading conditions.

Detention vaults must be constructed of structural reinforced concrete (3000 psi, ASTM 405). All construction joints must be provided with water stops.

In soils where groundwater may induce flotation and buoyancy, measures must be taken to counteract these forces. Ballasting with concrete or earth backfill, providing concrete anchors, or other counteractive measures must be required. Calculations must be required to demonstrate stability.

Tanks and vaults must be placed on stable, consolidated native soil with suitable bedding. Tanks and vaults must not be allowed in fill slopes, unless a geotechnical analysis is performed for stability and construction practices.

Flow Control Structures for Detention Systems: To restrict flow rates, a flow control structure must be used. This section presents the methods and equations for the design of flow-restricting control structures, for use with structural detention facilities. It includes details and equations for the design of orifices and equations for rectangular sharp crested weirs and v-notch weirs.

Note: Because of minimum orifice size requirements (2 inches for public facilities, 1 inch for private facilities), detention facilities that rely on orifice structures to control flows for small projects (under 15,000 square feet of impervious development footprint area) are not allowed.

Design Requirements – control structure design

Weir and orifice structures must be enclosed in a catch basin, manhole, or vault and must be accessible for maintenance.

The control structure must be designed to pass the 100-year storm event as overflow, without causing flooding of the contributing drainage area.

Orifices: Orifices may be constructed on a "tee" riser section or on a baffle.

The minimum allowable diameter for an orifice used to control flows in a public facility is 2 inches. Private facilities may use a 1-inch-diameter orifice if additional clogging prevention measures are implemented. The orifice diameter must always be greater than the thickness of the orifice plate.

Multiple orifices may be necessary to meet the 2- through 25-year design storm performance requirements for a detention system. However, extremely low flow rates may result in the need for small orifices (< 1 inch for private facilities, < 2 inches for public) that are prone to clogging. In these cases, retention facilities that do not rely on orifice structures must be used to the maximum extent practicable to meet flow control requirements (see Section 1.3.4 or Section 1.3.5). Large projects may also result in high flow rates that necessitate excessively large orifice sizes that are impractical to construct. In such cases, several orifices may be located at the same elevation to reduce the size of each individual orifice.

Orifices must be protected within a manhole structure or by a minimum 18-inch-thick layer of 1½ - 3-inch evenly graded, washed rock. Orifice holes must be externally protected by stainless steel or galvanized wire screen (hardware cloth) with a mesh of ¾ inch or less. Chicken wire must not be used for this application.

Orifice diameter must be greater than or equal to the thickness of the orifice plate.

Orifices less than 3 inches must not be made of concrete. A thin material (e.g., stainless steel, HDPE, or PVC) must be used to make the orifice plate; the plate must be attached to the concrete or structure.

Orifice Sizing Equation:

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

where:

Q = Orifice discharge rate, cfs

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

A = Area of orifice, square feet

h = hydraulic head, feet

g = 32.2 ft/sec2

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

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

where:

Q = flow, cfs

d = orifice diameter, inches

h = hydraulic head, feet

Rectangular Notched Sharp Crested Weir:

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

where:

Q= Weir discharge, cfs

C = 3.27 + 0.40×H/P, feet

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

H = Height from weir bottom to crest, feet

L = Length of weir, feet*

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

V-Notched Sharp Crested Weir:

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

where:

Q = Weir discharge, cfs

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

Θ = Internal angle of notch, degrees

H = Height from weir bottom to crest, feet

Submittal Requirements

See Section 2.4 for submittal requirements for the design specific approach. Additional information may be required on the drawings during permit review, depending on individual site conditions.

2.3.4.20. Drainageways and Drainage Reserves

Drainageways are landscape channels or depressions which continually or periodically convey water; this drainageway only has visible water in the winter during larger rainfall events.

Drainageways are constructed or natural channels or depressions that may collect and convey water at any time. A drainageway and its reserve area function together to manage flow rate, volume, and water quality.

A drainage reserve is a 30-foot wide buffer placed over a drainageway, centered on the middle of the channel. Drainage reserves are applied to drainageways to protect flow conveyance and receiving waters and to minimize impacts to properties downstream and upstream. Drainage reserves act as a no-build area, not an easement. In making a determination to place a drainage reserve over a drainageway and its buffer area, BES will evaluate the factors listed in Section 1.3.4 and Section 2.1.2. BES staff may allow modifications to a drainage reserve if the drainageway poses landslide, flooding, or other public health and safety concern. In those instances, drainageways may be modified by BES to protect public health and safety, in compliance Portland City Code with Title 24 and 33 regulations.

Proposed encroachments into the drainageway or drainage reserve must follow BES' requirements and standards and will require BES approval. Encroachments include, but are not limited to, culverts, outfalls, structures/buildings, paved areas, or decks and deck footings. Such proposals will be reviewed to ensure that the flow rate, timing, and pattern of the drainage continues be adequately conveyed through the site. See the design criteria in Section 2.3.4.21 for Drainage Reserve Encroachments and Section 2.3.4.22 for Channel Encroachments.

Proposed impacts to drainageways on property will be reviewed and inspected for protection and encroachment during the building permit process. All plan sets must clearly demark the drainageway, drainage reserve, proposed impacts, and appropriate protection measures (fencing, etc.). Any applicable maintenance practices, such as erosion control measures, must also be noted on plan sets. 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 adequacy of the applicant's efforts. Violations or failure to comply with drainage reserve protection requirements will be referred to BES staff for investigation and enforcement. Drainage reserve submittal requirements are found in Section 2.4.7.

Additional Requirements

Requirements for protecting drainageways in the public right-of-way and for public improvements to drainageways are addressed the during the City's review of the design of the public improvements, 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.

A drainageway providing fish passage will need to follow the requirements of the Oregon Department of Fish and Wildlife (ODFW) and potentially other state and federal agencies.

Delineation of Drainageways and Drainage Reserves. Drainageways must be protected to ensure that the current flow rate, timing, and pattern of the drainage continues to be conveyed adequately through the site. The City places drainage reserves on drainageways based on the conveyance requirements provided in Section 1.3.4 (Stormwater System Requirements) based on the determination of a drainageway as identified by the factors listed in Section 2.1.2 (under the drainageway discussion of Site Planning). A drainage reserves is established and measured based on the delineation of the drainageway.

- For lots that are smaller than 10,000 square feet, the drainageway and the drainage reserve must be surveyed and delineated.
- For lots that are greater than 10,000 square feet, a survey is required to delineate drainageways within the disturbance area. If a drainageway is not within the disturbance area, drainage reserves will be placed but not delineated and the estimated location will be noted on the Operations and Maintenance site plan.

Placement of Drainage Reserves

BES will apply drainage reserves during the development review process. A drainage reserve is typically 30 feet in width, extending 15 feet from the centerline of the identified channel on each side, with the following exceptions:

- The drainage reserve's dimensions and shape will only encompass those areas of the drainageway that are not adequately protected by environmental protection zoning or land-use requirements; or
- The drainage reserve may be wider than 30 feet if needed to protect the channel, including, but not limited to, an outer boundary measuring a minimum of 15 feet from top of the channel's bank.

An applicant may request a smaller reserve area or width 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.

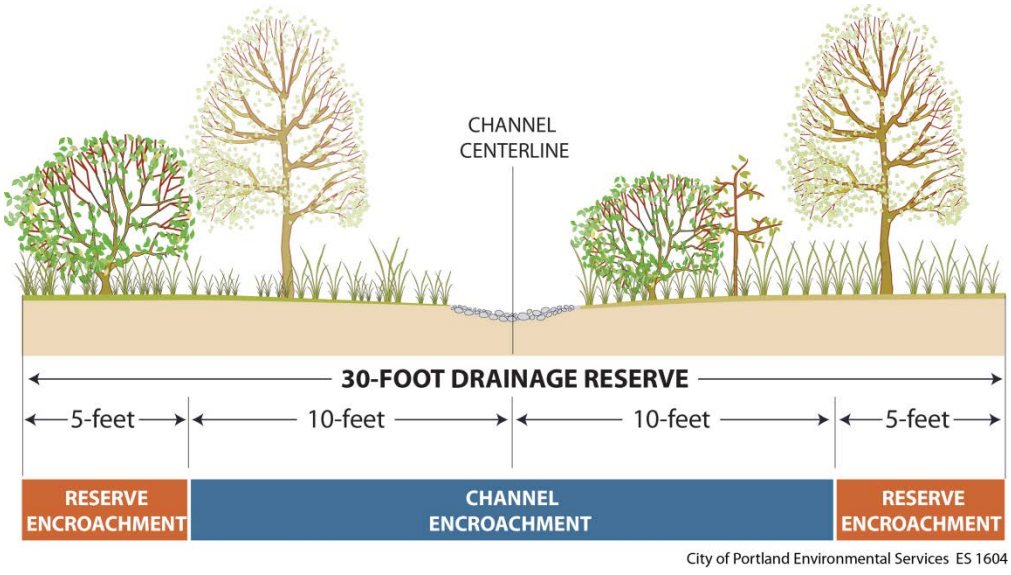
Encroachments

BES will evaluate proposals to encroach into a drainage reserve based on the encroachment feature's proximity to the drainageway channel. Structures in drainage reserves can cause flow diversion, flow capacity reduction, bank stabilization issues, and impede fish and wildlife passage. Encroachments include,

but are not limited to, culverts, outfalls, structures/buildings, paved areas, or decks and deck footings. Encroachments into the reserve can cause floodplain impingements for high-flow conditions, erosion and water quality impairment and can result in the cumulative loss of floodplain space. Encroachments can also pose a risk to the encroaching structure. For ease of review, BES has separated the review of encroachment into two types (see Figure 2-28 for cross section identifying encroachment areas):

1. Drainage Reserve Encroachment – An encroachment that will be located within the outside 5-foot edge of a drainage reserve. See Section 2.3.4.21 for the design criteria for Drainage Reserve Encroachments.
2. Channel Encroachment –An encroachment that will be located between the channel centerline and the outside 5-foot edge of a drainage reserve. If an applicant proposes removing more than 10 percent of the entire reserve area, the impacts will be reviewed under the Channel Encroachment review criteria. See Section 2.3.4.22 for the design criteria for Channel Encroachments.

Figure 2-28. Drainage Reserve Cross Section



Submittal Requirements

See Section 2.4.7 for submittal requirements for drainage reserves.

2.3.4.21. Drainage Reserve Encroachments

Any structure within 5 feet of a drainage reserve boundary is considered a drainage reserve encroachment. Encroachments include, but are not limited to, structures/buildings, paved areas, or decks and deck footings. Encroachments into the drainage reserve require ongoing maintenance by the property owner as per the recorded operations and maintenance plan.

Vegetation: Native plants are required in disturbance areas in drainage reserves. 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 must be planted in quantities as per Figure 2-29 and must reach 90 percent vegetation cover within one year. See Portland City Code Title 11 for tree requirements relating to development situations and 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.

Figure 2-29. Vegetation Density for Drainage Reserve Encroachments

Number of Plants	Vegetation Type	Per square feet	Size	Spacing density (on center)
115	Herbaceous plants	100	#1 container	12”
OR				
100	Herbaceous plants	100	4” pots	12”
4	Small shrubs	100	#1 container	Per plan
OR				
240	Herbaceous	100	Plugs	6”

Channel Crossing

Appropriate road-crossing methods are allowed as a drainage encroachment and are dictated by site-specific drainageway flow characteristics. Drainageway impacts must be avoided wherever practicable, including:

- Proposed street improvements should not impede or restrict flows within the drainageway.

- Proposed street improvements should minimally impact slope, width, depth and bed composition of the drainageway.
- Proposed street improvements should not impede fish passage in a drainageway that has been identified by the Oregon Department of Fish and Wildlife as fish bearing or historically fish bearing.
- Exposed soil must be replanted with native plants from the Portland Plant List.
- Before a water crossing structure or culvert may be placed within a drainageway that provides or could provide fish passage or other wildlife benefits requirements, Oregon Department of Fish and Wildlife (ODFW) consultation and approval will be required.

Additional Design Requirements

Requirements for protecting drainageways in the public right-of-way and for public improvements to drainageways are addressed during the City's review of the design of public improvements, including improvements requiring Public Works Permits. Design requirements for public improvements are found in the Sewer and Drainage Facilities Design Manual.

If a drainageway provides fish passage or other wildlife benefits, Oregon Department of Fish and Wildlife (ODFW) consultation and approval will be required.

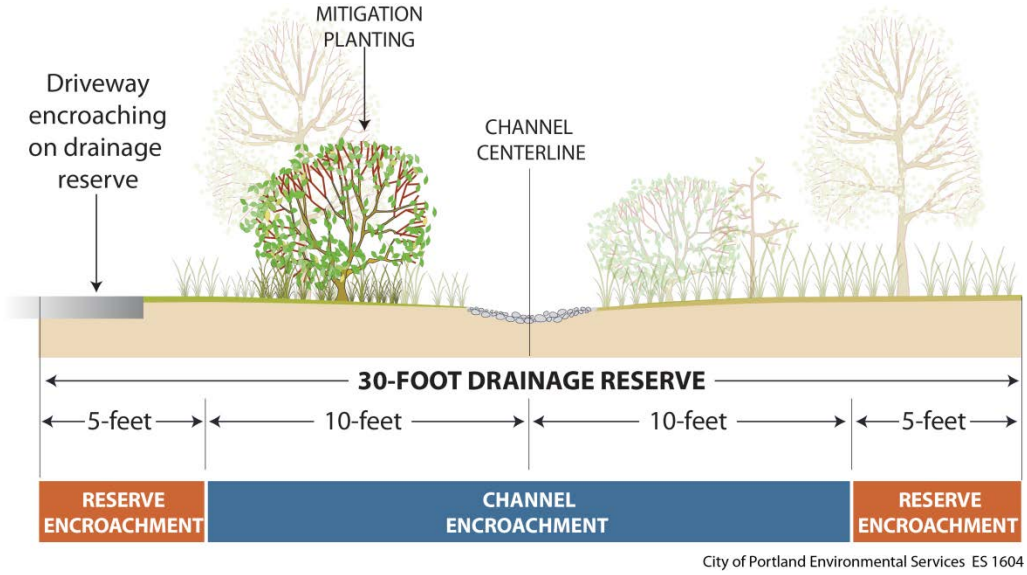
Drainage Reserve Encroachment Standards

For encroachments within the outside 5-foot edge of the drainage reserve, the proposal may be approved if the applicant has clearly demonstrated that ALL of the following standards maybe met:

- The encroachment will be minimized to the maximum extent practicable.
- The encroachment will occur in the most environmentally sensitive manner, considering seasonality, slope, soil, geologic, and erosion control issues to limit disturbance impact to flow capacity, connectivity, and channel stability.
- All mitigation for disturbances within the drainage reserve limits will be located on the project site. Proposed mitigation will equal or exceed any loss in conveyance volume, flow rate control, and vegetation density within the drainage reserve limits. See Figure 2-30 for an example of a drainage reserve encroachment with mitigation plantings.

- All structures, mitigation plantings, and drainageway improvements must be maintained in accordance with the submitted O&M plan. Vegetation coverage within the drainage reserve area must achieve 90% coverage within one year following construction.
- Proper temporary and permanent erosion control and exclusionary fencing measures, including but not limited to, those required by the Erosion and Sediment Control Manual, will be employed to ensure adequate protection of the drainageway during construction and during the establishment of vegetation within the drainage reserve limits.

Figure 2-30. Example of Drainage Reserve Encroachment.



Encroachments include, but are not limited to, culverts, outfalls, structures/buildings, paved areas, or decks and deck footings.

Submittal Requirements

See Section 2.4.7 for submittal requirements for drainage reserve encroachments and for design approach specific requirements.

2.3.4.22. Channel Encroachments

An encroachment that will be located between the channel centerline and the outside 5-foot edge of the drainage reserve or a proposal that will remove more than 10 percent of the entire reserve area on the development-related side of the drainage channel will be reviewed under channel encroachment criteria. Any proposals to move or otherwise modify the channel itself will also be reviewed under the channel encroachment criteria. Encroachments include, but are not limited to, culverts, outfalls, structures/buildings, or decks and deck footings. Channel encroachment requirements are in addition to the drainage reserve encroachment requirements. Encroachments near or modifications to a channel require ongoing maintenance by the property owner per the recorded operations and maintenance plan. The channel encroachment proposal may be approved if the applicant clearly demonstrates that all requirements of the drainage reserve encroachment standards and ALL of the following will be met:

- The encroachment will not worsen any existing drainageway conditions, such as channel erosion, channel hardening, or water impoundment.
- The channel encroachment will be mitigated by modifying the channel to retain its original capacity or by enhancing storage and conveyance volumes.
- Flows must be conveyed around the encroachment area during construction.
- Flows resulting from the encroaching facility must leave the site in a location and manner that maximizes the watershed benefits of the drainageway. Flow rates and outlet locations may be altered to improve watershed function. Hydrologic and/or hydraulic modeling may be required, depending on site conditions and the extent of encroachment.
- Erosion control measures must be used during construction of the improved/modified drainageway to ensure protection and functionality of the existing stormwater conveyance system. Erosion control measures to protect the drainageway are independent of those required on the building permit.

Flow volumes and/or drainageway capacities will be determined by the City's review of a number of information sources, including but not limited to:

- Drainage basin hydrology and hydrologic records.
- Delineation of the drainage catchment, including any impacts of adjacent open and piped drainage systems on the drainage catchment of concern.

- Modeling information, including volume and velocity, using a continuous simulation model as approved by BES.
- Historical data, such as permit records or monitoring data.
- Topographic features, if any, including LIDAR or other mapping based methods depicting channel migration zones, high water marks or other demarcations of drainage capacity.
- Soil inundation measures.
- Photographs of past flooding limits.

Additional Design Requirements

Requirements for protecting drainageways in the public right-of-way and for public improvements to drainageways are found in the City's Sewer and Drainage Facilities Manual and the technical standards of the City of Portland Standard Construction Specifications.

If a drainageway provides fish passage or other wildlife benefits, Oregon Department of Fish and Wildlife (ODFW) consultation and approval will be required.

Channel Encroachment Exemptions: Single outfalls 4" or smaller from stormwater management facilities, regardless of location, are allowed to encroach outright if they meet the standards that govern outfalls in the City's environmental zoning code (Chapter 33.430). These standards address many environmental sensitivity issues and are being used as a guide for the approval of all small outfalls, both within and outside of environmental overlay zones that reach drainageways. Outfalls that meet environmental zone standards are exempt from channel encroachment review and submittal requirements. Approval requests for all other outfalls will be processed according to the review standards and submittal requirements detailed below.

Vegetation: Native plants are required in disturbance areas in drainage reserves. For plant recommendations, see the Portland Plant List. Choose plants appropriate for to the native plant community type as described in the Portland Plant List. Vegetation must be planted in quantities as Figure 2-31 and must reach 90 percent vegetation cover within one year. See City Code Title 11 for tree requirements relating to development situations and 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.

Figure 2-31. Vegetation density for 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
10	Shrubs	100	#1 Container	1’
70	Herbaceous plants	100	4” pots	12”
OR				
240	Herbaceous plants	100	Plugs	6”

Submittal Requirements

See Section 2.4.7 for submittal requirements for channel encroachments and for design approach specific requirements.

Construction Considerations

Temporary and permanent erosion control measures must meet the requirements in the City’s Erosion and Sediment Control Manual. Additional erosion control measures (e.g., reinforced silt fence, bio-filter bags, or erosion blankets) may be required to ensure adequate protection of the drainageway during construction and during the establishment of vegetation within the drainage reserve.

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 City Code Title 10, or if such conditions are otherwise required by regulatory agencies including Oregon Dept. of Fish and Wildlife timing guidelines for in-water work.

Heavy machinery that produces excessive ground compaction may not be allowed within the drainage reserve during construction. Low ground-pressure vehicles (such as spider hoes or those approved under Environmental Zoning or Greenway Code allowances) may be allowed if the applicant can show adequate soil and vegetation protection during construction and restoration.

2.3.5 Typical Details

Typical details for stormwater management facilities have been developed to provide standard design specifications. Typical details for private stormwater facilities built under the Simplified Approach are found in the SW-100's. Typical details for private stormwater facilities built under the Presumptive or Performance Approach are found in the SW-200's. Typical details for public stormwater facilities in the public right-of-way are found in the SW-300's.

2.3.5 Private Simplified Stormwater Facility Typical Details

Table of Contents

SW-100 - Ecoroof

SW-101 - Habitat Ecoroof

SW-110 - Pervious Pavement

SW-120 - Downspout Extension

SW-121 - Rain Garden

SW-130 - Swale - Lined

SW-131 - Swale - Unlined

SW-140 - Planter - Lined

SW-141 - Planter - Unlined

SW-142 - Planter - Site Configurations

SW-150 - Basin - Lined

SW-151 - Basin - Unlined

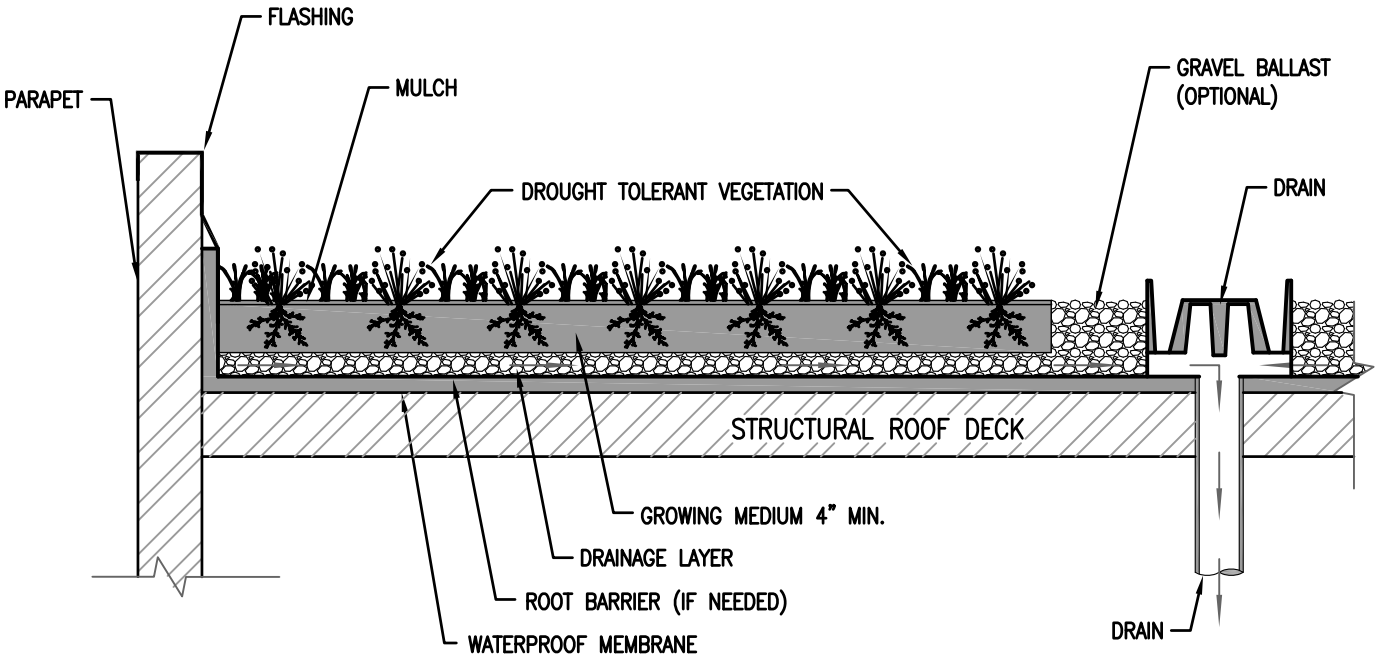
SW-160 - Filter Strip

SW-170 - Soakage Trench

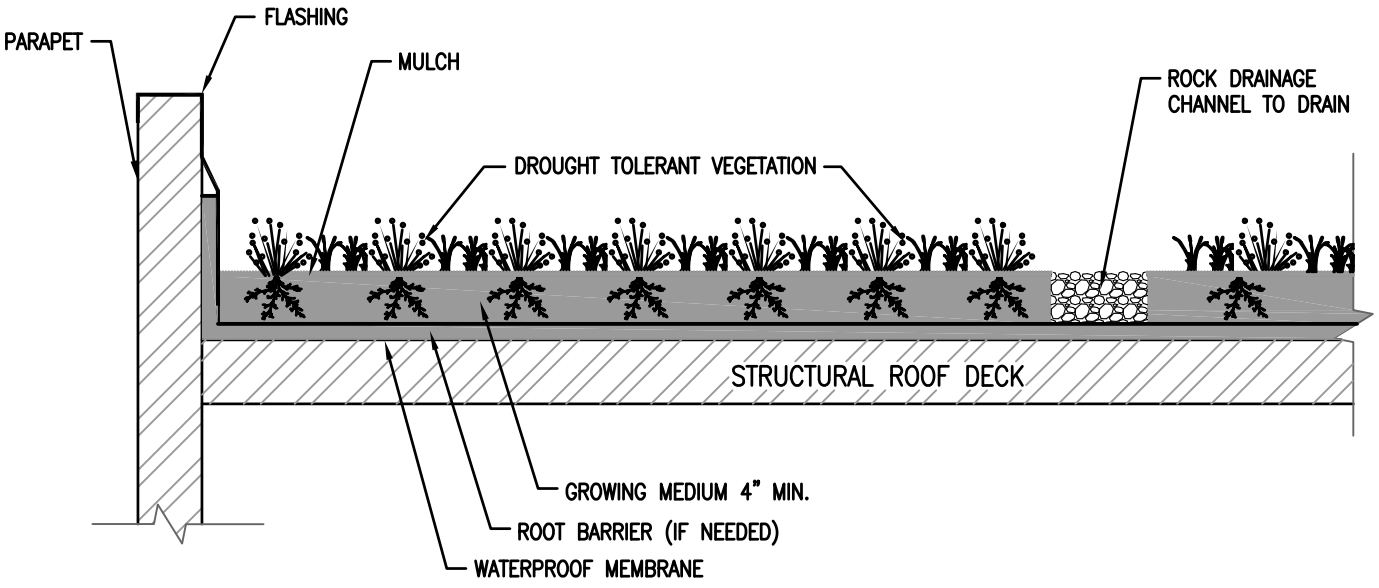
SW-180 - Drywell

SW-190 - Facility Overflow Configurations

– DRAWING NOT TO SCALE –



ECOROOF WITH DRAINAGE LAYER



ECOROOF WITH DRAINAGE CHANNELS

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

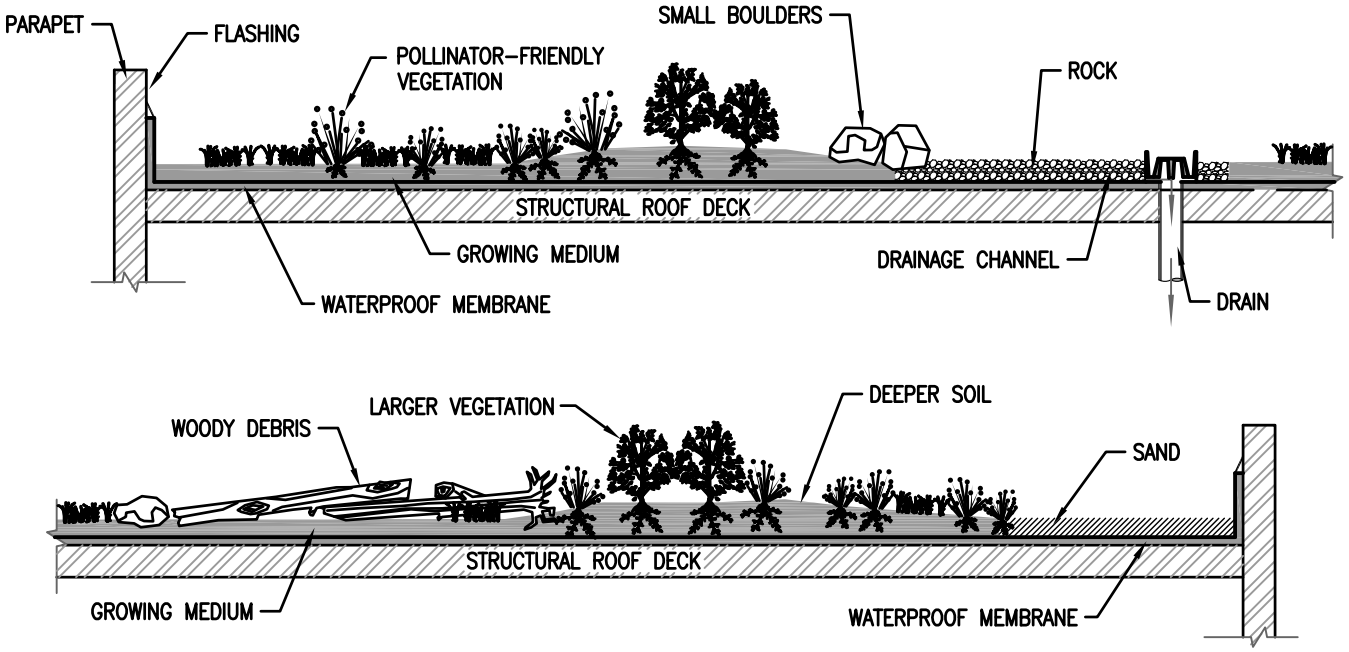
Ecoroof

Bureau of Environmental Services

NUMBER

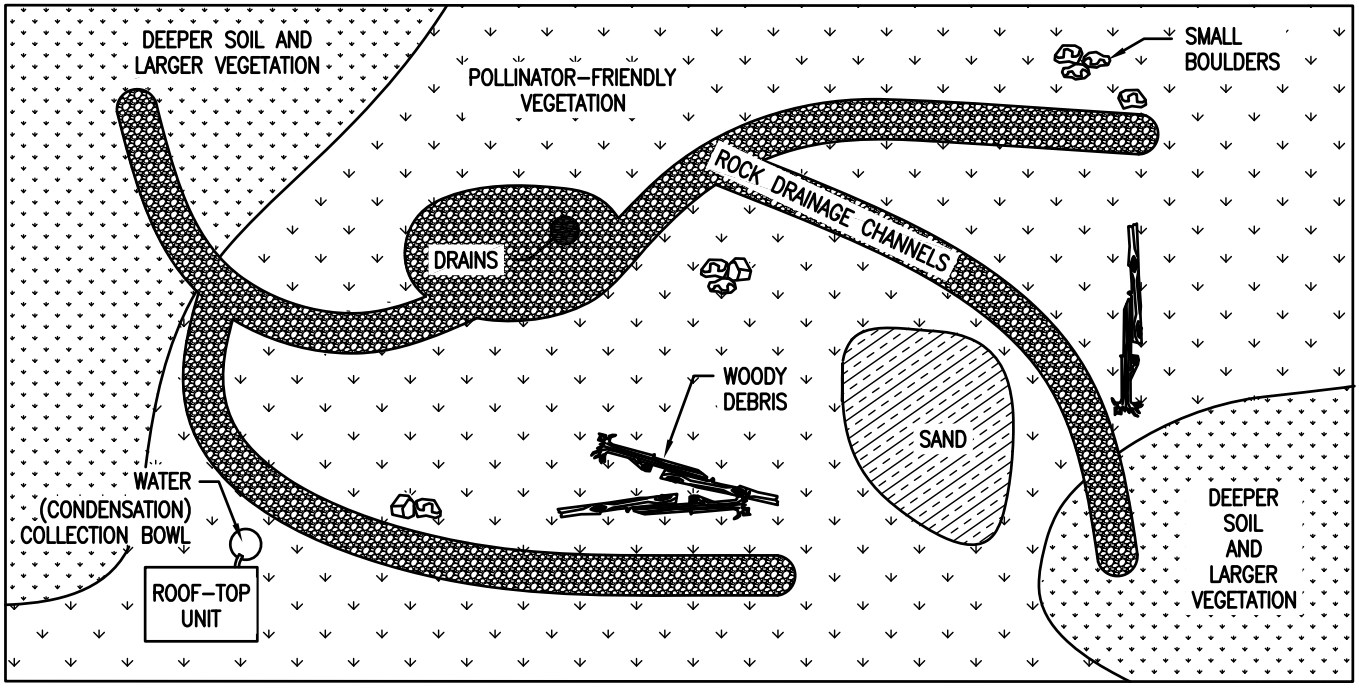
SW–100

7–1–16



HABITAT ECOROOF EXAMPLE SECTIONS

NOTE: Building elements such as glass and lighting placed near ecoroofs have the potential to exacerbate bird–srike mortality. BES recommends designs comply with Portland's Resource Guide for Bird–Friendly Building Design: http://www.portlandoregon.gov/bps/article/446308



HABITAT ECOROOF WITH DRAINAGE CHANNELS – EXAMPLE PLAN

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

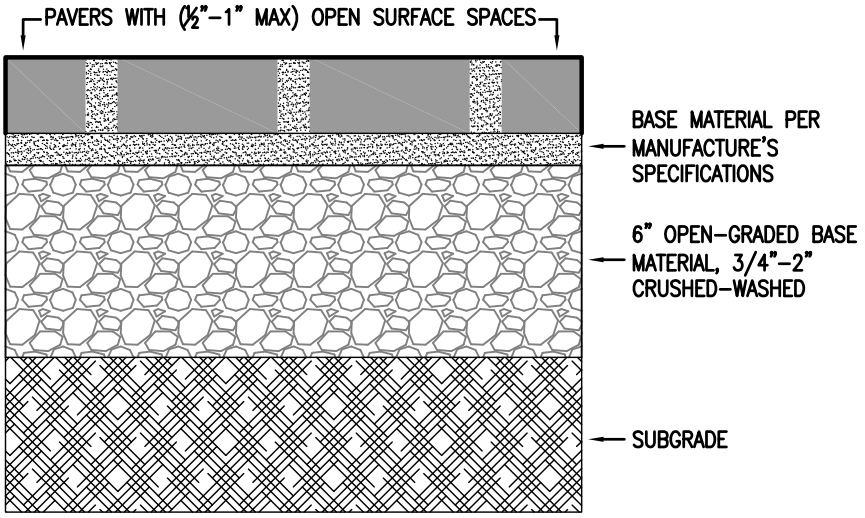
Habitat Ecoroof

Bureau of Environmental Services

NUMBER

SW–101

7–1–16

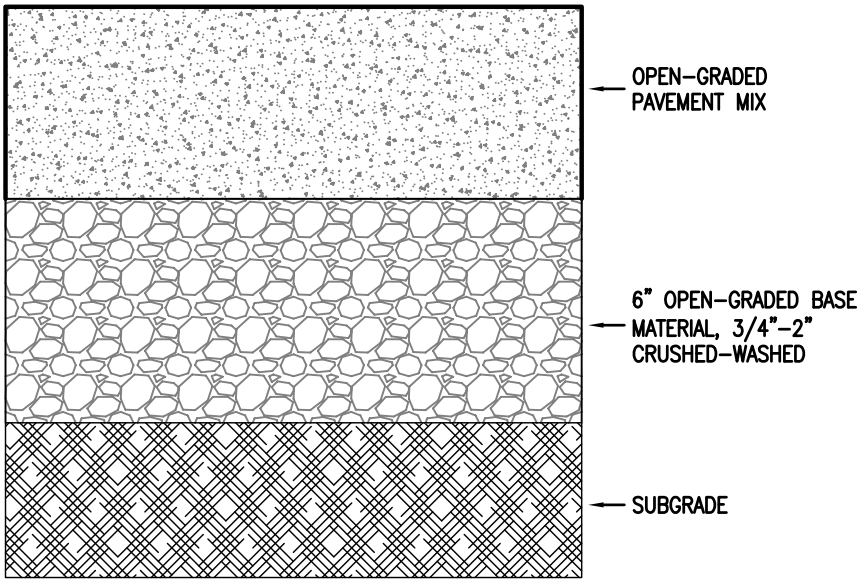


PERMEABLE CONCRETE BLOCK OR "PAVER" SYSTEMS

	RESIDENTIAL DRIVEWAY OR PEDESTRIAN ONLY
CONCRETE	4"
ASPHALT	2 ½"
PAVERS	2 ⅜"
ENGINEERING REQ'D	NO
COMPACTION REQ'D	NO

EXHIBIT 2–8

DESIGN REQUIREMENTS FOR TOP LIFT DEPTH



PERVIOUS (OPEN GRADED) CONCRETE AND ASPHALT SYSTEMS

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

Pervious Pavement

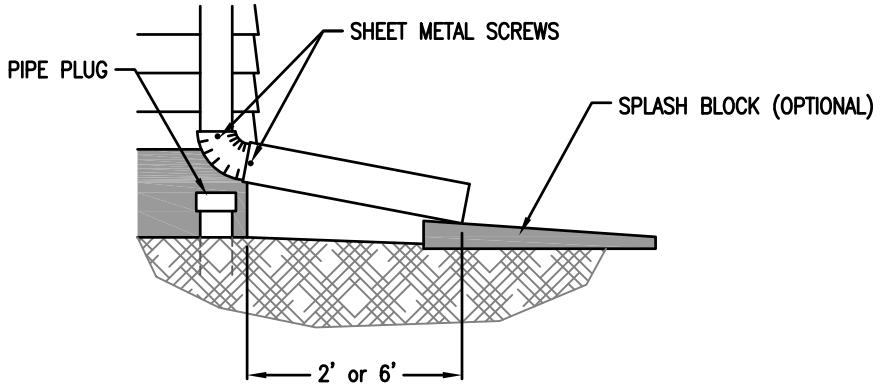
Pedestrian and Residential Driveway Only

Bureau of Environmental Services

NUMBER

SW–110

7–1–16



1. Site Suitability: Downspout extensions are suitable for sites that have well draining soils, >2" per hour, and have an overall slope of 10% or less.

2. Sizing: Area of discharge must be 10% of the contributing roof area. A maximum of 500 sf of roof area is allowed to drain to each downspout.

3. Downspouts must drain at least 6 feet from basement walls and at least 2 feet from crawl spaces and concrete slabs.

4. The end of the downspout must be at least 5 feet from the property line, and 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. Using a splash block at the end of the extension is optional, but it will help prevent soil erosion.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

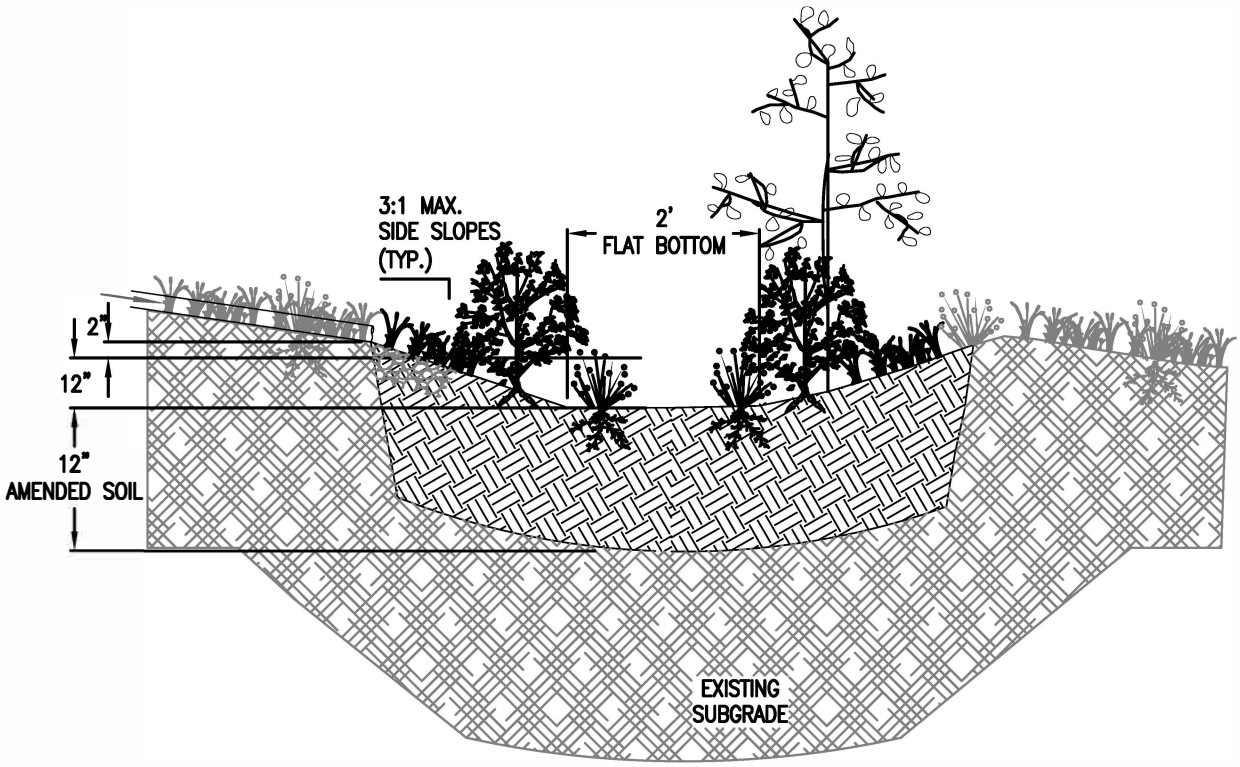
Downspout Extension

NUMBER

SW–120

7–1–16

Bureau of Environmental Services



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

2. Dimensions:
   Ponding depth (from top of growing medium to overflow elevation): 12".
   Flat bottom width: 2'x2' min.
   Side slopes of swale: 3:1 maximum.

3. Setbacks:
   A ten foot setback required from buried oil tanks or retaining walls over 36 inches high. The deepest point of a rain garden should be at least 10 ft from all structures. It is recommended to avoid installation over water service lines.

4. Overflow:
   Each rain garden design needs to include an escape route that allows stormwater to drain to a safe disposal point in periods of heavy rainfall, away from building foundations and adjacent properties. Escape routes should be planted or rocked to assist with potential erosion issues.

5. Piping: must be composed of cast iron or Schedule 40 ABS per 2.3.4 and the Uniform Plumbing Code. Flexible downspout extensions are not approvable materials.

6. Growing Medium: Amend native soils with 3 inches of compost blended 12 inches into native soil.

7. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Section 2.4.1. Minimum container size is #1. # of plantings per 100sf of facility area:
   80 herbaceous plants OR 72 herbaceous plants and 4 shrubs. Consider adding a tree if the rain garden is over 200 sf.

8. Splash Block: Splash blocks, rock, or flagstone must be utilized for erosion control and flow dispersal at the point of discharge.

9. Mulch: Rain gardens may be topped with 2" of compost

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

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified Design Approach -

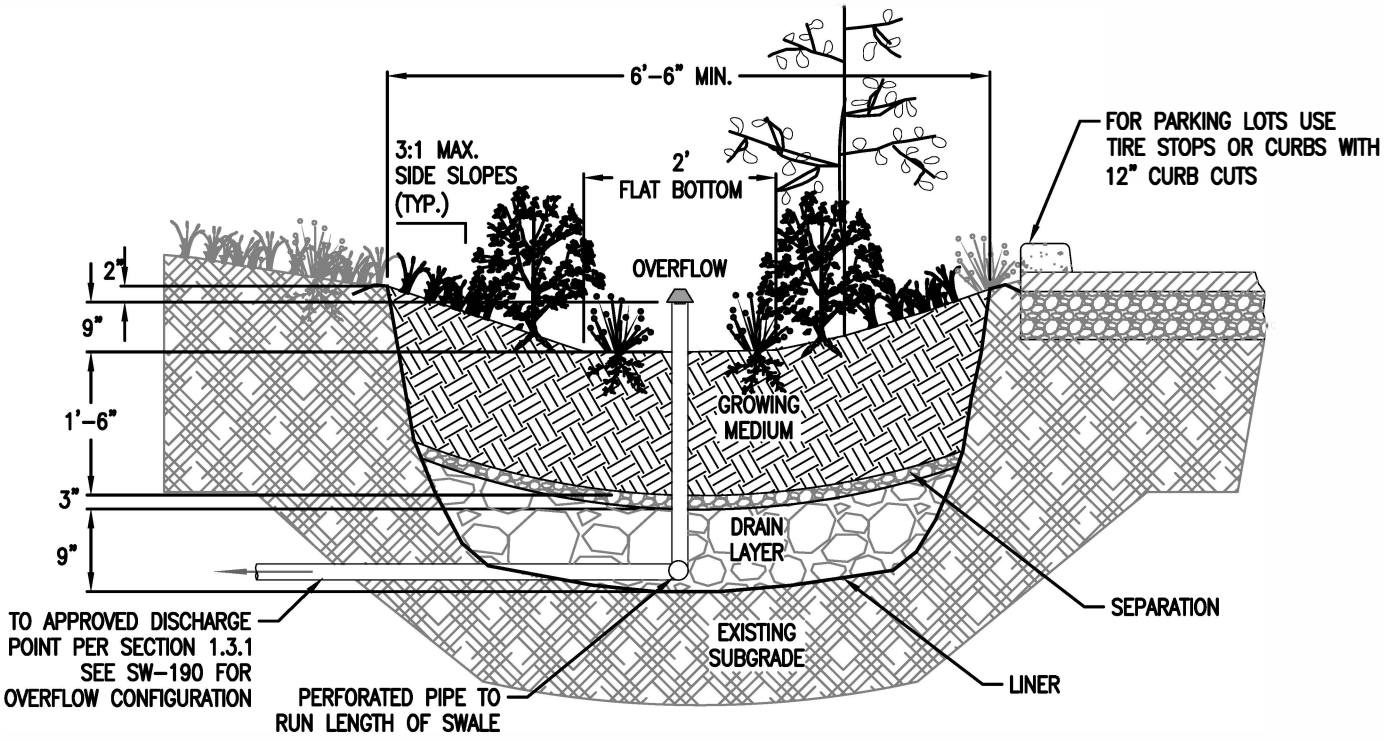
Rain Garden

Bureau of Environmental Services

NUMBER

SW-121

7-1-16



1. Dimensions:
   Width of swale: 6'–6" minimum
   Depth of swale (from top of growing medium to overflow elevation): 9".
   Longitudinal slope of swale: 6.0% or less.
   Flat bottom width: 2' recommended.
   Side slopes of swale: 3:1 maximum.

2. Overflow: Swales must connect to approved discharge point according to SWMM Section 1.3.1 and detail SW–190.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

3. Piping must be cast iron, ABS or PVC. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" minimum pipe. Uniform Plumbing Code also applies.

4. Drain Layer:
   3/4" – 1 ½" washed round rock. Depth: 9".
   Separation between drain rock and growing medium:
   Pea gravel lens, 2 to 3 inches deep.

5. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3–way mix, or approved mix that will support healthy plants.
   24" minimum depth is required If the lined facility is also meeting BDS landscape requirements.

6. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Section 2.4.1. Minimum container size is #1. # 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 must 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. Check Dams: Must be placed every 10' where slope exceeds 4% and be equal to the width of the planter.

8. Waterproof Liner: 30 mil EPDM, HDPE or approved equivalent.

9. Splash Block: Install 4–6" washed river rock or splash pad for erosion control at inlets and downspout.

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

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

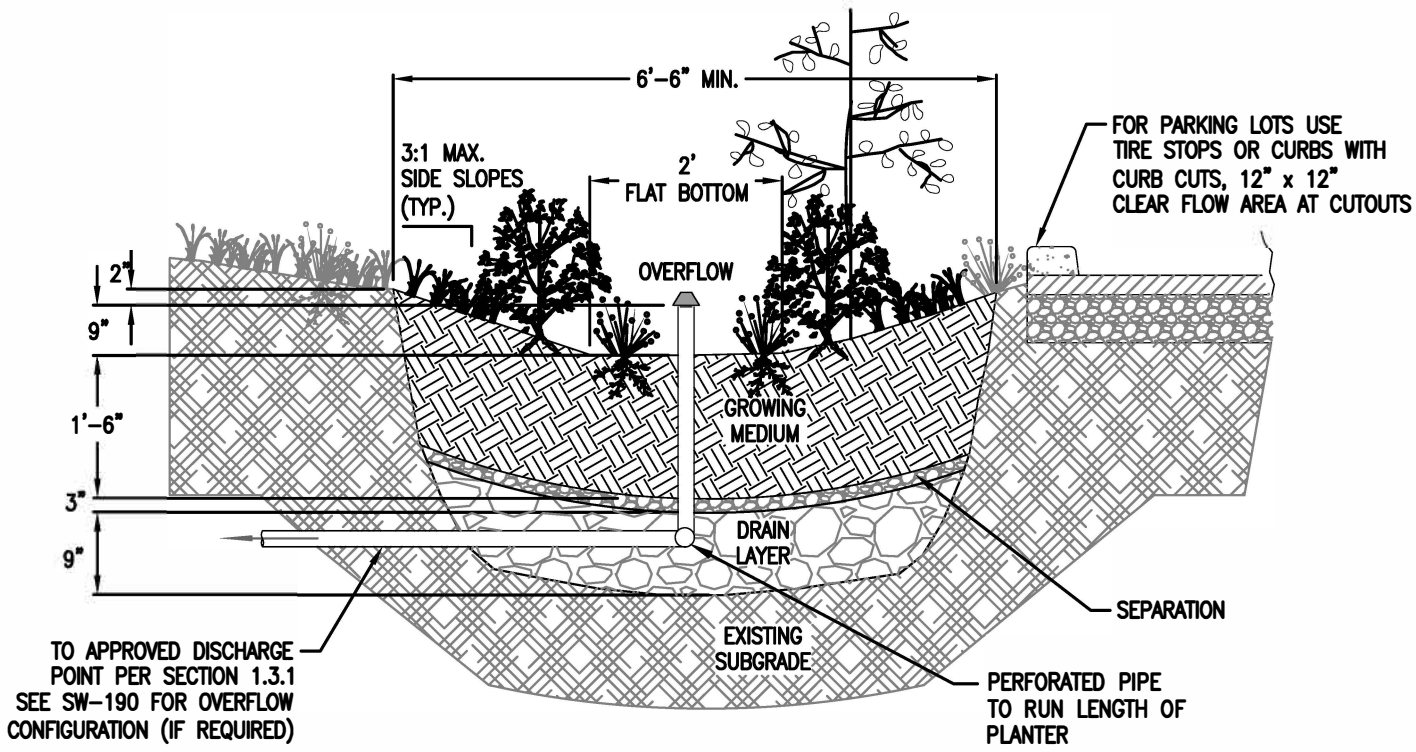
Swale – lined

Bureau of Environmental Services

NUMBER

SW–130

7–1–16



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

2. Dimensions:
   Width of swale: 6'–6" minimum
   Depth of swale (from top of growing medium to overflow elevation): 9".
   Longitudinal slope of swale: 6.0% or less.
   Flat bottom width: 2' recommended.
   Side slopes of swale: 3:1 maximum.

3. Setbacks:
   Swale must be 10' away from foundation and 5' away from property lines.

4. Overflow:
   Swales must connect to approved discharge point according to SWMM Section 1.3.1.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

5. Piping must be cast iron, ABS or PVC. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" minimum pipe. Uniform Plumbing Code also applies.

6. Drain Layer:
   3/4" – 1 ½" washed rock. Depth: 12".
   Separation between drain rock and growing medium:
   Pea gravel lens, 2 to 3 inches deep.

7. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3–way mix, or approved mix that will support healthy plants.

8. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Section 2.4.1. Minimum container size is #1. # 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.

9. Check Dams: Shall be placed every 10' where slope exceeds 4% and be equal to the width of the planter.

10. Splash Block: Install 4–6" washed river rock or splash pad for erosion control at inlets and downspout.

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

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

Swale – unlined

Bureau of Environmental Services

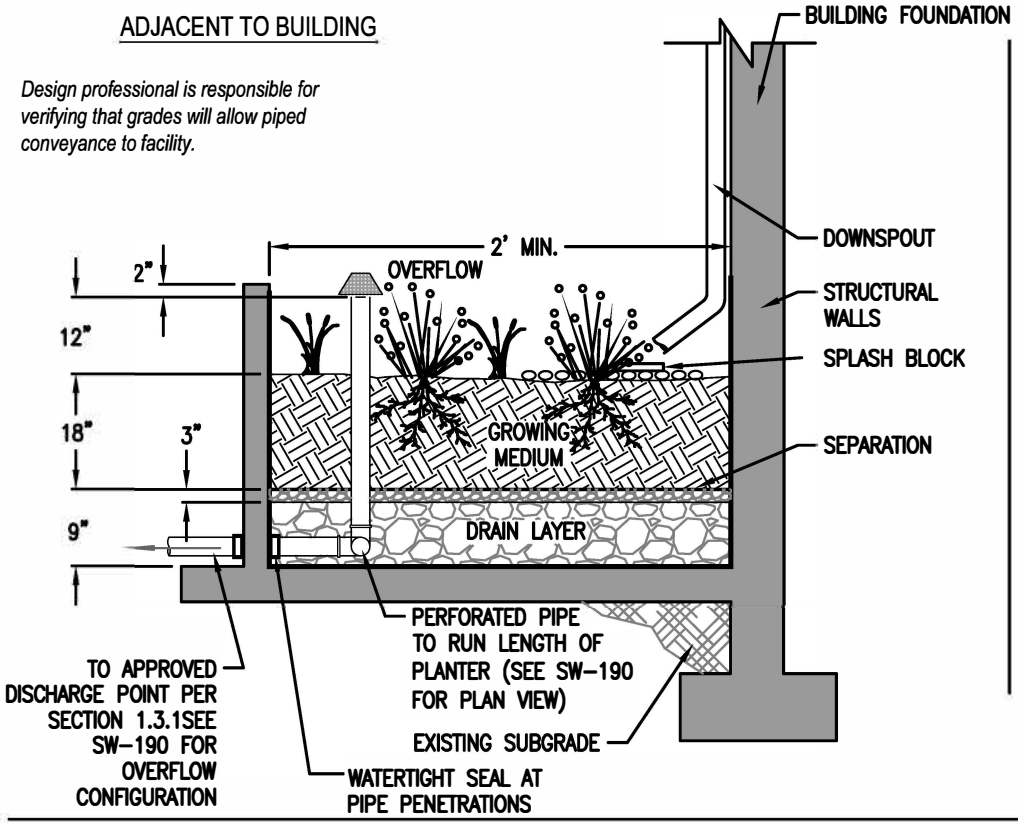
NUMBER

SW–131

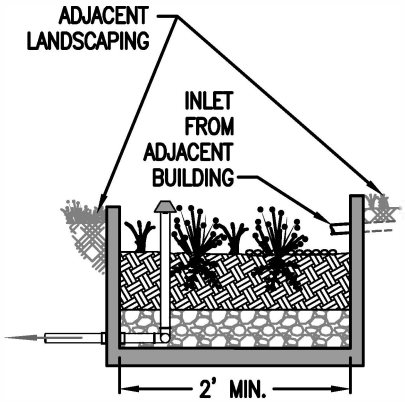
7–1–16

ADJACENT TO BUILDING

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



FREESTANDING PLANTER



1. Dimensions:
   Width of planter: 24" minimum.
   Depth of planter (from top of growing medium to overflow elevation): 12".
   Longitudinal slope of planter: 0.5% or less.

2. Setbacks:
   Planters must be less than 30" in height above finish grade if within 5-feet of property line.

3. Planter Walls:
   Material must be monolithically poured concrete. Walls must be included on foundation plans.

4. Waterproofing:
   Monolithically poured planter, without joints is required. Check state structural requirements for foundations.

5. Piping must be cast iron, ABS or PVC. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" minimum pipe. Uniform Plumbing Code also applies.

6. Drain Layer:
   3/4" – 1 ½" washed round rock. Depth: 9".
   Separation between drain rock and growing medium:
   Pea gravel lens, 2 to 3 inches deep.

7. Overflow:
   Planters must connect to approved discharge point according to section 1.3.1 and detail SW-190.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

8. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3-way mix, or approved mix that will support healthy plants.
   24" minimum depth is required if the lined facility is also meeting BDS landscape requirements.

9. Vegetation: Refer to plant list in SWMM Section 2.4.1. Minimum container size is #1. # of plantings per 100sf of facility area:
   80 herbaceous plants OR;
   72 herbaceous plants and 4 small shrubs.

10. Splash Block: Install 4-6" washed river rock or splash pad for erosion control at inlets and downspout.

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

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

Planter – lined

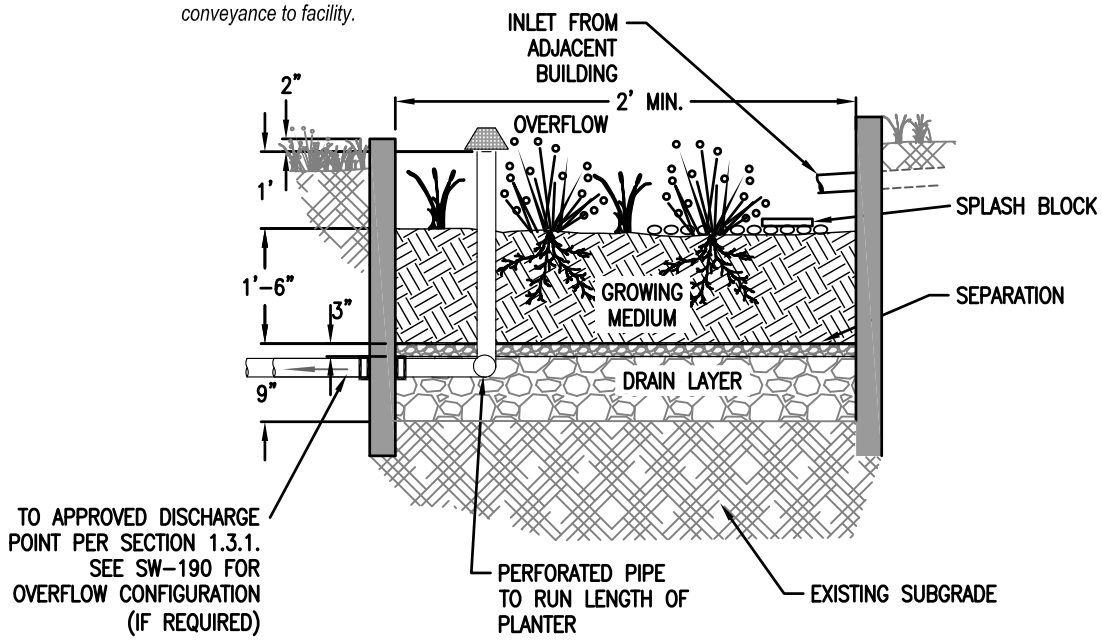
Bureau of Environmental Services

NUMBER

SW–140

7–1–16

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



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

2. Dimensions:
   Width of planter: 24" minimum.
   Depth of planter (from top of growing medium to overflow elevation): 12".
   Longitudinal slope of planter: 0.5% or less.

3. Setbacks:
   Planters must be 5-feet from property line and 10-feet from building foundations.

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

5. Piping must be cast iron, ABS or PVC. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" minimum pipe. Uniform Plumbing Code also applies.

6. Drain Layer:
   3/4" - 1 ½" washed. Depth: 9".
   Separation between drain rock and growing medium:
   Pea gravel lens, 2 to 3 inches deep.

7. Overflow:
   Planters must connect to approved discharge point according to section 1.3.1 and detail SW-190.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

8. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3-way mix, or approved mix that will support healthy plants.
   24" minimum depth is required If the lined facility is also meeting BDS landscape requirements.

9. Vegetation: Refer to plant list in SWMM Section 2.4.1. Minimum container size is #1. # of plantings per 100sf of facility area:
   80 herbaceous plants OR;
   72 herbaceous plants and 4 small shrubs.

10. Splash Block: Install 4-6" washed river rock or splash pad for erosion control at inlets and downspout.

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

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified Design Approach -

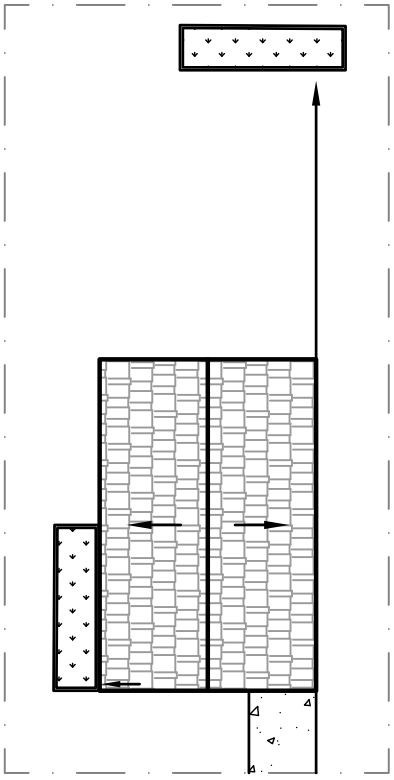
Planter - unlined

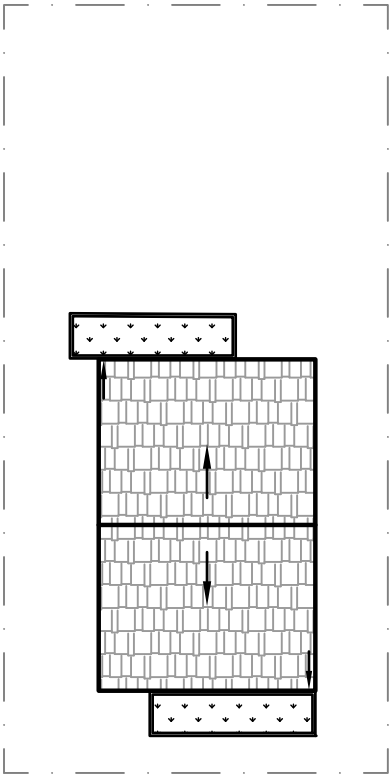
Bureau of Environmental Services

NUMBER

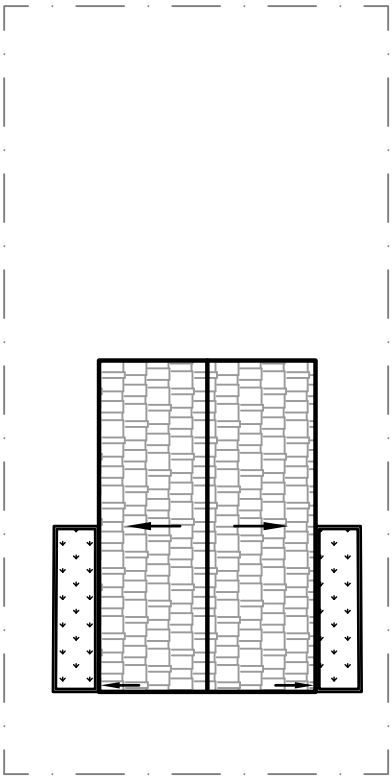
SW-141

7-1-16





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



– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

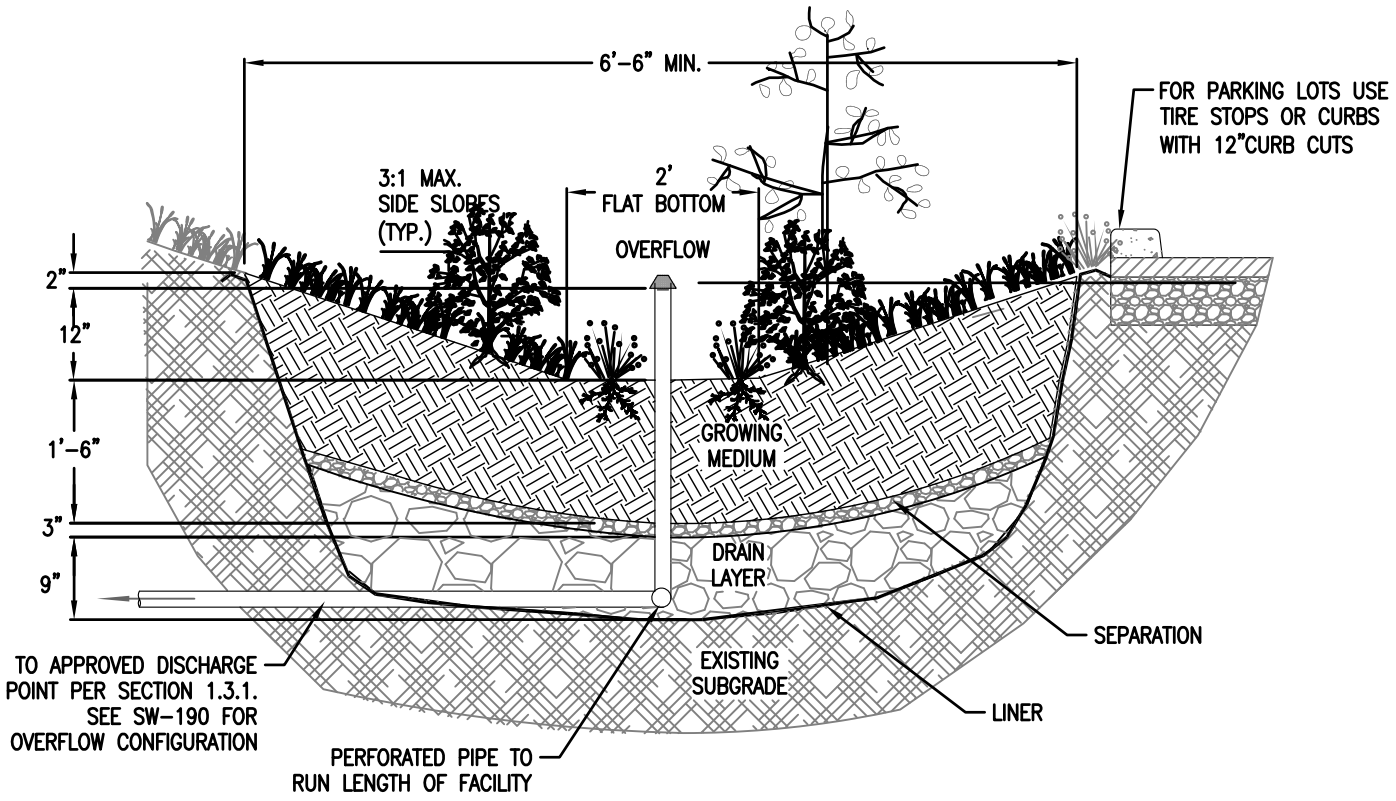
Planter – site configurations

Bureau of Environmental Services

NUMBER

SW–142

7–1–16



1. Dimensions:
   Width of basin: 6'–6" minimum
   Depth of basin(from top of growing medium to overflow elevation): 9".
   Flat bottom width: 2' recommended.
   Side slopes of swale: 3:1 maximum.

2. Setbacks: None required.

3. Overflow:
   Basins must connect to approved discharge point according to SWMM Section 1.3.1.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

4. Piping must be cast iron, ABS or PVC. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" minimum pipe. Uniform Plumbing Code also applies.

5. Drain Layer:
   3/4" – 1 ½" washed round rock. Depth: 9".
   Separation between drain rock and growing medium:
   Pea gravel lens, 2 to 3 inches deep.

6. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3–way mix, or approved mix that will support healthy plants.
   24" minimum depth is required If the lined facility is also meeting BDS landscape requirements.

7. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Section 2.4.1. Minimum container size is #1. # 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 must be either at the outlet elevation or the check dam elevation, whichever is lowest.
   If project area is over 200sf consider adding a tree.

8. Waterproof Liner: 30 mil EPDM, HDPE or approved equivalent.

9. Splash Block: Install 4–6" washed river rock or splash pad for erosion control at inlets and downspout.

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

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

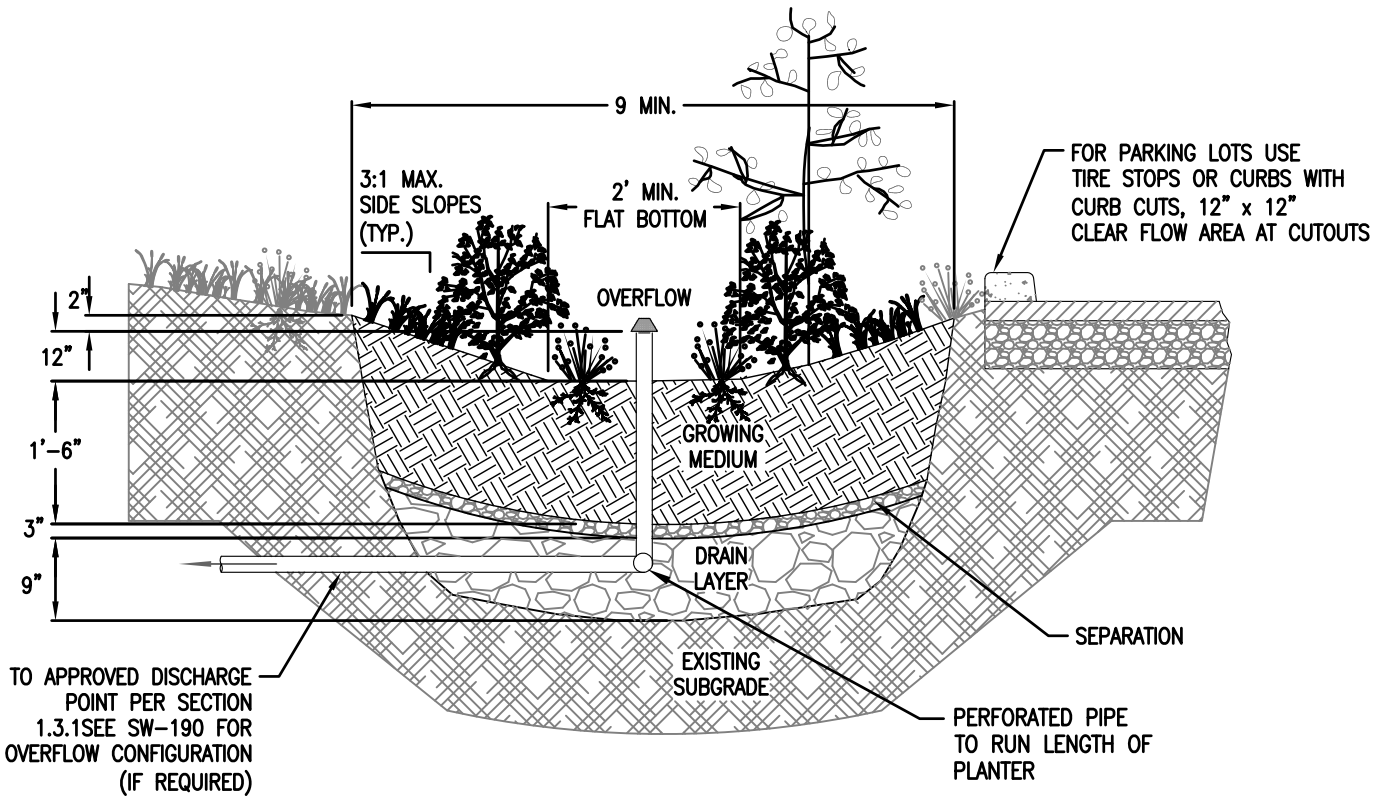
Basin – lined

Bureau of Environmental Services

NUMBER

SW–150

7–1–16



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

2. Dimensions:
   Width of basin: 9' minimum
   Depth of basin(from top of growing medium to overflow elevation): 9".
   Flat bottom width: 2' minimum.
   Side slopes of swale: 3:1 maximum.

3. Setbacks:
   Basin must be 10' away from foundations and 5' away from property lines.

4. Overflow:
   Basins must connect to approved discharge point according to SWMM Section 1.3.1 and detail SW-190.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

5. Piping must be cast iron, ABS or PVC. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" minimum pipe. Uniform Plumbing Code also applies.

6. Drain Layer:
   3/4" - 1 ½" washed rock. Depth: 9".
   Separation between drain rock and growing medium:
   Pea gravel lens, 2 to 3 inches deep.

7. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3-way mix, or approved mix that will support healthy plants.

8. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Section 2.4.1. Minimum container size is #1. # 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 must be either at the outlet elevation or the check dam elevation, whichever is lowest.
   If project area is over 200sf consider adding a tree.

9. Splash Block: Install 4-6" washed river rock or splash pad for erosion control at inlets and downspout.

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

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Simplified Design Approach -

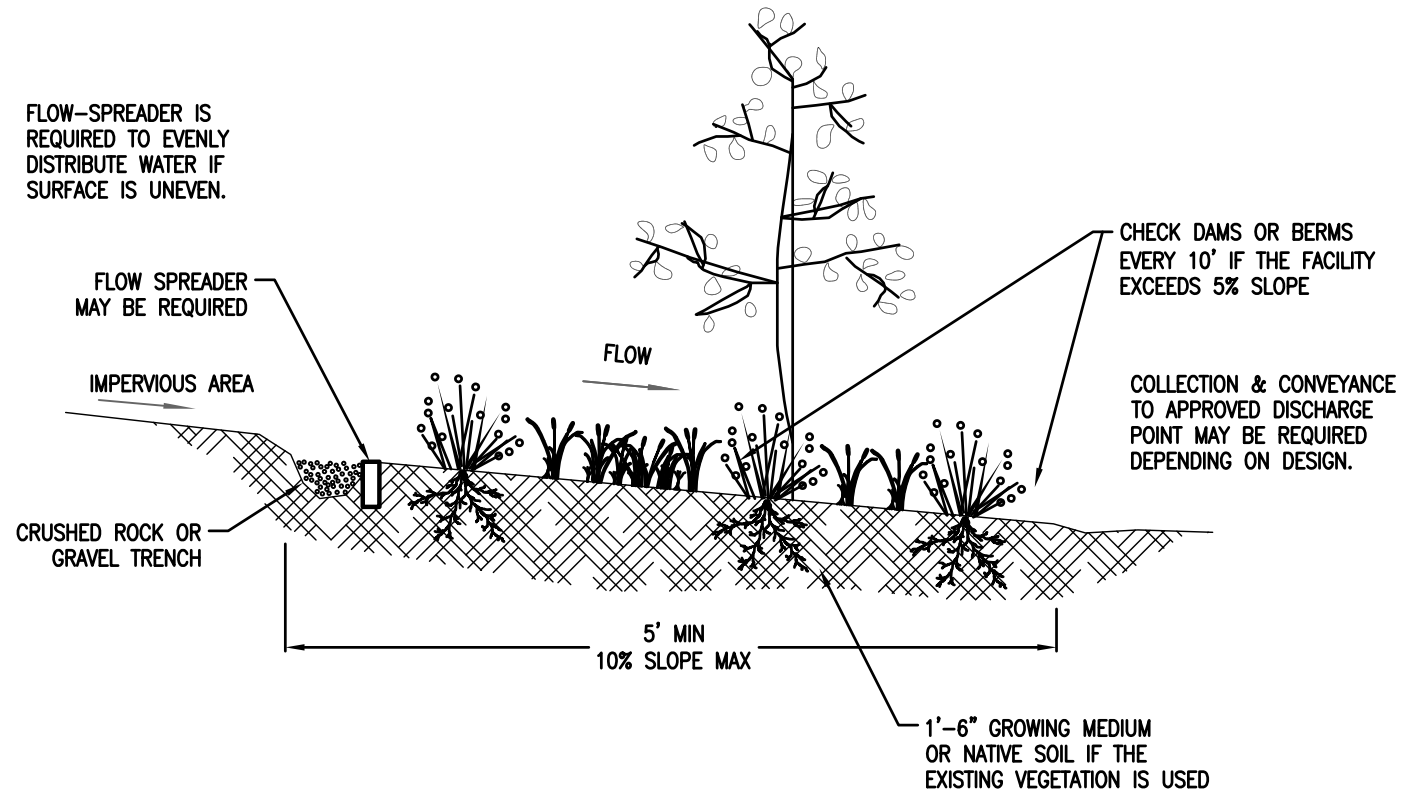
Basin - unlined

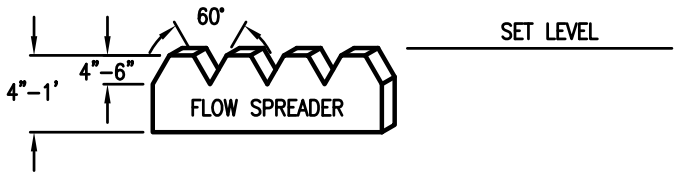
Bureau of Environmental Services

NUMBER

SW-151

7-1-16





1. Provide protection from all vehicle traffic, equipment staging, as well as foot traffic for proposed infiltration areas prior to and during construction.

2. Dimensions:
   a. Flow line length: 5' minimum.
   b. Slopes: 0.5 – 10%

3. Setbacks (from beginning of facility):
   a. 5' from property line
   b. 10ft from buildings
   c. 50ft from wetlands, rivers, streams, and creeks where required.

4. Overflow: Collection from filter strip shall be specified on plans to approved discharge point according to SWMM Section 1.3.

5. Growing Medium: Unless existing vegetated areas are used for the filter strip, growing medium shall be used within the top 18" (Use sand/loam/compost 3–way mix or approved mix that will support healthy plants).

6. Vegetation: The entire filter strip must have 100% coverage by native grasses, native wildflower blends, native ground covers, or any combination thereof.

7. Flow Spreaders: A grade board or sand/gravel trench may be required to disperse the runoff evenly across the filter strip to prevent a point of discharge. The top of the level spreader must be horizontal and at an appropriate height to provide sheetflow directly to the soil without scour. Level spreaders shall not hold a permanent volume of runoff. Grade boards can be made of any material that will withstand weather and solar degradation. Trenches used as level spreaders can be filled with washed crushed rock, pea gravel, or sand

8. Check Dams: shall be placed according to facility design otherwise:
   a. 12" in length
   b. Equal to the width of the filter
   c. 3 to 5" in height
   d. Every 10' where slope exceeds 5%.

9. Inspections: call BDS IVR Inspection Line, (503) 823–7000, for appropriate inspections.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

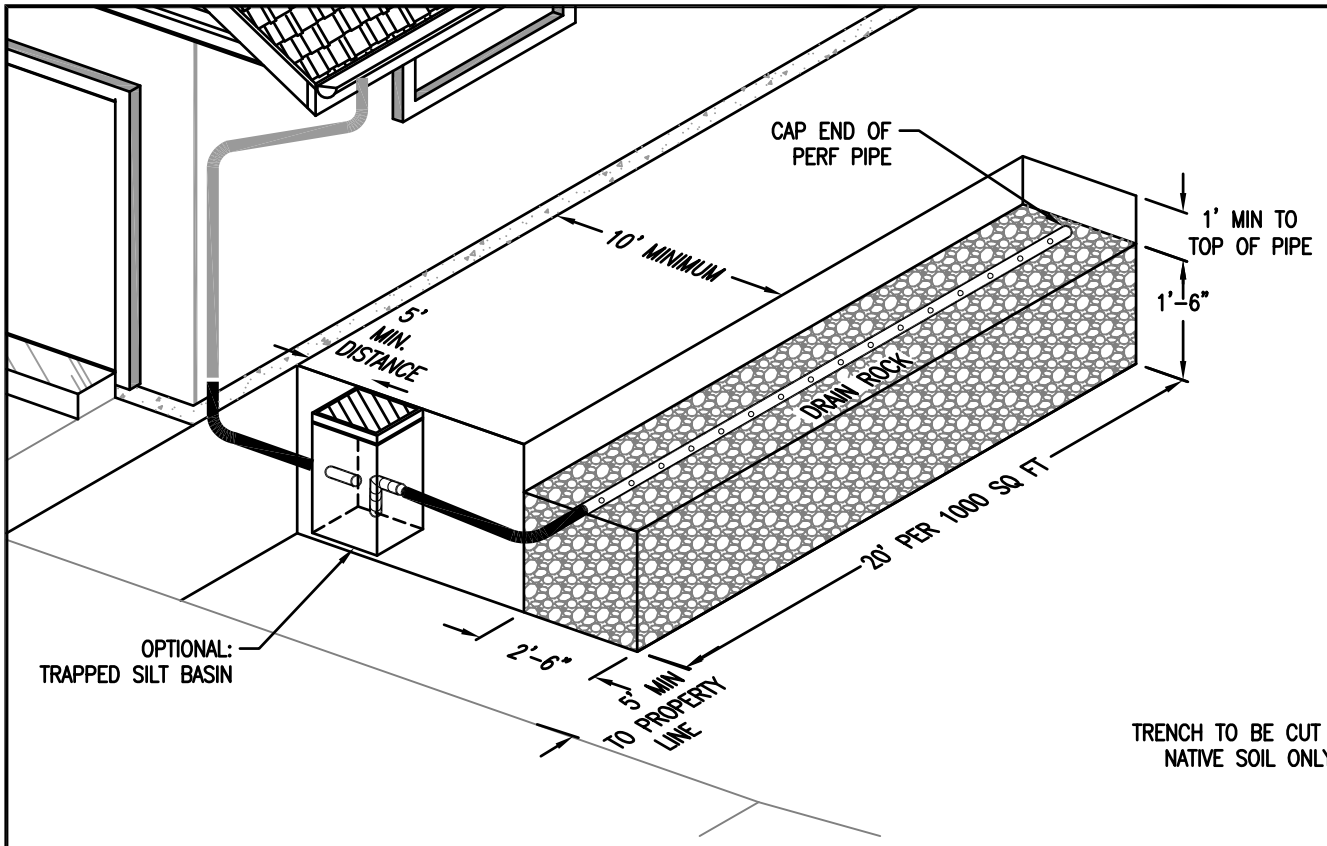
Filter Strip

Bureau of Environmental Services

NUMBER

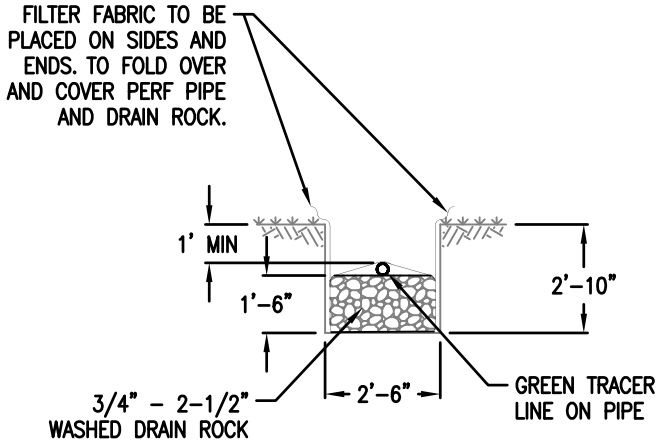
SW–160

7–1–16



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during and after construction.
2. Siting Criteria: Infiltration rate must be 2" per hour minimum. Soakage trench shall not be placed where base of facility has less than 5' of separation to water table.
3. Sizing: 2'–6" wide x 1'–6" tall x 20' long per 1000 square feet of impervious surface.
4. Setbacks: Soakage trench must be 10' from foundations, 5' from property lines, and 20' from cesspools.
5. Piping must be cast iron, ABS or PVC. 3" pipe required for facilities draining up to 1500 sf, otherwise 4" minimum pipe. Uniform Plumbing Code also applies.
6. Trapped Silt Basin: Optional for roof runoff or pedestrian only paved areas.

DETAIL B: SOAKAGE TRENCH CONSTRUCTION



LINE TRENCH SIDES WITH PERMEABLE FILTER FABRIC AS SHOWN, ADD 18" OF DRAIN ROCK. PLACE PERF. PIPE AND COVER ALL.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

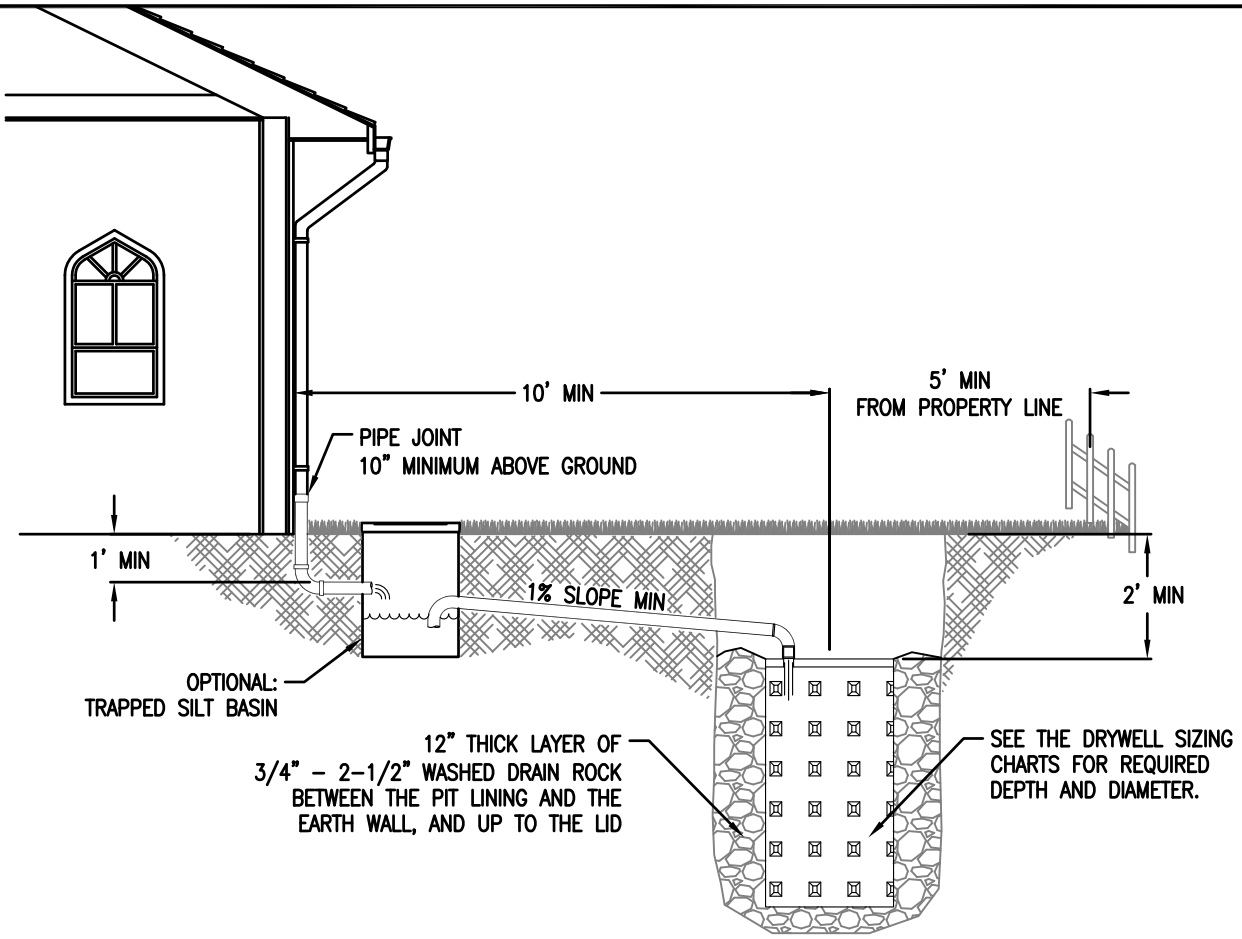
Soakage Trench

Bureau of Environmental Services

NUMBER

SW–170

7–1–16



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during and after construction.
2. Siting Criteria: Gravelly sand, gravelly loamy sand or other equally porous material must occur in a continuous 5' deep stratum within 12' of the ground surface. Drywell shall not be placed where base of facility has less than 5' of separation to water table.
3. Sizing: Exhibit 2–36 is used to size the drywell(s) based on impervious area.
4. Top of drywell must be below lowest finished floor.
5. Setbacks: Drywell must be 10' from foundations, 5' from property lines, and 20' from cesspools.
6. Piping must be cast iron, ABS or PVC. 3" pipe required for facilities draining up to 1500 sf, otherwise 4" minimum pipe. Uniform Plumbing Code also applies.
7. Trapped Silt Basin: Optional for roof runoff or pedestrian only paved areas.

Exhibit 2–36: Drywell Sizing Table

Once approval has been given by BES for onsite infiltration of stormwater, the following chart shall be used to select the number and size of drywells. Gray boxes are acceptable.

IMPERVIOUS Area (sq-ft)	28" Diameter Drywell Depth				48" Diameter Drywell Depth			
	5'	10'	15'	20'	5'	10'	15'	20'
1000								
2000								
3000								
4000								
5000								
6000								
7000								
8000								
9000								
10000								

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

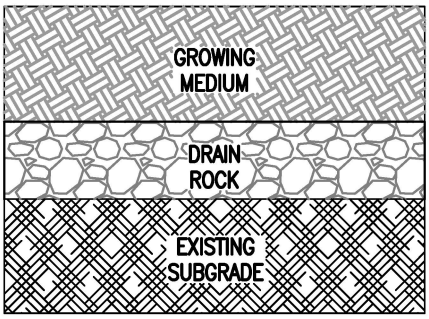
Drywell

Bureau of Environmental Services

NUMBER

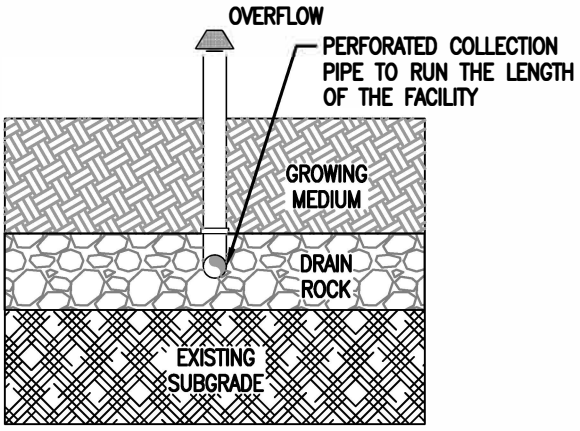
SW–180

7–1–16



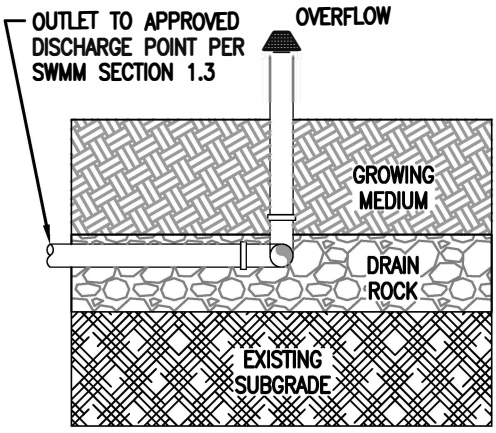
INFILTRATION

STORMWATER HIERARCHY CATEGORY 1



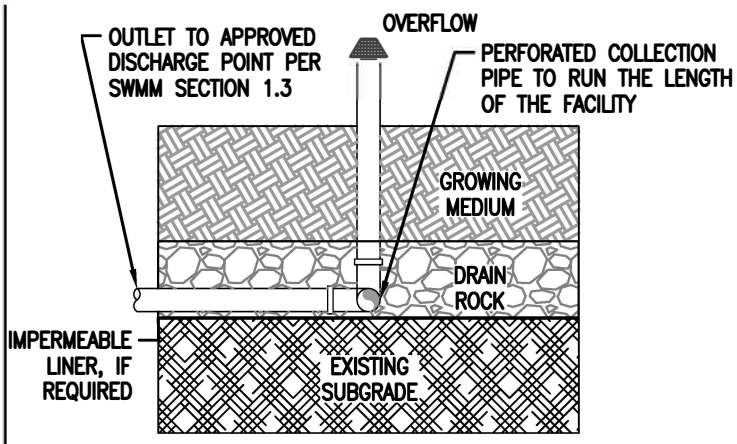
HYBRID

STORMWATER HIERARCHY CATEGORY 2
OVERFLOW DIRECTED TO DRAIN ROCK.



PARTIAL INFILTRATION

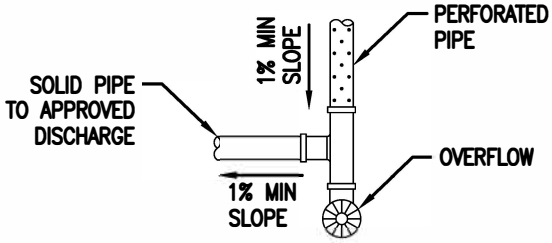
STORMWATER HIERARCHY CATEGORY 3 or 4
OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN WITHIN DRAIN ROCK



LINED

STORMWATER HIERARCHY CATEGORY 3 or 4
OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN AT BASE OF DRAIN ROCK LINER.

NOTE: Hybrid facilities must be registered as a UIC designed under the presumptive approach.



PLAN VIEW

PIPE W/ UNDERDRAIN & DISCHARGE POINT

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Simplified Design Approach –

Facility Overflow Configurations

Bureau of Environmental Services

NUMBER

SW–190

7–1–16

2.3.5 Private Presumptive and Performance Stormwater Facility Typical Details

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SW-200 - Ecoroof

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SW-231 - Planter - Unlined

SW-240 - Basin - Lined

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SW-260 - Filter Strip

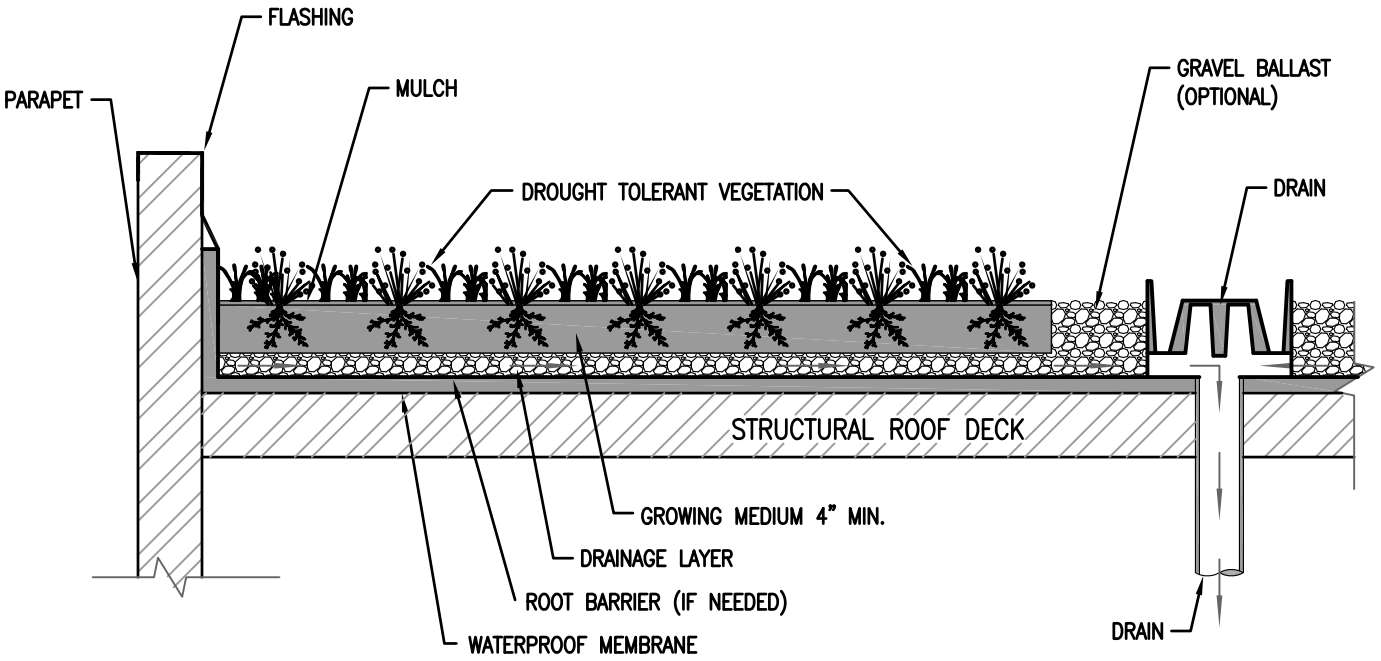
SW-270 - Soakage Trench

SW-280 - Drywell

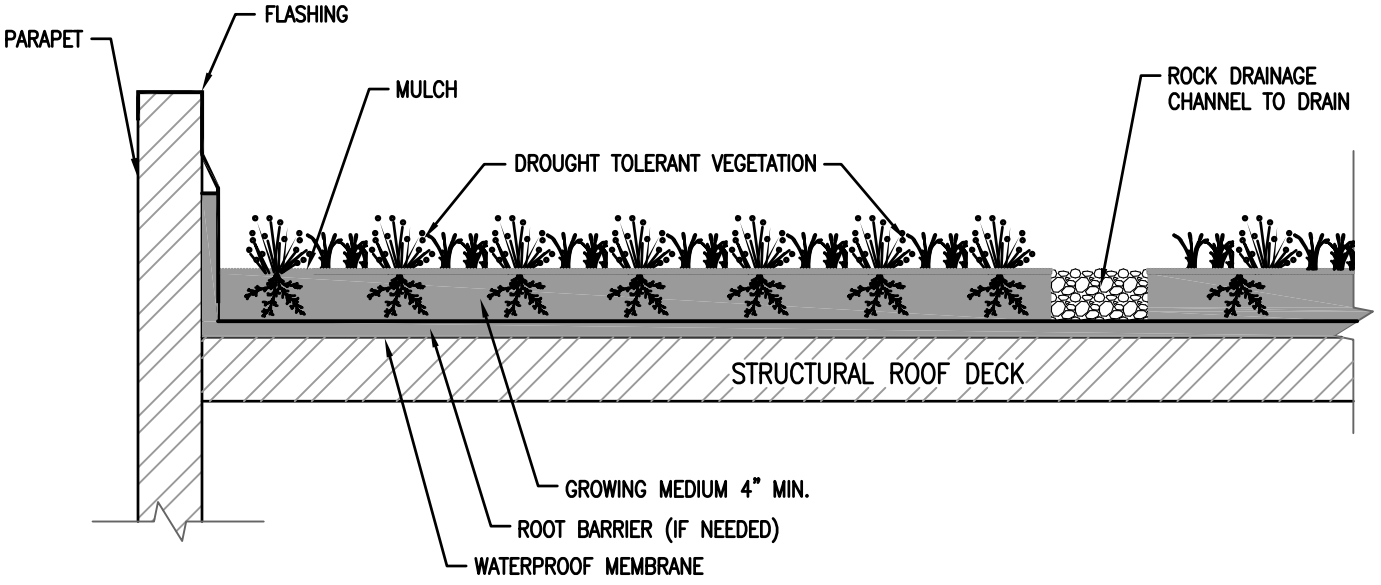
SW-290 - Sand Filter - Infiltration

SW-291 - Sand Filter - Sub-Surface

– DRAWING NOT TO SCALE –



ECOROOF WITH DRAINAGE LAYER



ECOROOF WITH DRAINAGE CHANNELS

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

– Performance Design Approach –

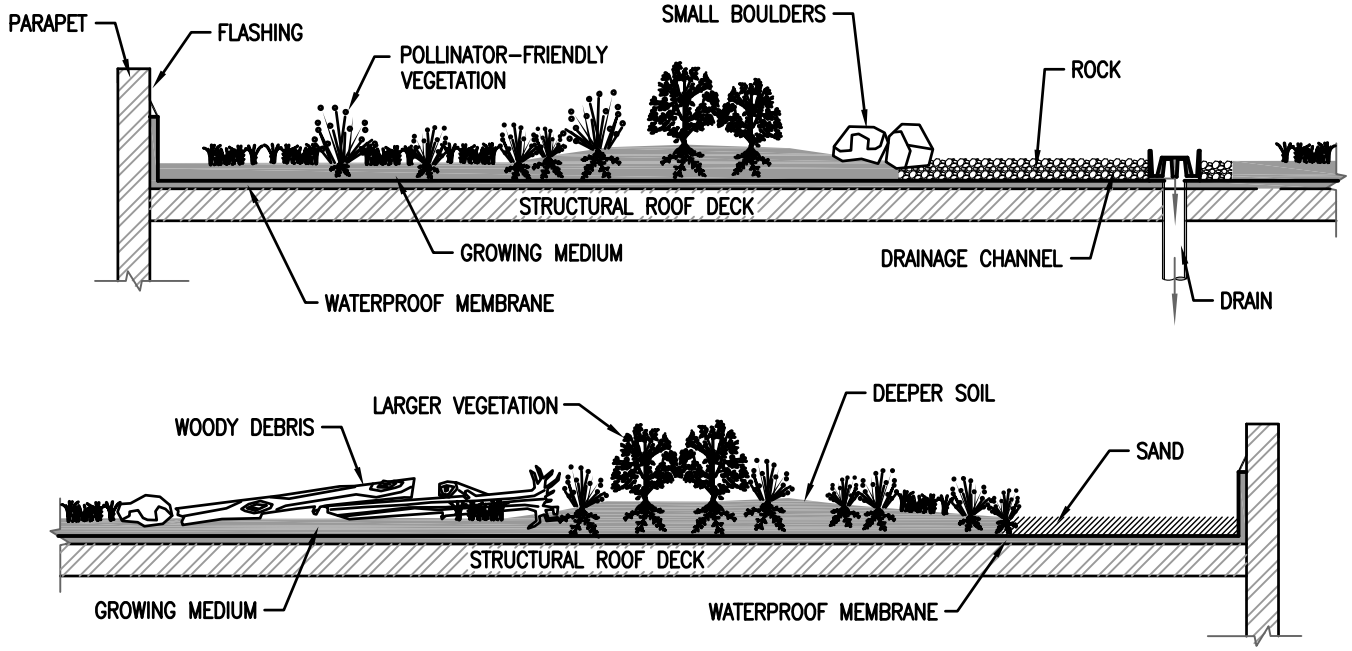
Ecoroof

Bureau of Environmental Services

NUMBER

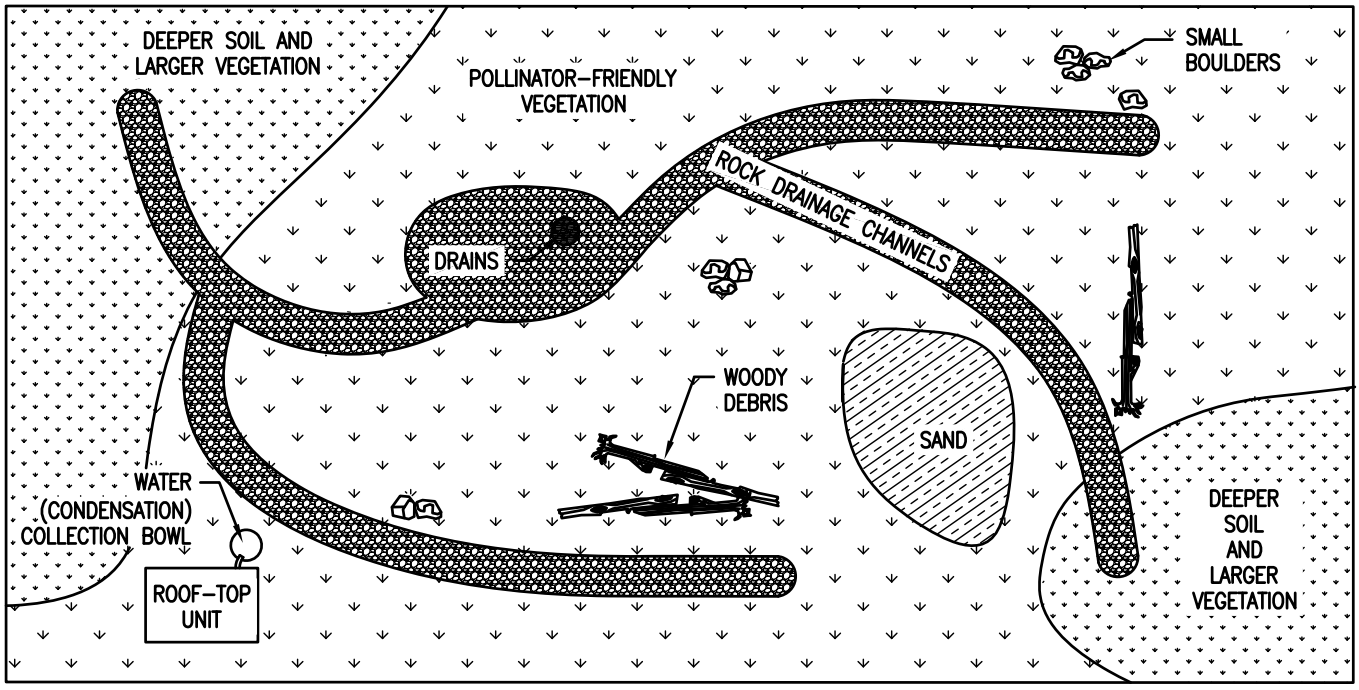
SW–200

7–1–16



HABITAT ECOROOF EXAMPLE SECTIONS

NOTE: Building elements such as glass and lighting placed near ecoroofs have the potential to exacerbate bird–srike mortality. BES recommends designs comply with Portland's Resource Guide for Bird–Friendly Building Design: http://www.portlandoregon.gov/bps/article/446308



HABITAT ECOROOF WITH DRAINAGE CHANNELS – EXAMPLE PLAN

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Performance Design Approach –

Habitat Ecoroof

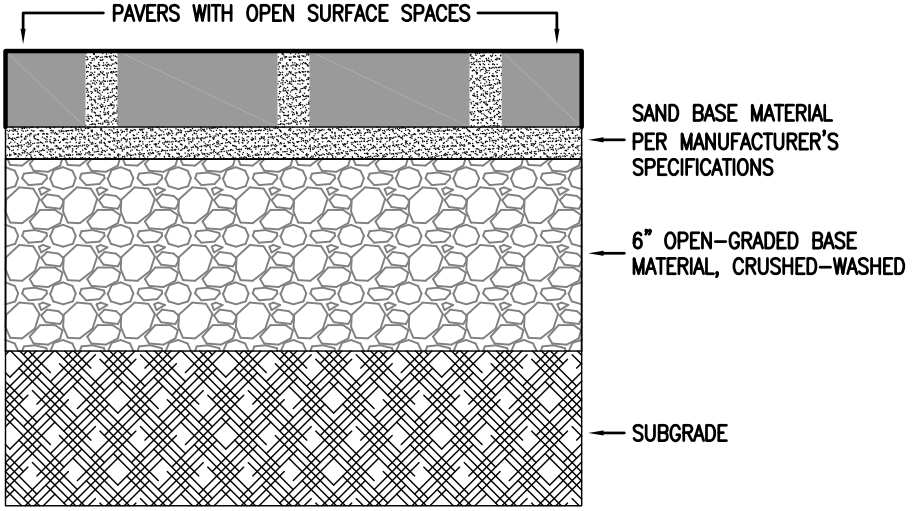
Bureau of Environmental Services

NUMBER

SW–201

7–1–16

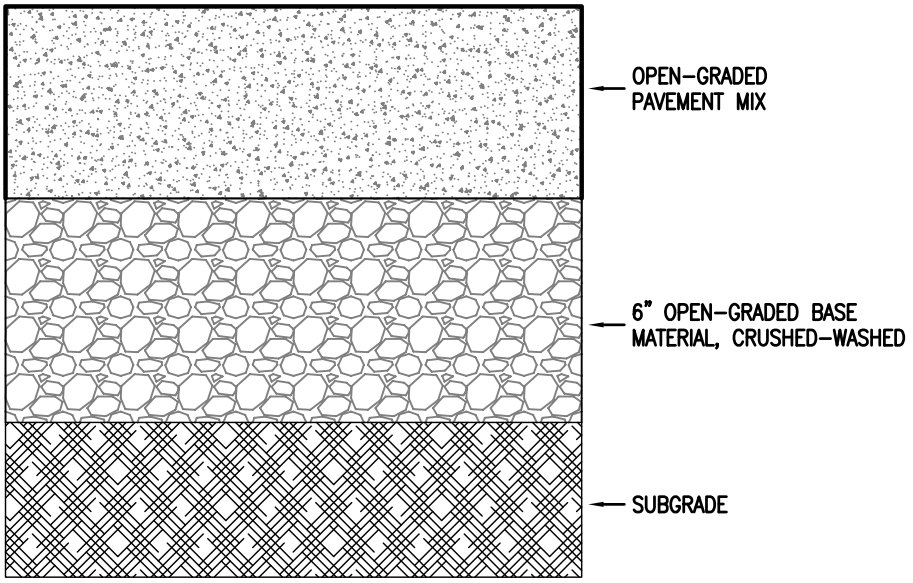
DETAIL INTENDED AS AN EXAMPLE. DETAIL MUST MATCH PAC ASSUMPTIONS AND/OR DESIGN REPORT.



PERMEABLE CONCRETE BLOCK OR "PAVER" SYSTEMS

---

1. Detail intended as an example. Detail must match design report.
2. Pervious pavement for public streets is a case-by-case basis.
3. For all applications, pavement designs must be prepared by a registered professional engineer.



PERVIOUS (OPEN GRADED) CONCRETE AND ASPHALT SYSTEMS

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Performance Design Approach -

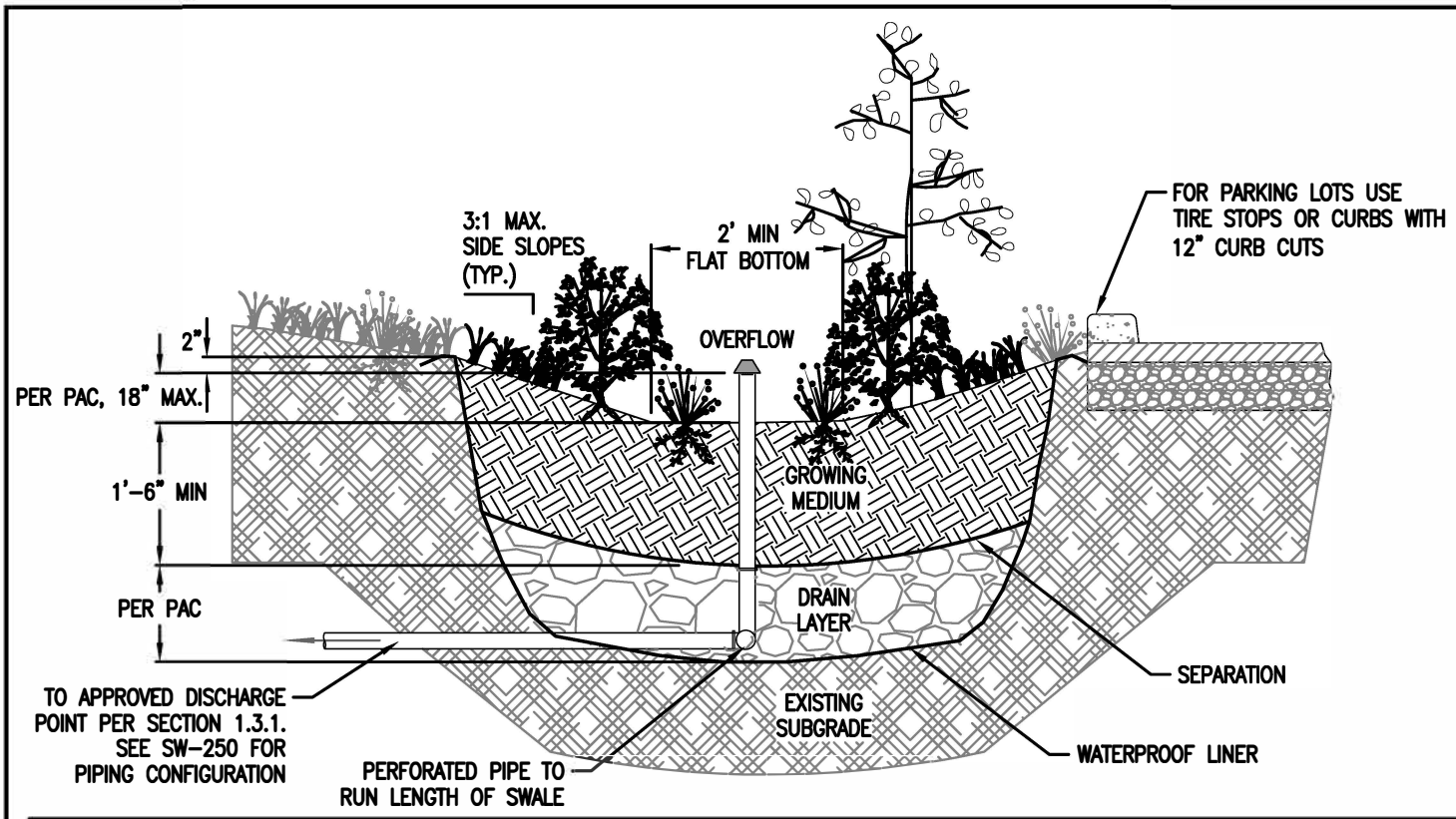
Pervious Pavement

Bureau of Environmental Services

NUMBER

SW-210

7-1-16



NOTES:

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

2. Dimensions:
   Width of swale: 6'-6" minimum
   Depth of swale (from top of growing medium to overflow elevation): per PAC
   Longitudinal slope of swale: 6.0% or less.
   Flat bottom width: 2' minimum.
   Side slopes of swale: per PAC, 3:1 maximum.

3. Setbacks:
   None required.

4. Overflow:
   Swales must connect to approved discharge point according to SWMM Section 1.3.1.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

5. Piping must be ABS Sch.40, cast iron, or PVS Sch.40. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" min. pipe. Piping must have 1% grade and follow the Uniform Plumbing Code.

6. Drain Layer:
   Determined by designer. Options include, but are not limited to drain mat, 3/4" washed round rock, or other approved system.
   Separation between drain and growing medium:
   Use appropriate filter fabric or a gravel lens (3/4 – 1/4 inch washed, rock 2 to 3 inches deep), or as per approved design.

7. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3-way mix, or approved mix that will support healthy plants.
   24" minimum depth is required If the lined facility is also meeting BDS landscape requirements.

8. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM, Section 2.4.1. Minimum container size is #1 container. # 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 must be either at the outlet elevation or the check dam elevation, whichever is lowest.
   If project area is over 200 sf consider adding a tree.

9. Check Dams: Must be placed per PAC and be equal to the width of the swale.

10. Waterproof Lner: 30 mil EPDM, HDPE or approved equivalent.

11. Splash Block: Install 4-6" washed river rock or splash pad for erosion control at inlets and downspout.

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

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Presumptive and Performance Design Approach -

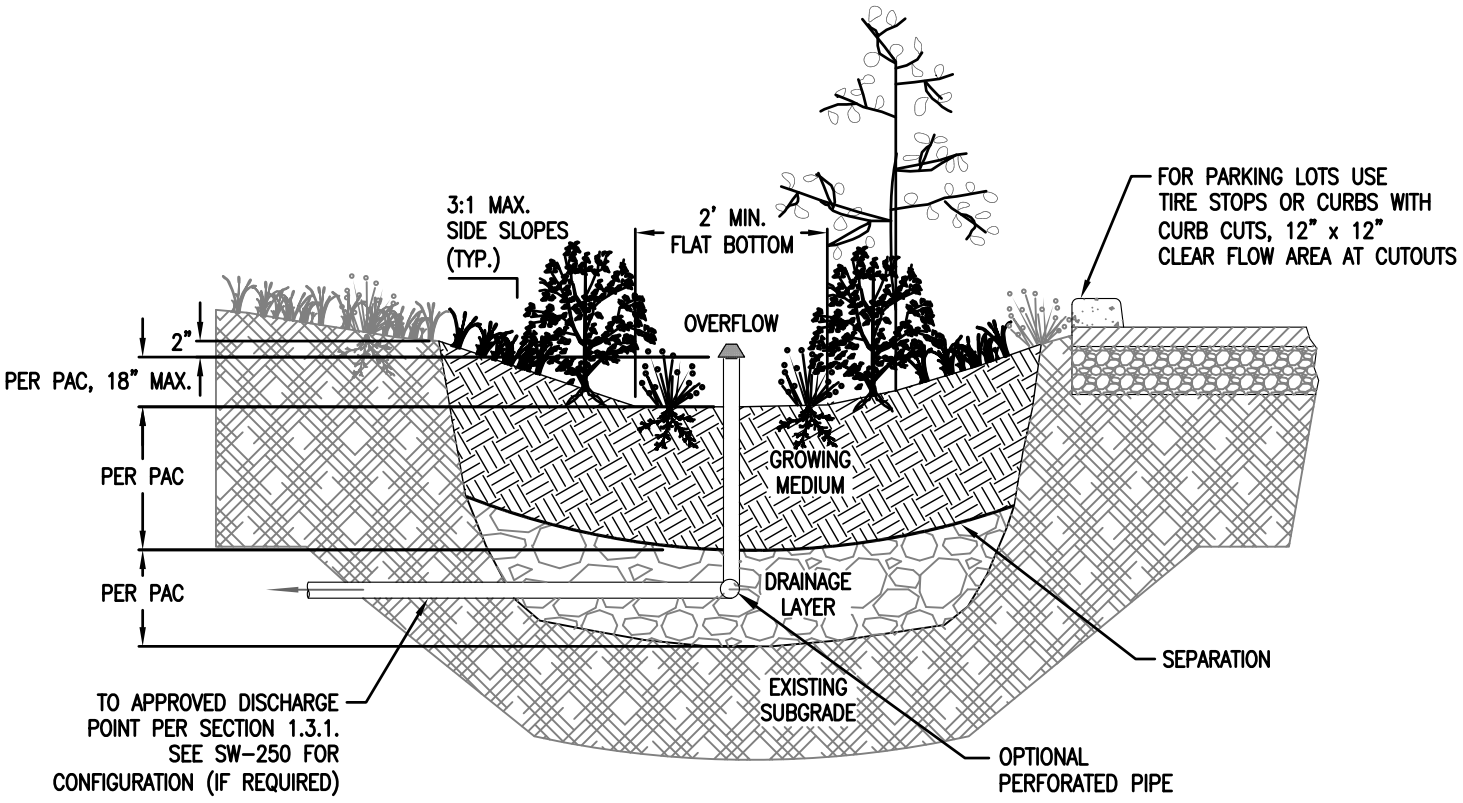
Swale - lined

Bureau of Environmental Services

NUMBER

SW-220

7-1-16



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

2. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

3. Dimensions:
   Width of swale: 6'–6" minimum
   Depth of swale (from top of growing medium to overflow elevation): per PAC
   Longitudinal slope of swale: 6.0% or less.
   Flat bottom width: 2' minimum.
   Side slopes of swale: per PAC, 3:1 maximum.

4. Setbacks:
   Swale must be 10' away from foundation and 5' away from property lines.

5. Overflow:
   Swales must connect to approved discharge point according to SWMM Section 1.3.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

6. Piping must be ABS Sch.40, cast iron, or PVS Sch.40. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" min. pipe. Piping must have 1% grade and follow the Uniform Plumbing Code.

7. Drain Layer: If needed 3/4" – 1 ½" washed rock or as approved. Depth per PAC.

8. Separation between drain rock and growing medium: if needed pea gravel lens, 2 to 3 inches deep or as approved.

9. Growing Medium:
   Use sand/loam/compost 3–way mix, or approved mix that will support healthy plants. 18" minimum depth if there is a drainage layer. If soils are well draining and there is not a drainage layer depth may be reduced as approved.

10. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM, Section 2.4.1. Minimum container size is #1 container. # 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 must be either at the outlet elevation or the check dam elevation, whichever is lowest.
    If project area is over 200sf consider adding a tree.

11. Check Dams: Must be placed per PAC and be equal to the width of the swale.

12. Splash Block: Install 4–6" washed river rock or splash pad for erosion control at inlets and downspout.

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

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Presumptive and Performance Design Approach –

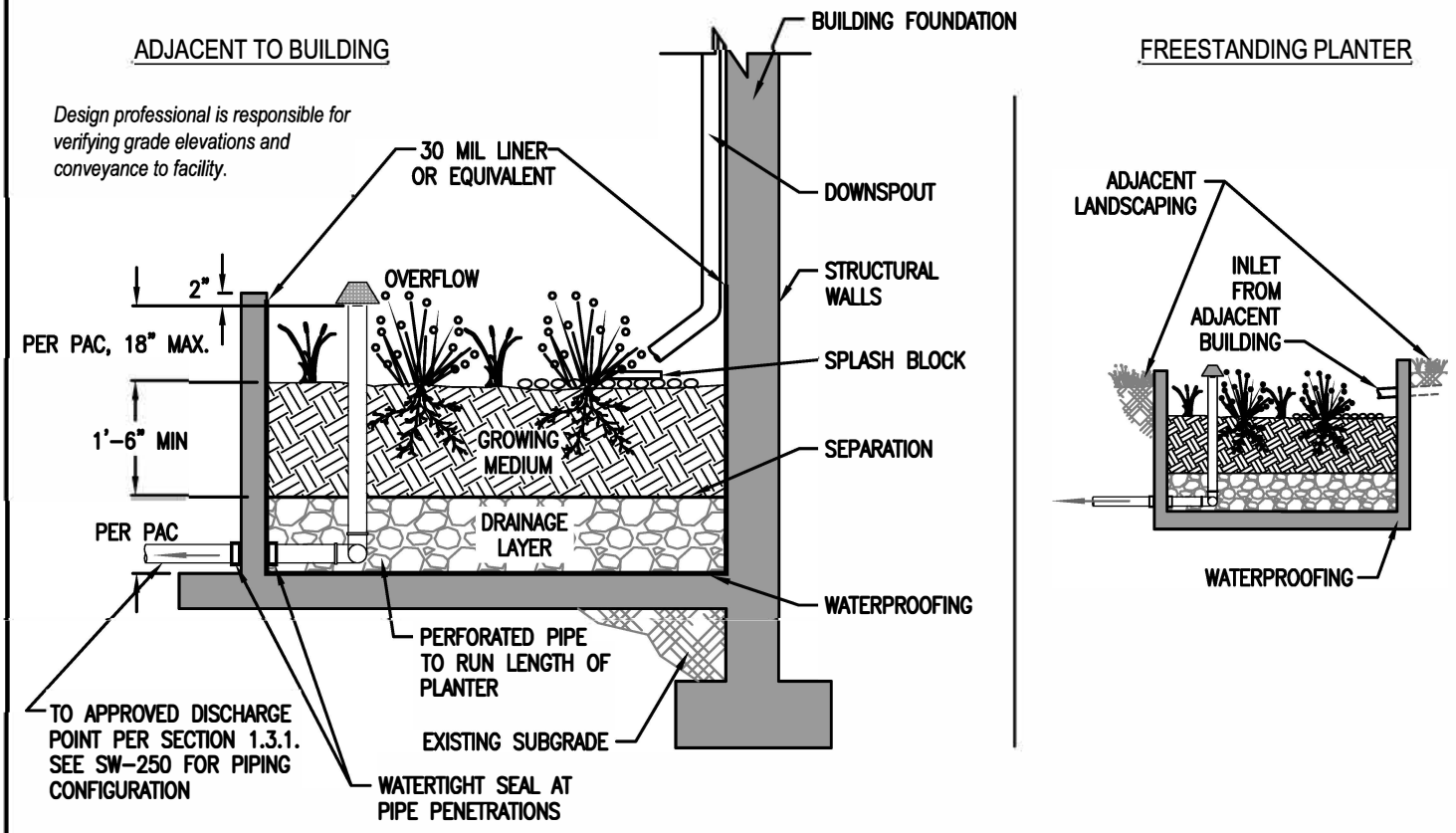
Swale – unlined

Bureau of Environmental Services

NUMBER

SW–221

7–1–16



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

2. Dimensions:
   Width of planter: 24" minimum.
   Depth of planter (from top of growing medium to overflow elevation): per PAC calculations.
   Longitudinal slope of planter: 0.5% or less.

3. Setbacks:
   Planters must be less than 30" in height above finish grade if within 5-feet of property line.

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

5. Waterproofing:
   If planter is monolithically poured no additional liner/waterproofing is required. Check state structural requirements for foundations.

6. Piping must be ABS Sch.40, cast iron, or PVS Sch.40. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" min. pipe. Piping must have 1% grade and follow the Uniform Plumbing Code.

7. Drain Layer:
   Determined by designer. Options include, but are not limited to drain mat, 3/4" washed round rock, or other approved system.
   Separation between drain and growing medium:
   Use appropriate filter fabric or a gravel lens (3/4 – 1/4 inch washed, crushed rock 2 to 3 inches deep), or as per approved design.

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

9. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3-way mix, or approved mix that will support healthy plants.
   24" minimum depth is required if the lined facility is also meeting BDS landscape requirements.

10. Vegetation: Refer to plant list in SWMM, Section 2.4.1. Minimum container size is #1 container. # of plantings per 100sf of facility area:
    80 herbaceous plants OR;
    72 herbaceous plants and 4 small shrubs.

11. Splash Block: Install 4-6" washed river rock or splash pad for erosion control at inlets and downspout.

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

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

– Presumptive and Performance Design Approach –

Planter – lined

Bureau of Environmental Services

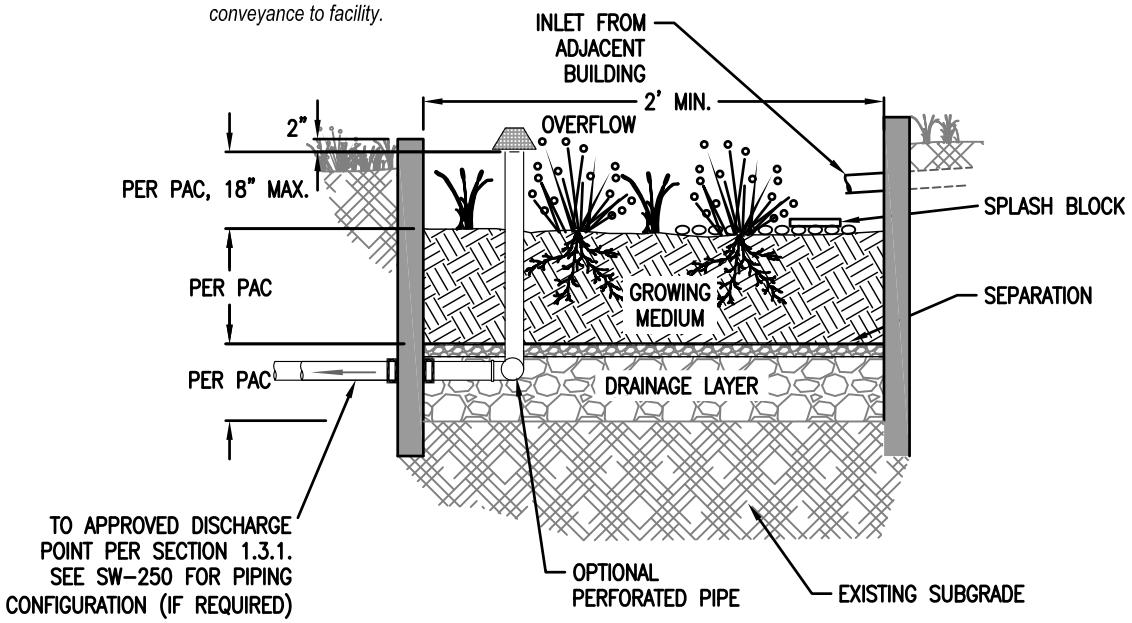
NUMBER

SW-230

7-1-16

ADJACENT TO LANDSCAPING

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



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

2. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

3. Dimensions:
   Width of planter: 24" minimum.
   Depth of planter (from top of growing medium to overflow elevation): per PAC calculations.
   Longitudinal slope of planter: 0.5% or less.

4. Setbacks:
   Planters must be 5-feet from property line and 10-feet from building foundations.

5. Planter Walls:
   Material must be concrete, unless otherwise approved.

6. Piping must be ABS Sch.40, cast iron, or PVS Sch.40. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" min. pipe. Piping must have 1% grade and follow the Uniform Plumbing Code.

7. Drain Layer:
   Per PAC calculations. Options include, but are not limited to drain mat, 3/4" washed rock, or other approved system.
   Separation between drain and growing medium:
   Use appropriate filter fabric or a gravel lens (3/4 – 1/4 inch washed, crushed rock 2 to 3 inches deep), or as per approved design.

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

9. Growing Medium:
   Use sand/loam/compost 3-way mix, or approved mix that will support healthy plants. 18" minimum depth if there is a drainage layer. If soils are well draining and there is not a drainage layer depth may be reduced as approved.

10. Vegetation: Refer to plant list in SWMM, Section 2.4.1. Minimum container size is #1 container. # of plantings per 100sf of facility area:
    80 herbaceous plants OR;
    72 herbaceous plants and 4 small shrubs.

11. Splash Block: Install 4-6" washed river rock or splash pad for erosion control at inlets and downspout.

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

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Presumptive and Performance Design Approach –

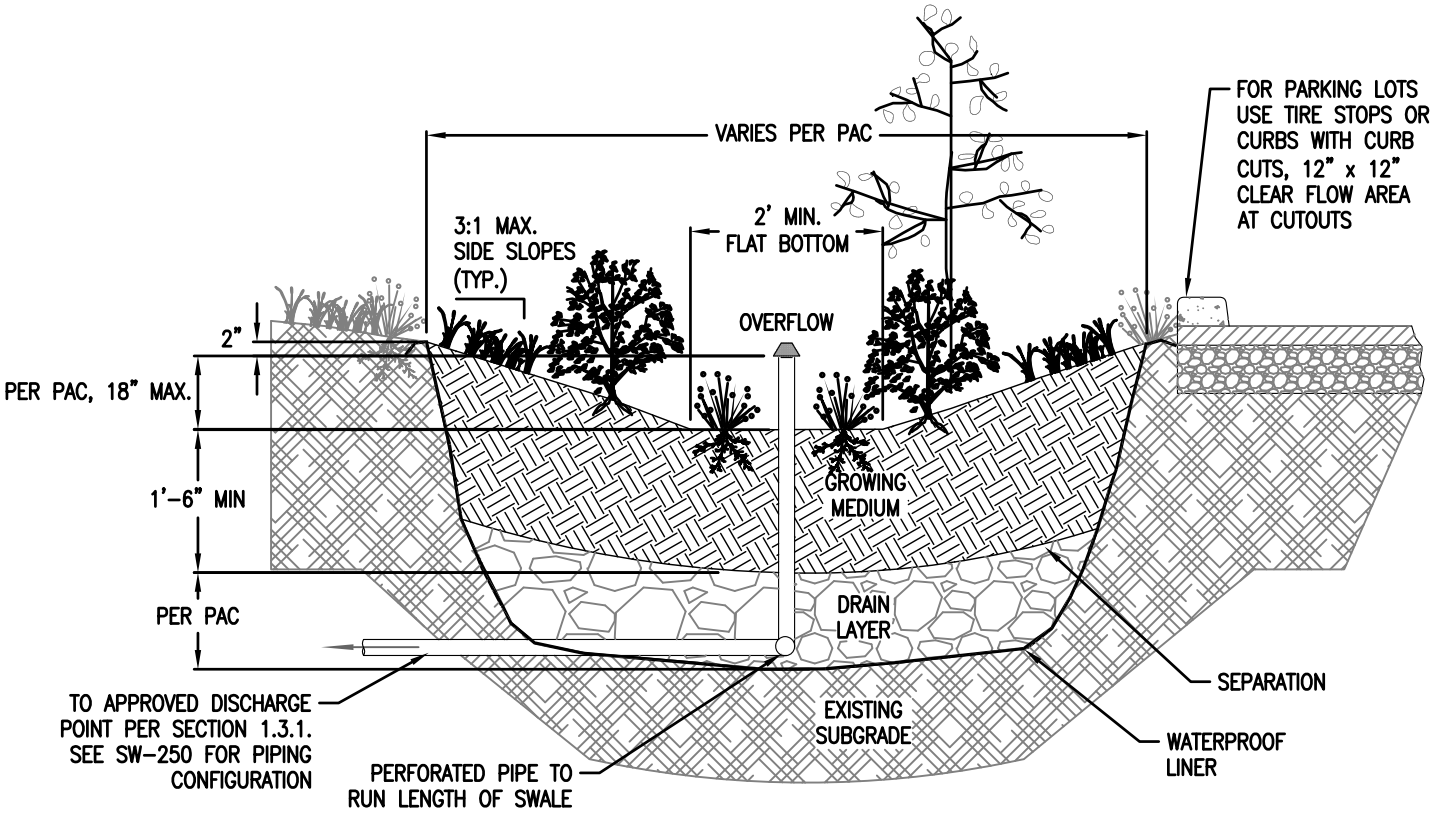
Planter – unlined

Bureau of Environmental Services

NUMBER

SW–231

7–1–16



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

2. Dimensions:
   Width of basin: 5' minimum
   Depth of basin (from top of growing medium to overflow elevation): per PAC
   Flat bottom width: 2' minimum.
   Side slopes of swale: Per PAC, 3:1 maximum.

3. Setbacks: None required.

4. Overflow:
   Basins must connect to approved discharge point according to SWMM Section 1.3.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

5. Piping must be ABS Sch.40, cast iron, or PVS Sch.40. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" min. pipe. Piping must have 1% grade and follow the Uniform Plumbing Code.

6. Drain Layer:
   Determined by designer. Options include, but are not limited to drain mat, 3/4" washed round rock, or other approved system.

7. Separation between drain and growing medium:
   Use appropriate filter fabric or a gravel lens (3/4 – 1/4 inch washed, crushed rock 2 to 3 inches deep), or as per approved design.

8. Growing Medium:
   18" minimum depth. Use sand/loam/compost 3-way mix, or approved mix that will support healthy plants.
   24" minimum depth is required If the lined facility is also meeting BDS landscape requirements.

9. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Section 2.4.1. Minimum container size is #1 container. # 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.

10. Waterproof Liner: 30 mil EPDM, HDPE or approved equivalent.

11. Splash Block: Install 4-6" washed river rock or splash pad for erosion control at inlets and downspout.

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

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Presumptive and Performance Design Approach –

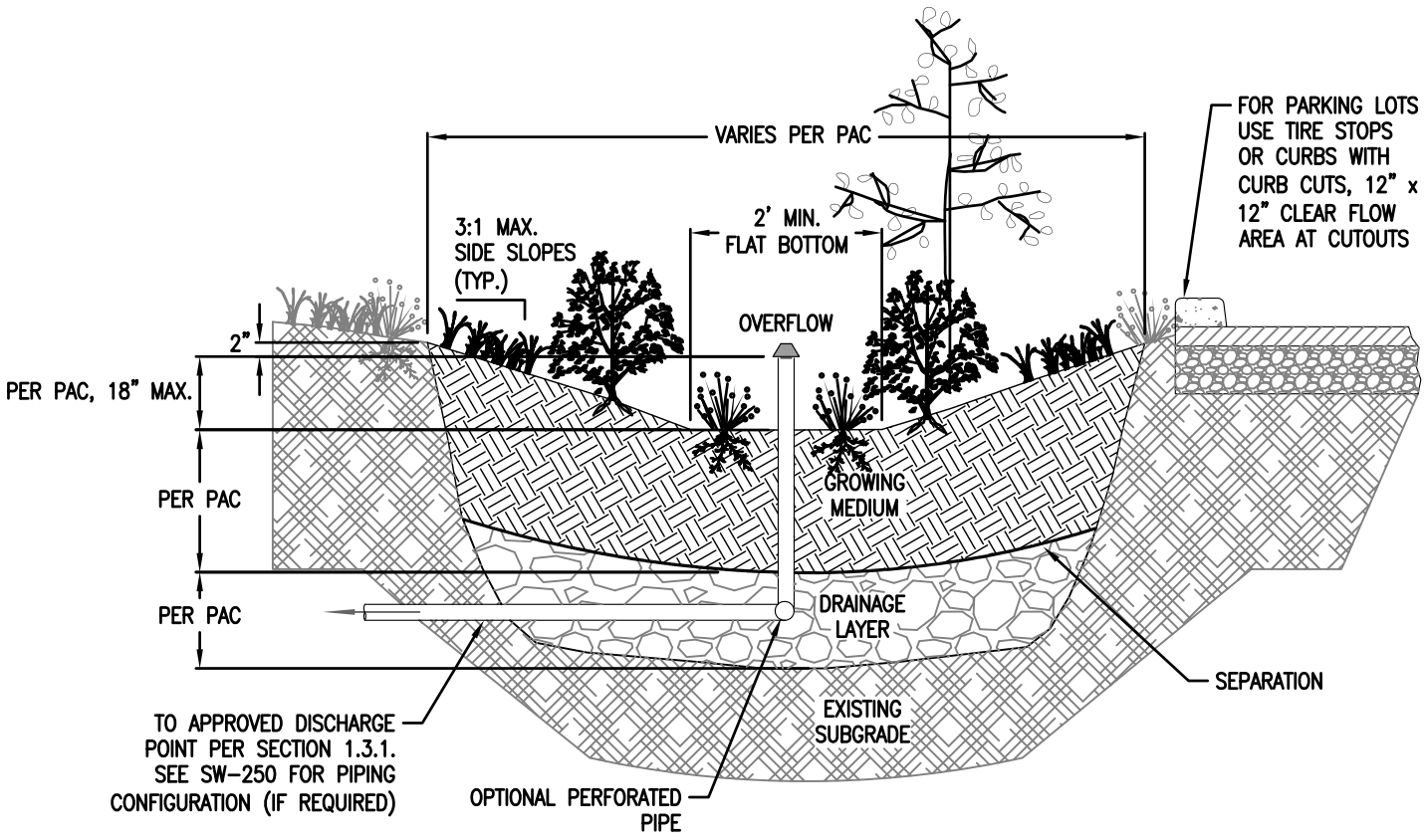
Basin – lined

Bureau of Environmental Services

NUMBER

SW-240

7-1-16



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

2. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

3. Dimensions:
   Width of basin: 5' minimum
   Depth of basin(from top of growing medium to overflow elevation): Per PAC
   Flat bottom width: 2' minimum.
   Side slopes of swale: 3:1 maximum.

4. Setbacks:
   Basin must be 10' away from foundations and 5' away from property lines.

5. Overflow:
   Basins must connect to approved discharge point according to SWMM Section 1.3.
   Inlet elevation must allow for 2" of freeboard, minimum.
   Protect from debris and sediment with strainer or grate.

6. Piping must be ABS Sch.40, cast iron, or PVS Sch.40. 3" pipe required for facilities draining up to 1500 s.f., otherwise 4" min. pipe. Piping must have 1% grade and follow the Uniform Plumbing Code.

7. Drain Layer: If needed 3/4" – 1 ½" washed rock or as approved. Depth per PAC.

   Separation between drain rock and growing medium: if needed, pea gravel lens, 2 to 3 inches deep or as approved.

8. Growing Medium:
   Use sand/loam/compost 3–way mix, or approved mix that will support healthy plants. 18" minimum depth if there is a drainage layer. If soils are well draining and there is not a drainage layer depth may be reduced as approved.

9. Vegetation: Follow landscape plans otherwise refer to plant list in SWMM Section 2.4.1. Minimum container size is #1. # 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.

10. Splash Block: Install 4–6" washed river rock or splash pad for erosion control at inlets and downspout.

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

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Presumptive and Performance Design Approach –

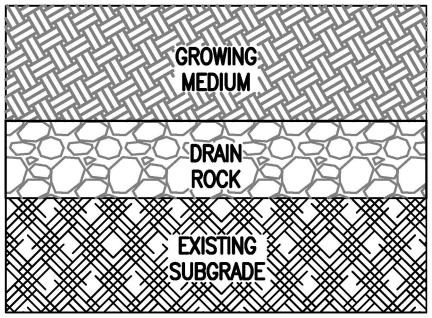
Basin – unlined

Bureau of Environmental Services

NUMBER

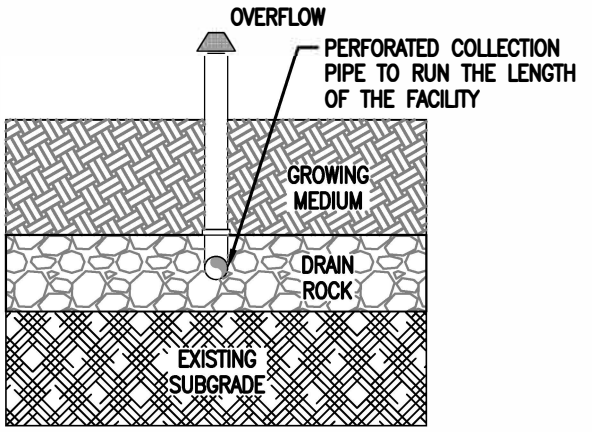
SW–241

7–1–16



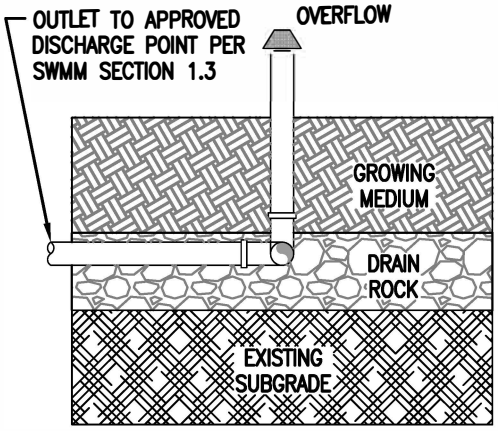
INFILTRATION

STORMWATER HIERARCHY CATEGORY 1
PAC CONFIGURATION A, B



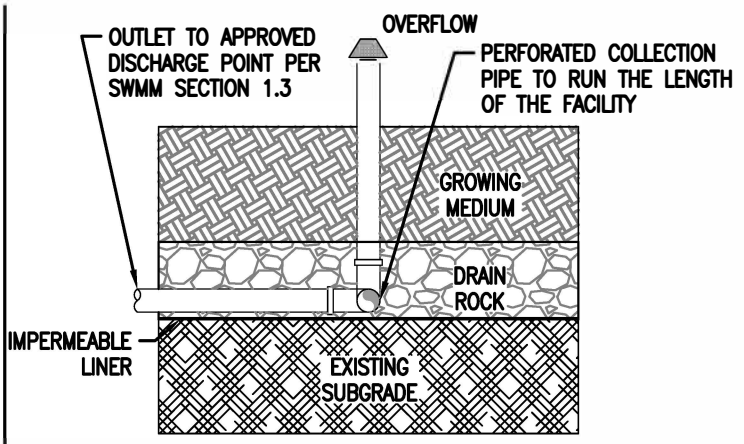
HYBRID

STORMWATER HIERARCHY CATEGORY 2
OVERFLOW DIRECTED TO DRAIN ROCK.
(SEE SW-251 AND SW-252 FOR MORE INFORMATION)
PAC CONFIGURATION E, F



PARTIAL INFILTRATION

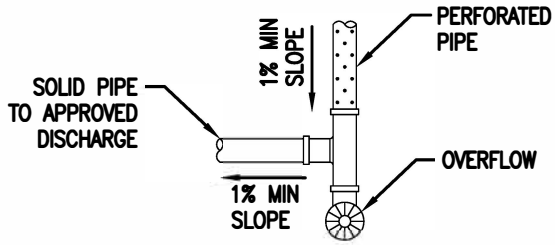
STORMWATER HIERARCHY CATEGORY 3 or 4
OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN WITHIN DRAIN ROCK.
PAC CONFIGURATION C



LINED

STORMWATER HIERARCHY CATEGORY 3 or 4
OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN AT BASE OF DRAIN ROCK LINER.
PAC CONFIGURATION D

NOTE: Hybrid facilities must be registered as a UIC designed under the presumptive approach.



PLAN VIEW

PIPE W/ UNDERDRAIN & DISCHARGE POINT

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

– Presumptive Design Approach –

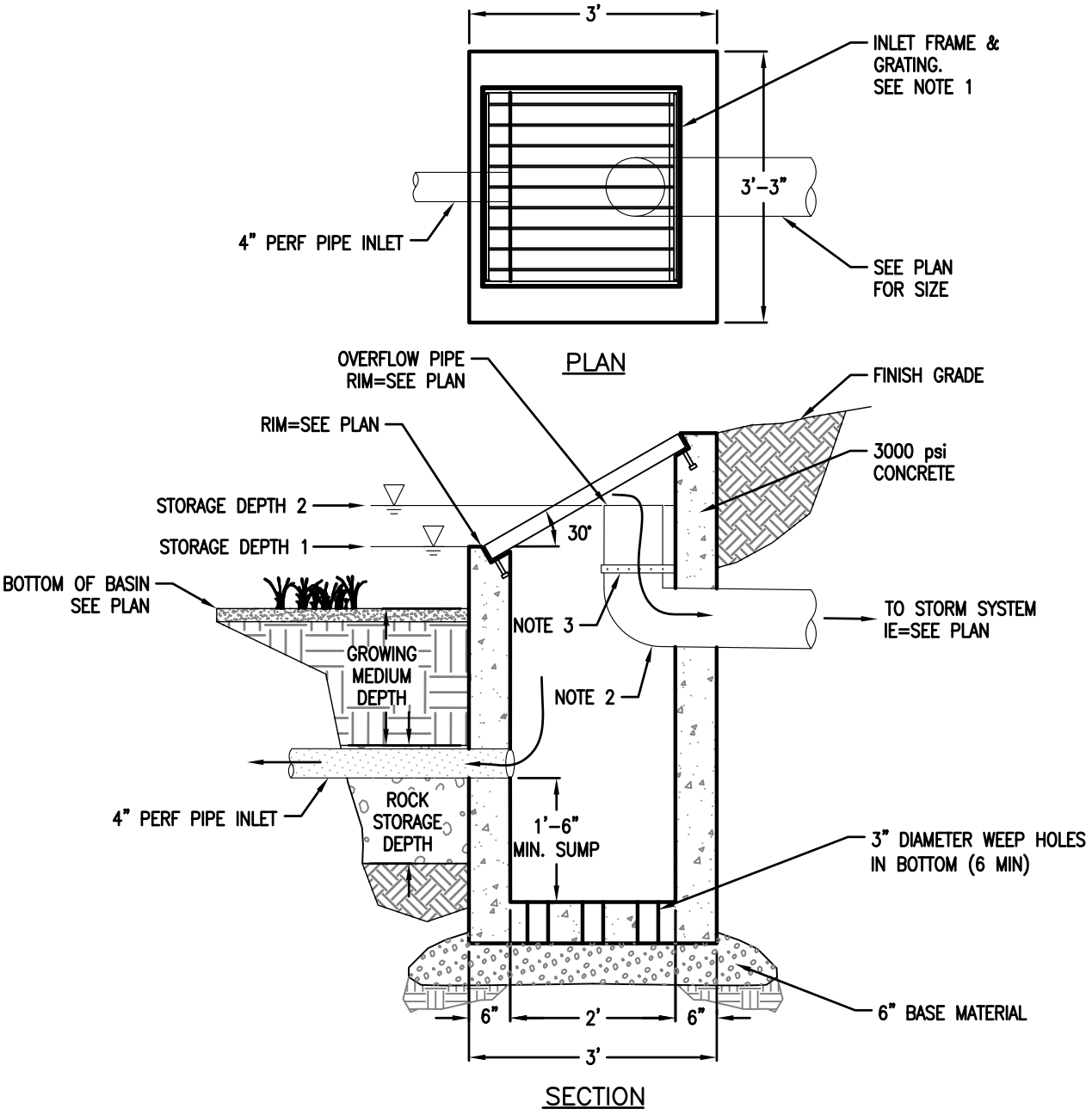
Facility Overflow Configurations

Bureau of Environmental Services

NUMBER

SW–250

7–1–16



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.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Presumptive Design Approach –

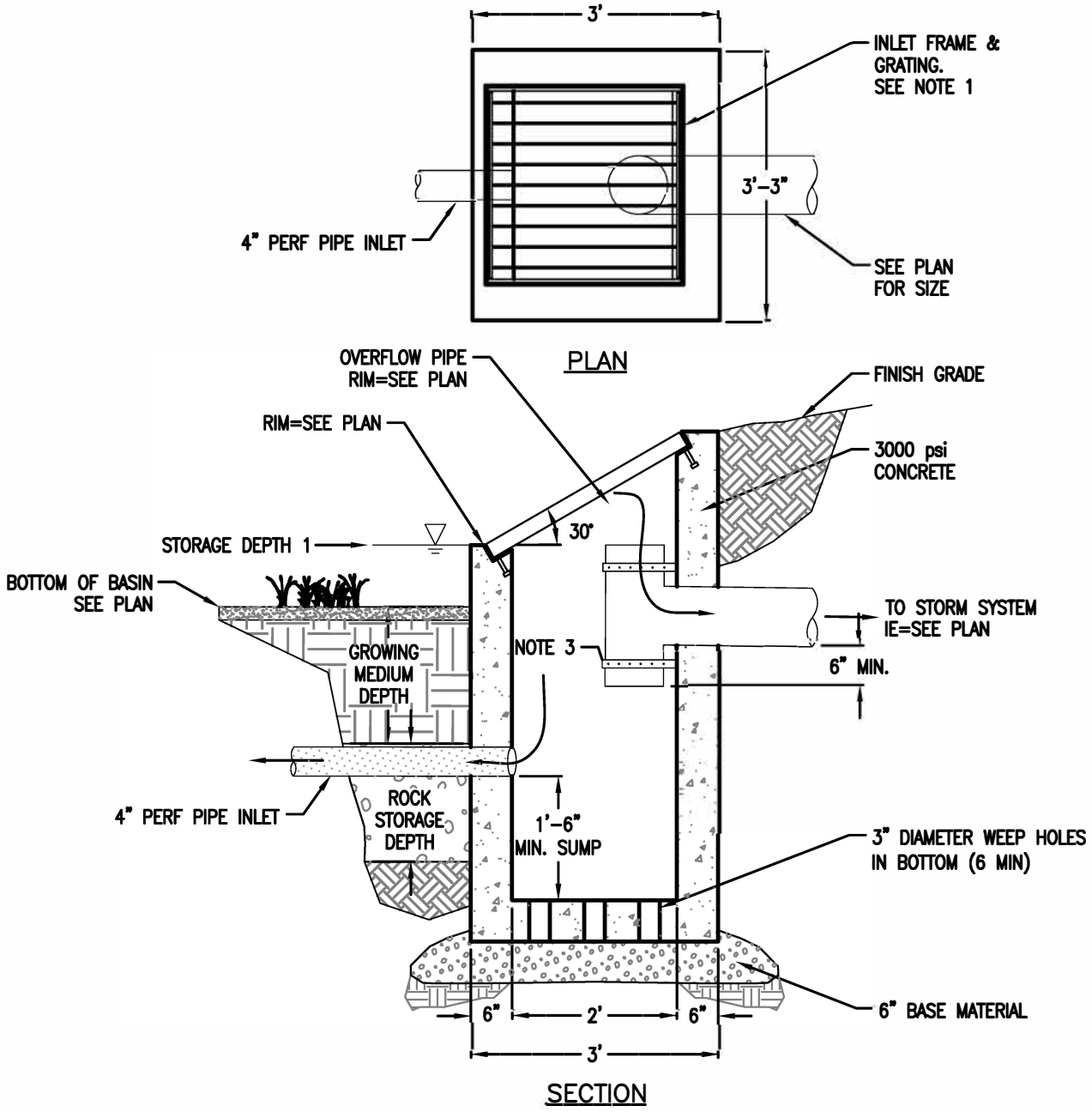
Facility Overflow Configuration E

Bureau of Environmental Services

NUMBER

SW–251

7–1–16



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.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

– Presumptive Design Approach –

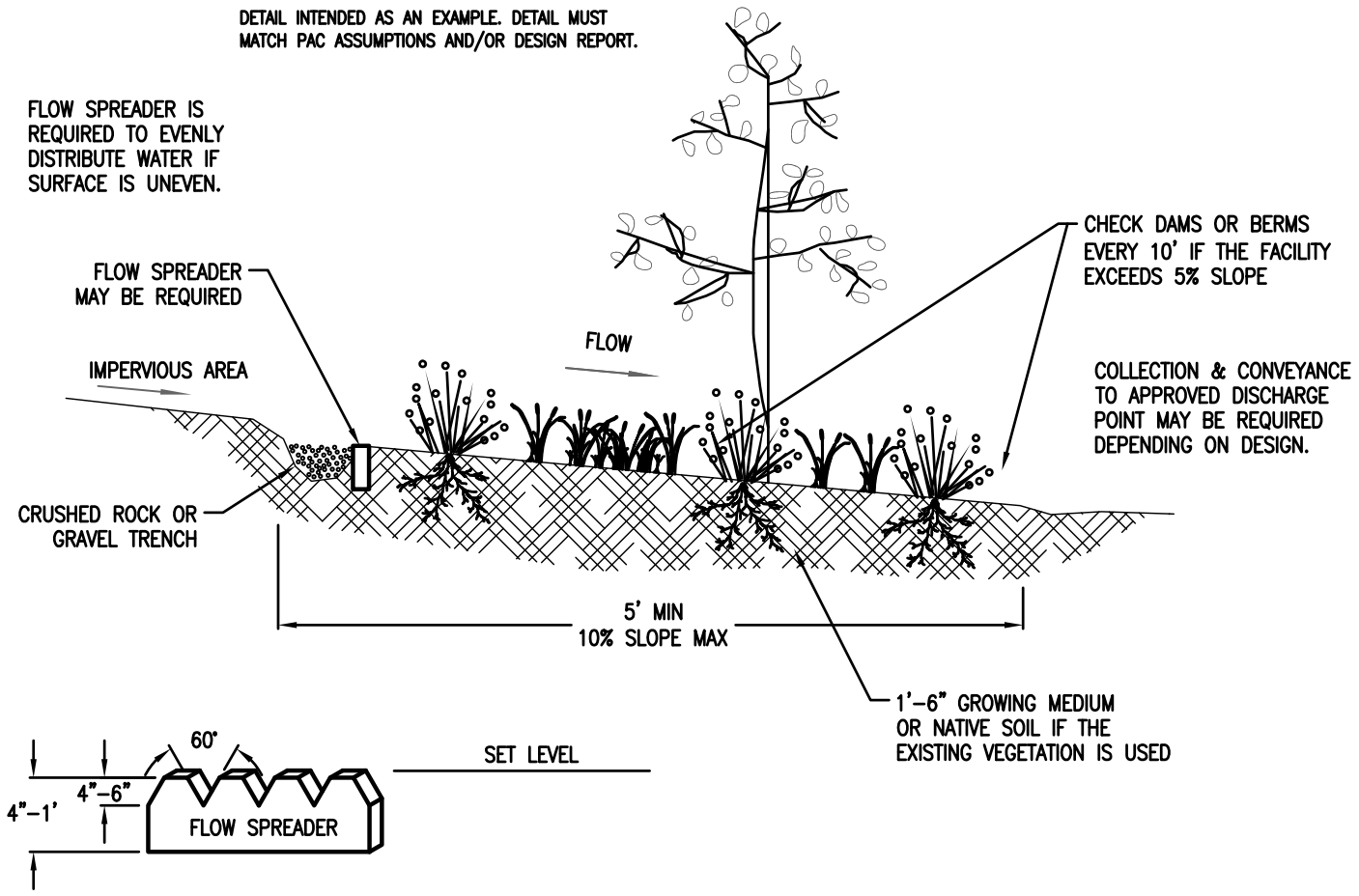
Facility Overflow Configuration F

Bureau of Environmental Services

NUMBER

SW–252

7–1–16



1. Detail intended as an example. Detail must match PAC assumptions and/or design report.
2. Provide protection from all vehicle traffic, equipment staging, as well as foot traffic for proposed infiltration areas prior to and during construction.
3. Dimensions:
   a. Flow line length: 5' minimum.
   b. Slopes: 0.5 – 10%
4. Setbacks (from beginning of facility):
   a. 5' from property line
   b. 10ft from buildings
   c. 50ft from wetlands, rivers, streams, and creeks where required.
5. Overflow: Collection from filter strip must be specified on plans to approved discharge point according to SWMM Section 1.3.
6. Growing Medium: Unless existing vegetated areas are used for the filter strip, growing medium must be used within the top 18" (Or approved mix. Use sand/loam/compost 3-way mix).
7. Vegetation: The entire filter strip must have 100% coverage by native grasses, native wildflower blends, native ground covers, or any combination thereof.
8. Flow Spreaders: A grade board or sand/gravel trench may be required to disperse the runoff evenly across the filter strip to prevent a point of discharge. The top of the level spreader must be horizontal and at an appropriate height to provide sheetflow directly to the soil without scour. Level spreaders must not hold a permanent volume of runoff. Grade boards can be made of any material that will withstand weather and solar degradation. Trenches used as level spreaders can be filled with washed crushed rock, pea gravel, or sand
9. Check Dams: must be placed according to facility design otherwise:
   a. Equal to the width of the filter
   b. 3 to 5" in height
   c. Every 10' where slope exceeds 5%.
9. Inspections: call BDS IVR Inspection Line, (503) 823-7000, for appropriate inspections.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Performance Design Approach –

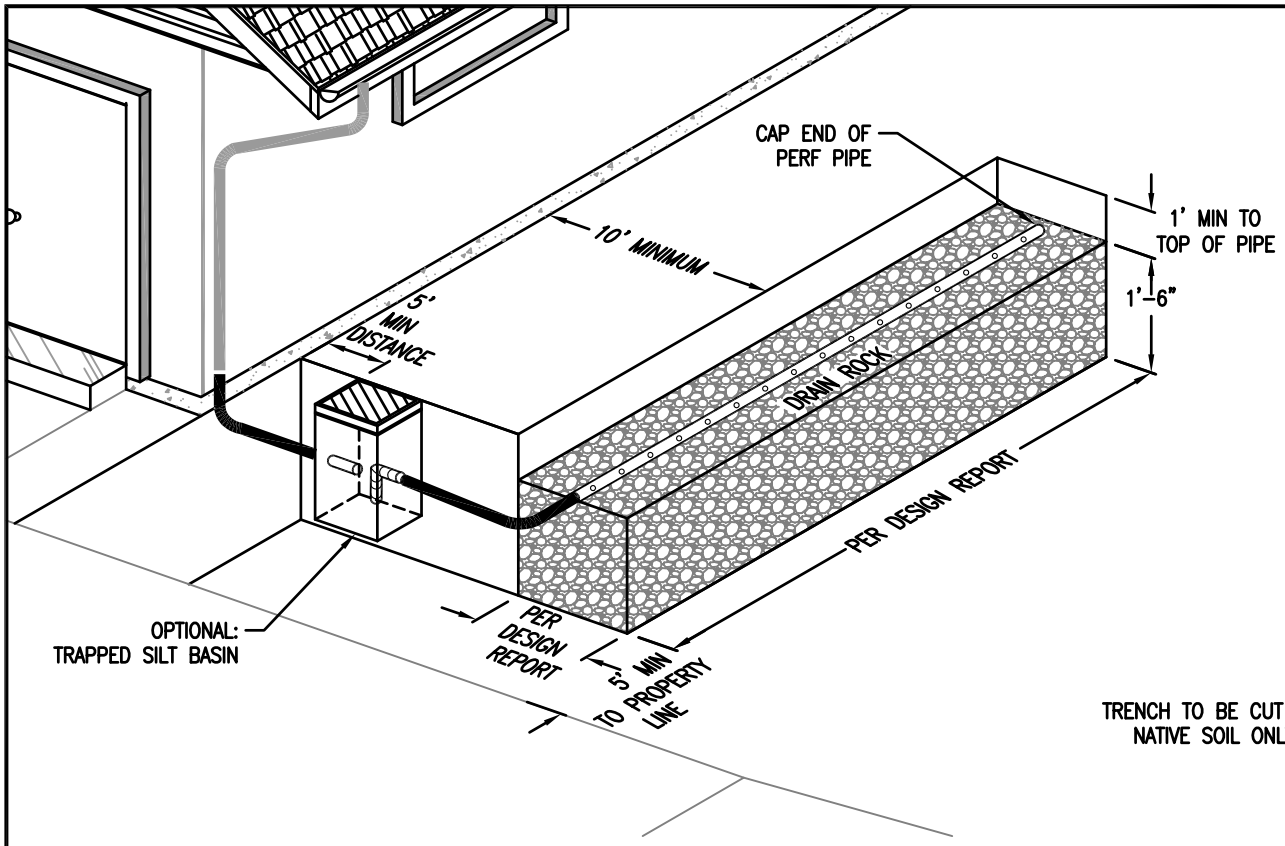
Filter Strip

Bureau of Environmental Services

NUMBER

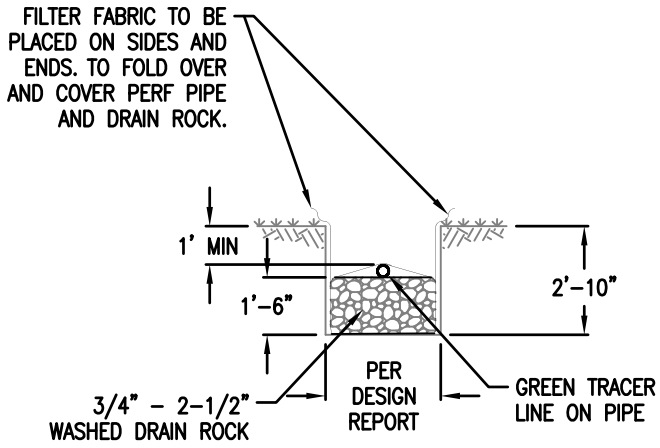
SW–260

7–1–16



1. Detail intended as an example. Detail must match design report.
2. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during and after construction.
3. Siting Criteria: Soakage trench must not be placed where base of facility has less than 5' of separation to water table.
4. Sizing: Per design report.
5. Setbacks: Soakage trench measured from outside edge of facility, must be 10' from foundations, 5' from property lines, and 20' from cesspools.
6. Piping: must be ABS Sch.40, cast iron, or PVC Sch.40. 3" pipe required for up to 1,500 sq ft of impervious area, otherwise 4" min. Piping must have 1% grade and follow the Uniform Plumbing Code.
7. Trapped Silt Basin: Optional for roof runoff or pedestrian-only paved areas.

SOAKAGE TRENCH CONSTRUCTION-SECTION



LINE TRENCH SIDES WITH FILTER FABRIC AS SHOWN, ADD 18" OF DRAIN ROCK. PLACE PERF. PIPE AND COVER ALL.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT TYPICAL DETAILS

- Performance Design Approach -

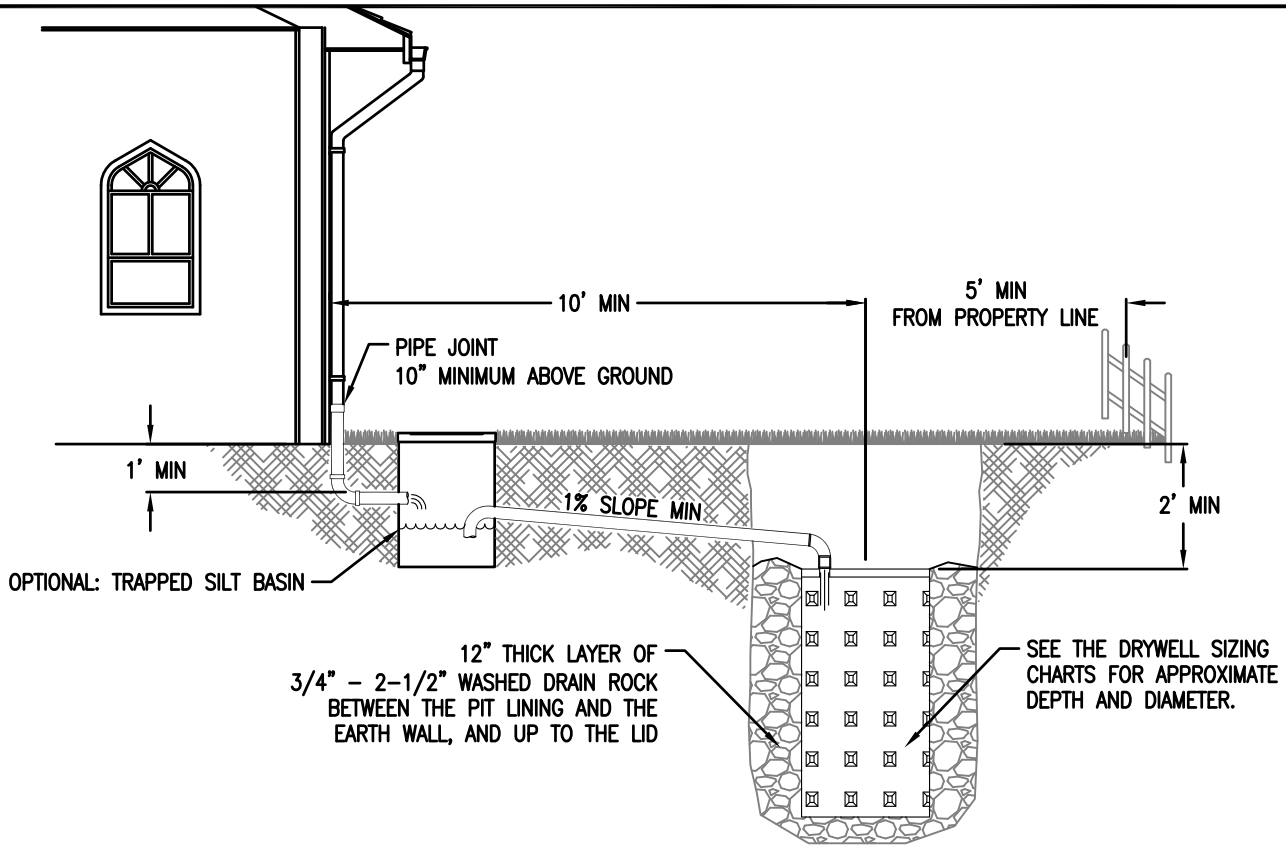
Soakage Trench

Bureau of Environmental Services

NUMBER

SW-270

7-1-16



1. Detail intended as an example. Detail must match design report.
2. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during and after construction.
3. Siting Criteria: Gravelly sand, gravelly loamy sand or other equally porous material must occur in a continuous 5' deep stratum within 12' of the ground surface. Drywell must not be placed where base of facility has less than 5' of separation to water table.
4. Sizing: Exhibit 2–36 is used as guidance to size drywells. Sizing per stormwater report.
5. Top of drywell must be below lowest finished floor.
6. Setbacks: Measured from center of drywell, must be 10' from foundations, 5' from property lines, and 20' from cesspools. Drywells sized using the performance approach that use a significantly sized rock gallery must measure setbacks from the edge of the rock gallery or get approval from geotechnical and structural engineers to place drywell closer to the foundation.
7. Piping: must be ABS Sch.40, cast iron, or PVC Sch.40. 3" pipe required for up to 1,500 sq ft of impervious area, otherwise 4" min. Piping must have 1% grade and follow the Uniform Plumbing Code.
8. Trapped Silt Basin: Optional for roof runoff or pedestrian only paved areas.

Exhibit 2–36: Drywell Sizing Table

Once approval has been given by BES for onsite infiltration of stormwater, the following chart shall be used as a general guide for sizing. Sizing per stormwater report.

IMPERVIOUS Area (sq-ft)	28" Diameter Drywell Depth				48" Diameter Drywell Depth			
	5'	10'	15'	20'	5'	10'	15'	20'
1000								
2000								
3000								
4000								
5000								
6000								
7000								
8000								
9000								
10000								

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Performance Design Approach –

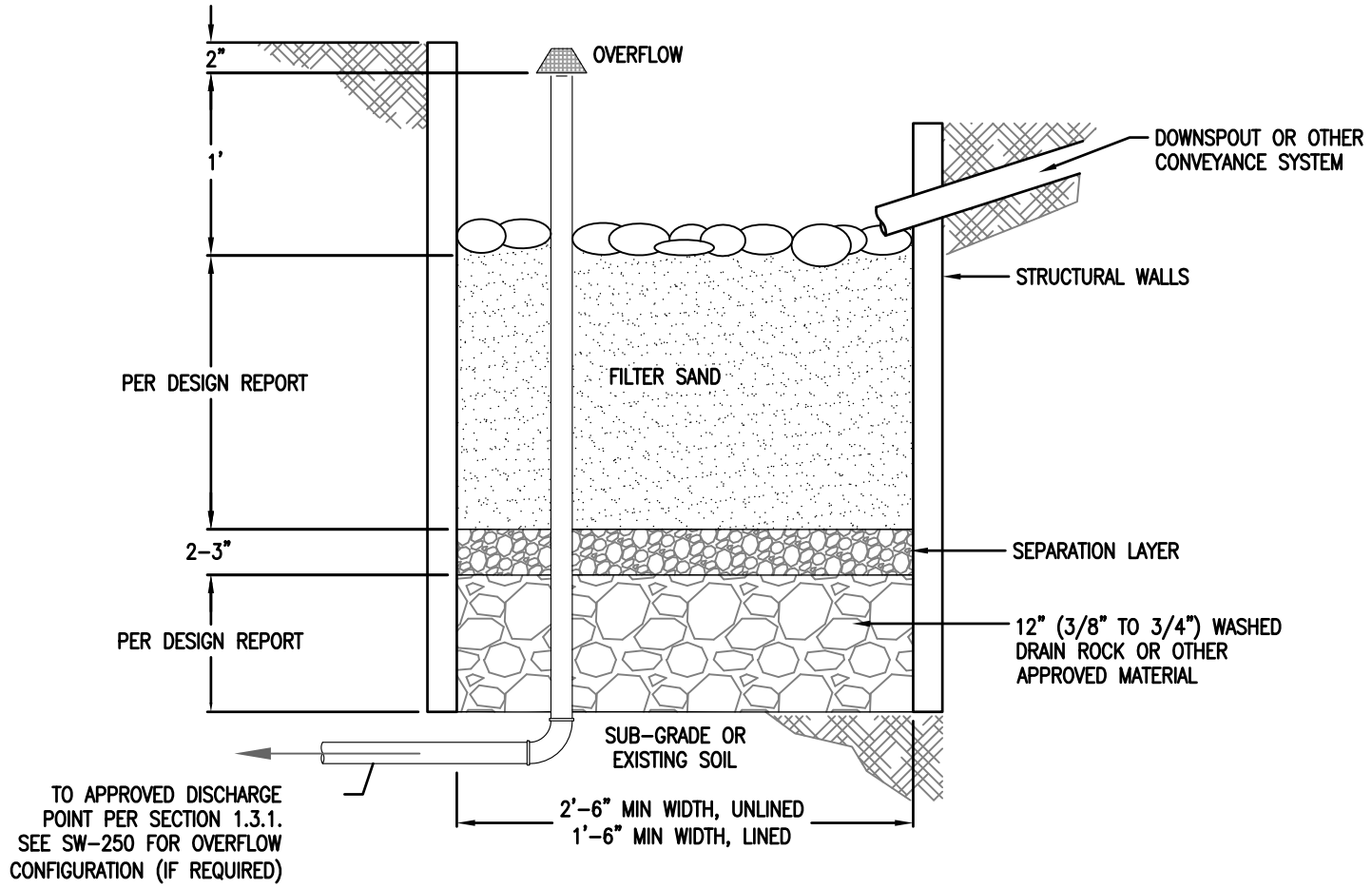
Drywell

Bureau of Environmental Services

NUMBER

SW–280

7–1–16



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.

2. Dimensions:
   a. Width of sand filter: 2'–6" minimum, unlined. 1'–6" minimum lined.
   b. Depth of sand filter (from top of sand to overflow elevation). Simplified: 12"; Presumptive: 6"– 18".
   c. Slope of sand filter: 0.5% or less.

3. Setbacks (from edge of facility):
   a. Infiltration sand filters must be 10' from foundations and 5' from property lines.
   b. Walls must be less than 30" in height above surrounding area if within 5 feet of property line.

4. Overflow (where required):
   a. Inlet elevation must allow for 2" of freeboard, minimum.
   b. Protect from debris, sand, and sediment with strainer or grate.

5. Piping: must be ABS Sch.40, cast iron, or PVC Sch.40. 3" pipe required for up to 1,500 sq ft of impervious area, otherwise 4" min. Piping must have 1% grade and follow the Uniform Plumbing Code.

6. Drain Rock (minimum):
   a. Infiltration sand filter: 12" of 1–1/2" – 3/4" washed.
   b. Flow–through sand filter: 8" of 3/4" washed.

7. Separation between drain rock and sand:
   Use a gravel lens (3/4 – 1/4 inch washed, crushed rock 2 to 3 inches deep) or approved equivalent.

8. Filter Sand:
   a. 18" minimum.
   b. See sand spec in SWMM chapter 2

9. Sand Filter Walls:
   a. Material must be concrete unless otherwise approved.
   b. Walls must be included on foundation plans.

10. Waterproofing: If walls are monolithically poured no additional liner/waterproofing is required. Check state structural requirements for foundations.

11. Install washed pea gravel or river rock to transition from inlet or splash pad to sand.

12. Inspections: Call BDS IVR Inspection Line, (503) 823–7000, for appropriate inspections.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Performance Design Approach –

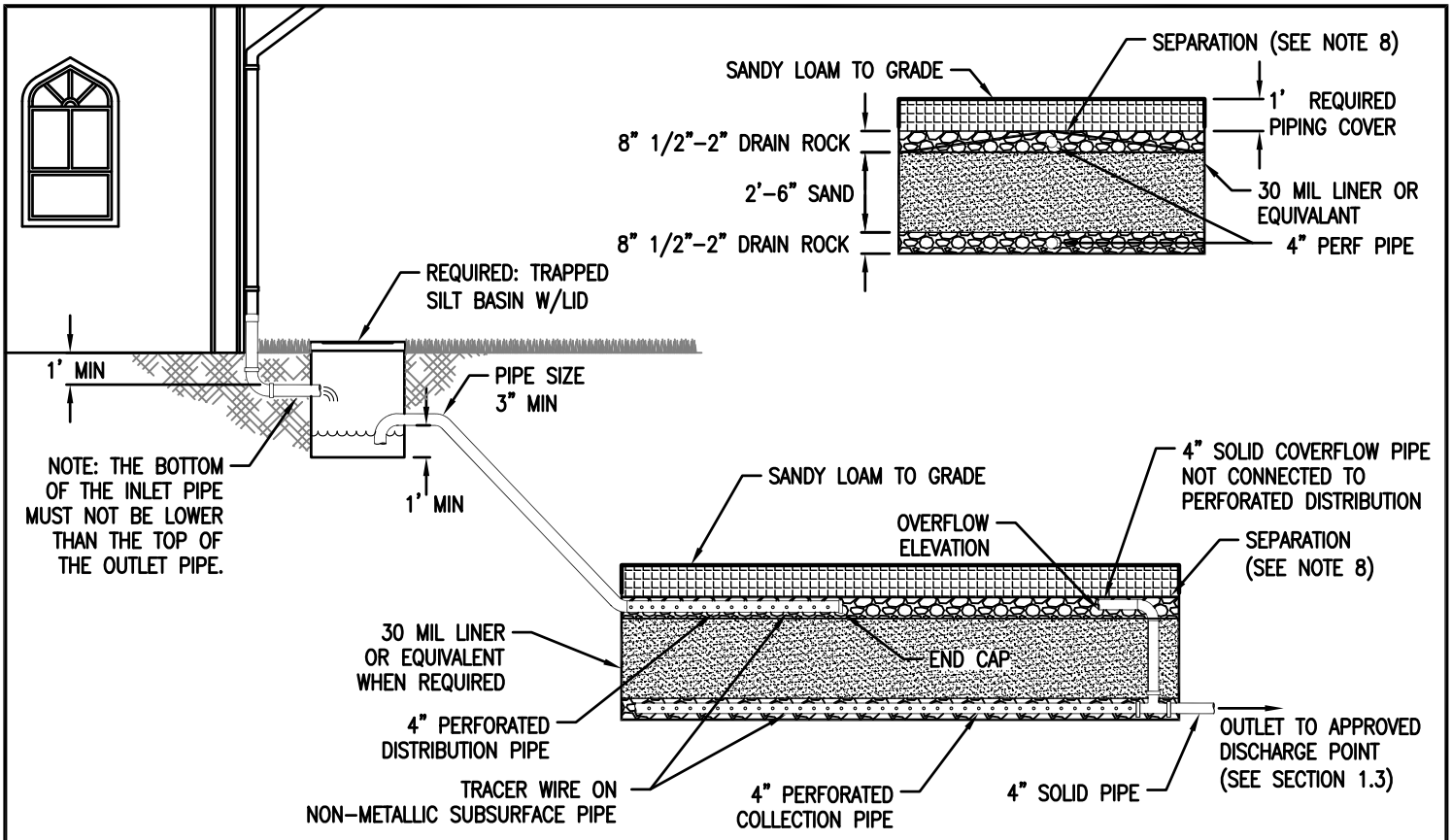
Sand Filter

Bureau of Environmental Services

NUMBER

SW–290

7–1–16



1. Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to and during construction.

2. Dimensions:
   a. Height of subsurface sandfilter: 46" from base.
   b. Depth of excavation: 58" Min. (to accommodate 12"of cover).

3. Setbacks (from edge of facility):
   a. Infiltration facilities must be 10' from foundations and 5' from property lines.
   b. Lined facilities may be within 10' of foundation and within 5' of property line if properly lined.

4. Trapped silt basin required prior to inlet to subsurface sand filter.

5. Overflow: perforated collection pipe within top gravel layer connected to approved discharge point according to Section 1.3.

6. Piping must be ABS Sch40, cast iron, or PVC Sch40. 3" pipe must be used for up to 1500sf of impervious area, otherwise 4" minimum. Piping must have 1% grade and must follow current Uniform Plumbing Code.
   a. Underdrain piping system must consist of minimum 4" diameter collector manifold with perforated lateral branch lines.
   b. Underdrain laterals must be placed with minimum 1% positive gravity drainage to the collector manifold.
   c. The collector manifold must have a minimum 1% grade toward the discharge joint.
   d. Lateral spacing of collection or distribution pipes must not exceed 10'.
   e. All laterals and collector manifolds must have cleanouts installed, accessible from the surface without removing or disturbing filter media.
   f. Outlet to approved discharge point must be protected from soil, gravel, or sand displacement with filter fabric or equivalent.

7. Drain Rock and Sand Depth:
   a. 8" of 3/4" washed drain rock as base.
   b. 30" of washed sand per chapter 2.
   c. 8" top layer of 3/4" washed drain rock over sand.

8. 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.

9. Waterproof Liner: Must be 30 mil EPDM, HDPE or equivalent for facilities when lining is required.

10. Inspections: Call BDS IVR Inspection Line, (503) 823-7000, for appropriate inspections.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT TYPICAL DETAILS

– Performance Design Approach –

Subsurface Sand Filter

Bureau of Environmental Services

NUMBER

SW–291

7–1–16

2.3.5 Green Street Typical Details

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- SW-311A – Plan View with Parking (2.5' Step-out)
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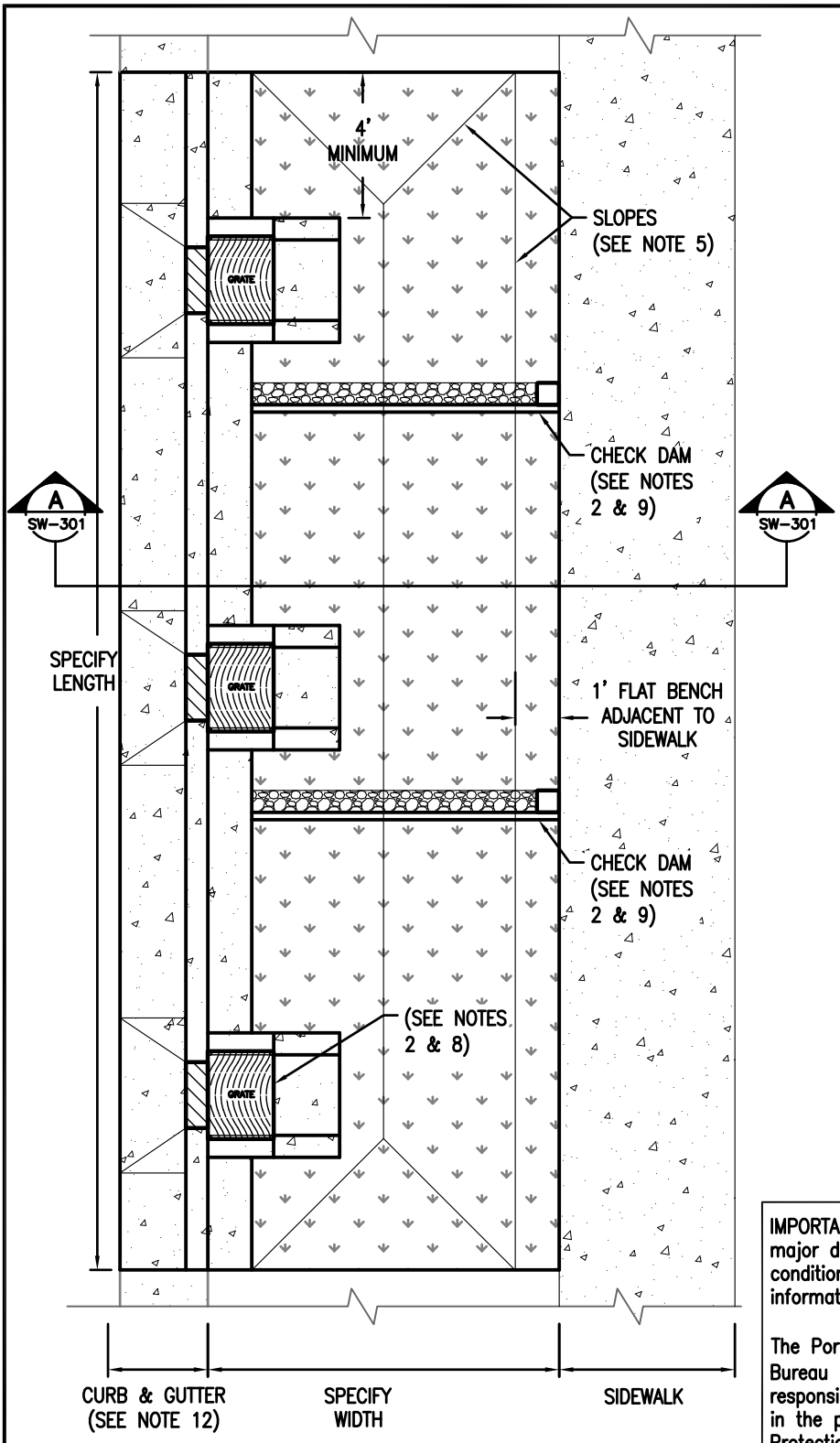
- SW-361 – Tree Well Detail Without Rock Storage
- SW-362 – Tree Well Detail With Rock Storage
- SW-363 – Herbaceous Plants, Groundcovers & Shrubs
- SW-364 – Facility Overflow Configurations



PLAN VIEW

(Swale with Parking shown here)

– DRAWING NOT TO SCALE –

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet and check dam.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Proposed utility lines to be located out of facility.
5. Slopes 3:1. See swale sections on SW–301, unless otherwise specified.
6. Longitudinal slope of swale matches the road.
7. Area and Depth of facility are based upon engineering calculations and right–of–way constraints. See chapter 2 of the City of Portland Stormwater Management Manual (SWMM).

RELATED DETAILS AND RESOURCES:

8. Inlet and Grate details SW–332, SW–335B and SW–336.
9. Check Dam details SW–341 and SW–342.
10. Special requirements for water lines, meters, and fire hydrants. (see SW–304)
11. Swale Planting Template. (see SW–303)
12. Curb and Gutter per PBOT standard drawing P–540.
13. Stormwater facility construction and blended soil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d).

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

For more information contact:

PBOT	(503) 823–7884	BES	(503) 823–7761
PWB	(503) 823–7368	Urban Forestry	(503) 823–4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Plan View

Swale

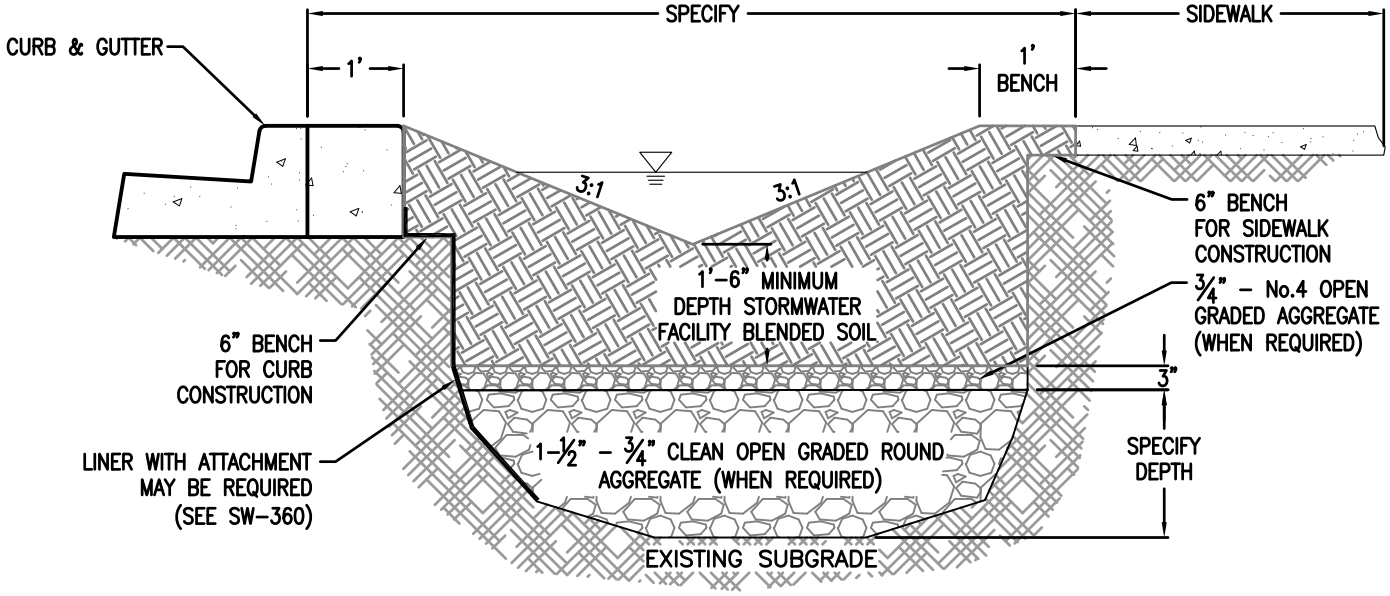
Bureau of Environmental Services

NUMBER

SW–300

7–1–2016

– PARKING –



SECTION A–A
SWALE

DESIGNER INFORMATION:

1. Show liner and perf–pipe in the Section view if they are required
2. Typical facility width is 8' from back of curb to sidewalk

CONSTRUCTION NOTE:

In facilities that are unlined, fracture and loosen soil to a depth of 12" below grade before installing blended soil or aggregate. Do not till.

FOR PLAN VIEW
SEE SW–300

– ***DRAWING NOT TO SCALE*** –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Section View

Swale

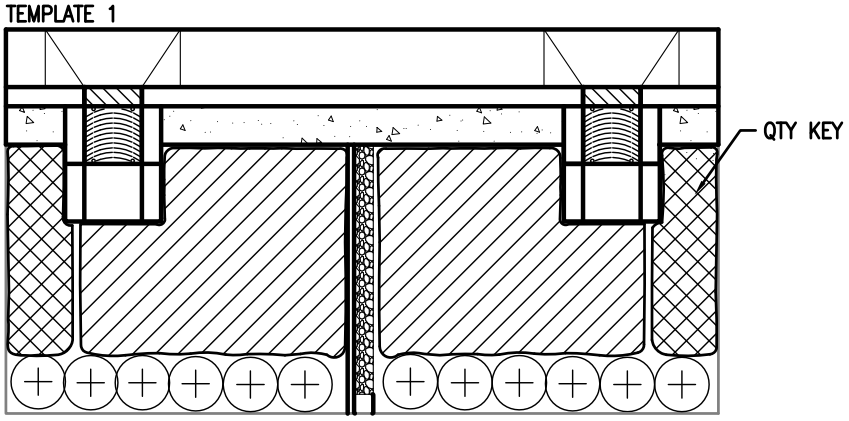
Bureau of Environmental Services

NUMBER

SW–301

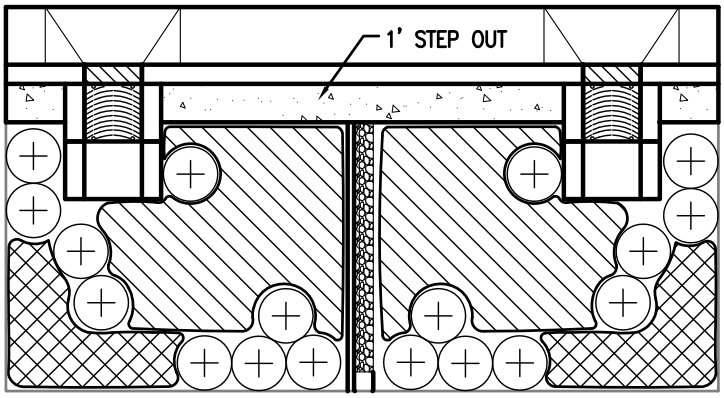
7–1–2016

TEMPLATE 1



Key	Recommended Plants
ZONE A	
	Carex obnupta Slough Sedge
	Juncus patens Spreading rush
ZONE B	
	Mahonia repens Creeping oregon grape
	Spiraea x bumalda 'Goldflame' Goldflame spiraea
	Rubus calycinoides Creeping raspberry

TEMPLATE 2



Key	Recommended Plants
ZONE A	
	Carex obnupta Slough Sedge
	Juncus patens Spreading rush
ZONE B	
	Cornus sericea 'Kelseyi' Dwarf Red-Twig Dogwood
	Spiraea x bumalda 'Goldmound' Goldmound spiraea
	Fragaria chiloensis Coastal Strawberry

SQ. FOOT AREA – ZONE A	X
SQ. FOOT AREA – ZONE B	X

SAMPLE PLANT LEGEND

SYMBOL	BOTANIC NAME	COMMON NAME	SIZE	SPACING	QTY. ZONE A	QTY. ZONE B
	Xxxxx xxxxx	xxxxx	X	X	X	X
	Xxxxx xxxxx	xxxxx	X	X	X	X

INSTRUCTIONS

1. Choose a template and alter it to design. These are examples of approved planting templates. Other planting plans may be approved.
2. Plant lists and on-center spacing requirements are found in Section 2.4.1 of the City of Portland Stormwater Management Manual.
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-363 for plant spacing.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Landscape Planting Templates

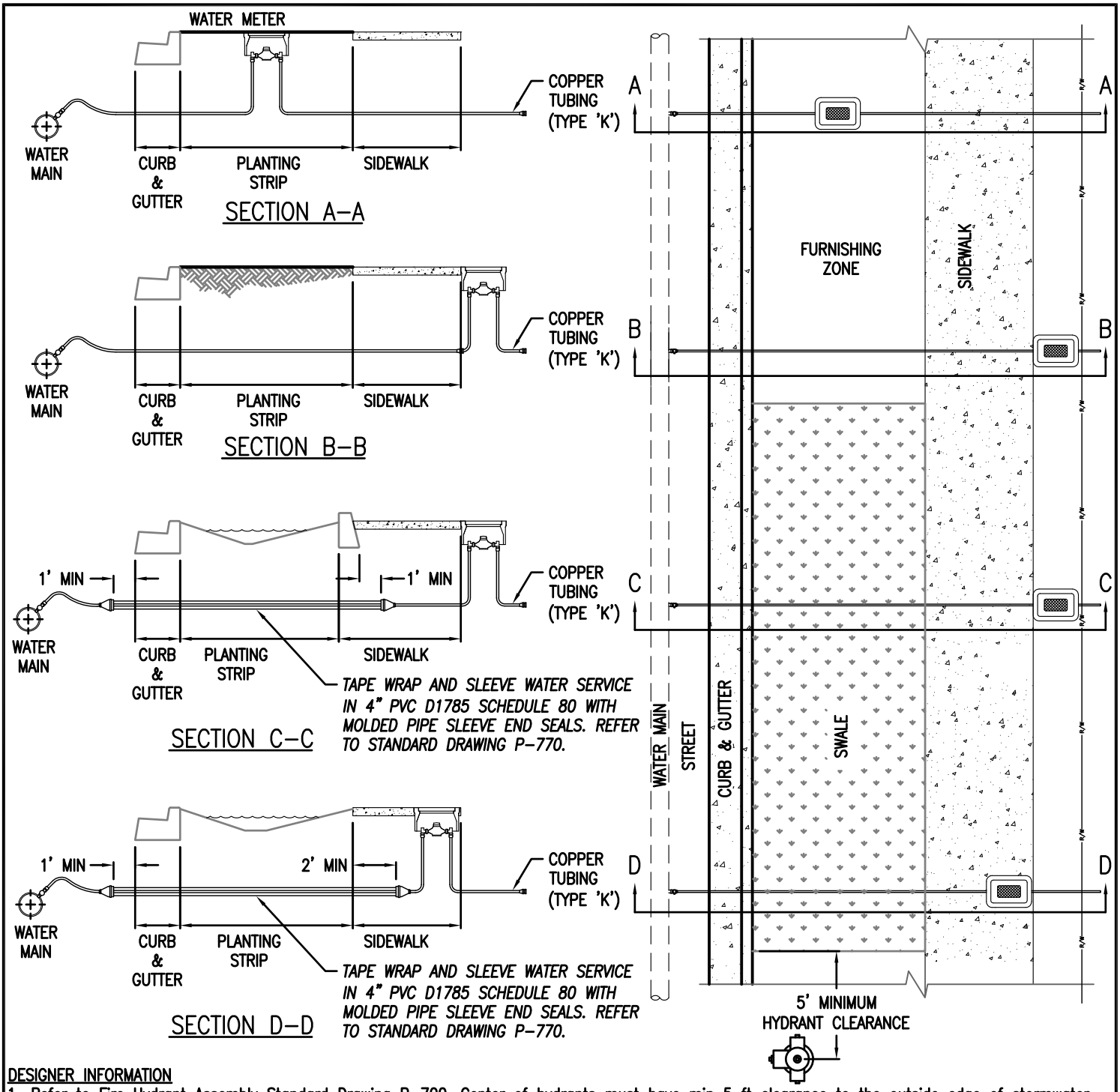
Swales

Bureau of Environmental Services

NUMBER

SW-303

7-1-2016



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P–700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A. Option B or C can be used only if a minimum of 3' is available between back of sidewalk and the Right–of–Way line. Option D can only be used for an existing service when other options are infeasible, where a minimum of 1' is available between the back of sidewalk and the Right–of–Way line, and it requires a Design Exception from PBOT, to be obtained by the project owner.
3. Refer to 1" Service Assembly Standard Drawing P–780. For larger services or other appurtenances, contact PWB development services at (503) 823–7368. Water service line must be 2 ft min. from bottom of stormwater facility blended soil.
4. Maintain 2 ft skin–to–skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross–section views are not required on construction plans.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Meter & Hydrant Locations

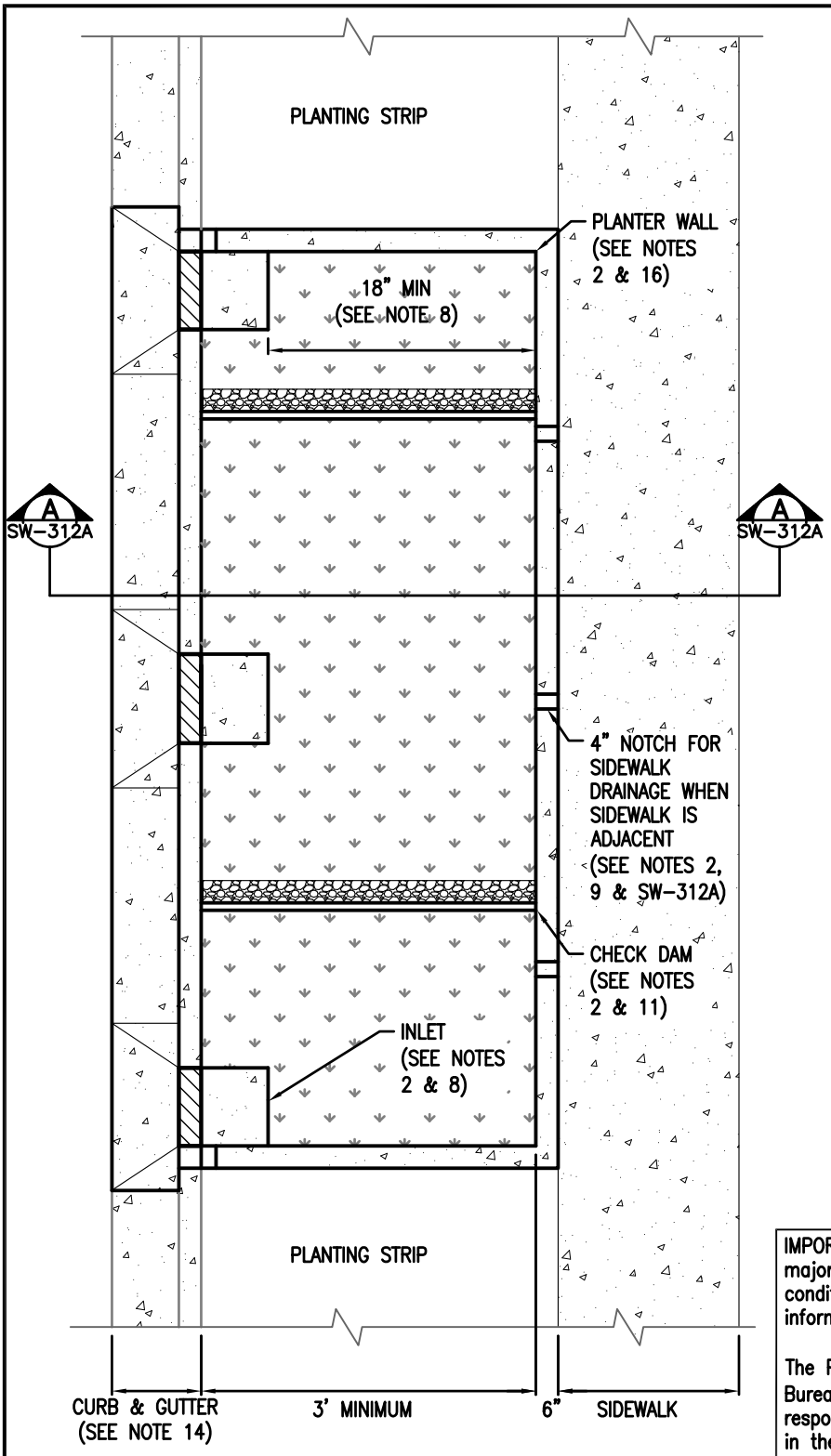
Swales

Bureau of Environmental Services

NUMBER

SW–304

7–1–2016



PLAN VIEW

– DRAWING NOT TO SCALE –

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, planter corner and sidewalk notches.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Proposed utility lines to be located out of facility.
5. Longitudinal slope of planter matches the road, unless otherwise specified.
6. Area and Depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
7. Minimum interior planter width is 3ft. A minimum of 4 feet is required for planters with street trees.
8. If less than 18" between splash pad and planter wall, extend pad to wall.
9. Place one notch at low point of sidewalk. Space additional notches approximately 6ft apart.

RELATED DETAILS AND RESOURCES:

10. Inlet details SW-331 and SW-332
11. Check Dam details SW-342 and SW-343
12. Special requirements for water lines, meters, and fire hydrants (see SW-316B)
13. Planter Planting Template (see SW-315)
14. Curb and Gutter per PBOT standard drawing P-540
15. Stormwater facility construction and blended soil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
16. Planter wall detail (see SW-313)

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

For more information contact:

PBOT	(503) 823-7884	BES	(503) 823-7761
PWB	(503) 823-7368	Urban Forestry	(503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

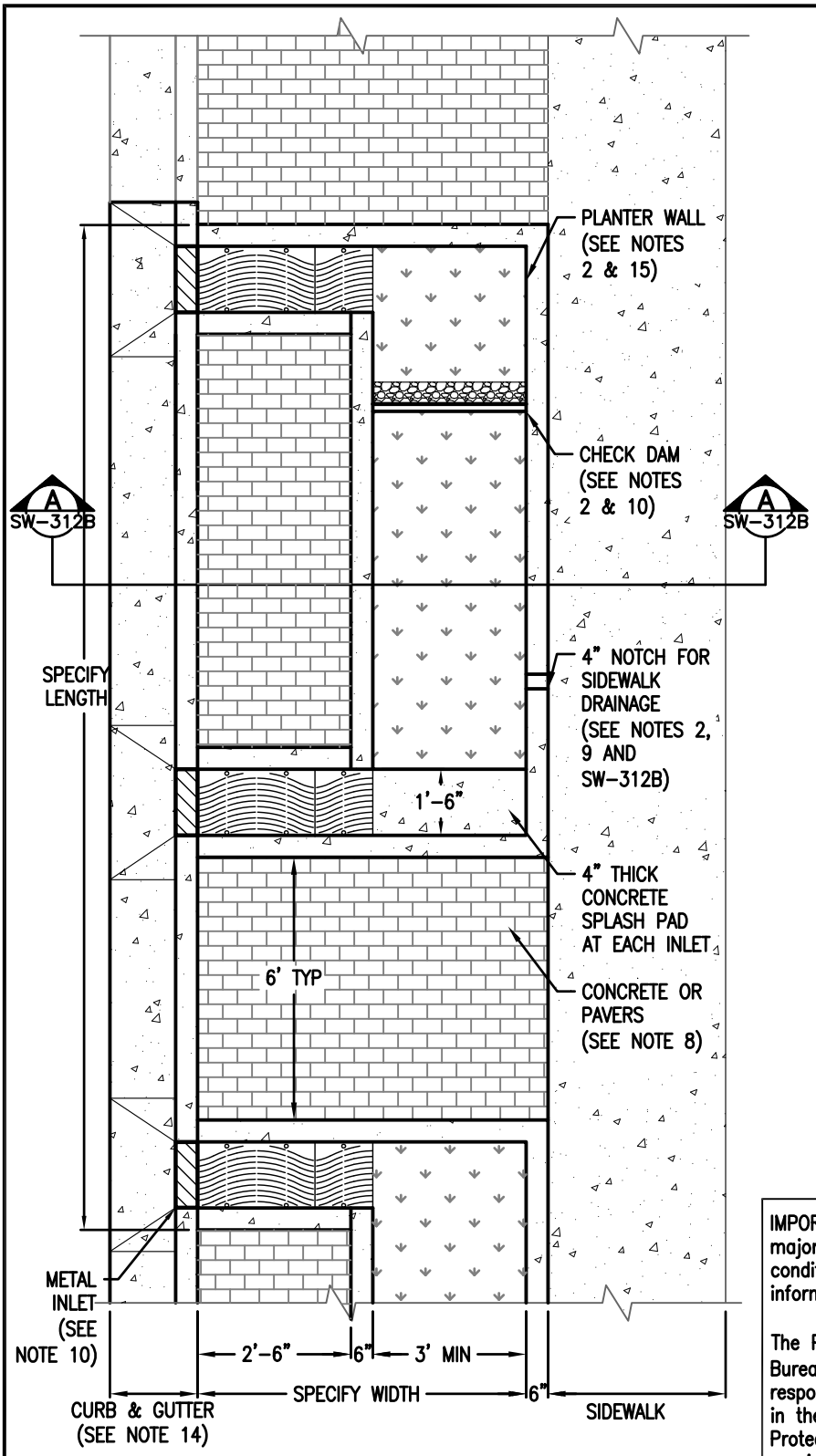
Plan View without Parking Planters

Bureau of Environmental Services

NUMBER

SW-310

7-1-2016



PLAN VIEW

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, planter corner and sidewalk notches.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Proposed utility lines to be located out of facility.
5. Longitudinal slope of planter matches the road, unless otherwise specified.
6. Area and Depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
7. Minimum interior planter width is 3 feet. A minimum of 4 feet is required for planters with street trees.
8. May use concrete or pavers per City Standards.
9. Place one notch at low point of sidewalk. Space additional notches approximately 6ft. apart.

RELATED DETAILS AND RESOURCES:

10. Metal Inlet details SW-335A and SW-336
11. Check Dam details SW-342 and SW-343
12. Special requirements for water lines, meters, and fire hydrants (see SW-316A)
13. Planter Planting Template (see SW-315)
14. Curb and Gutter per PBOT standard drawing P-540
15. Stormwater facility construction and blended soil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
16. Planter wall detail (see SW-313)

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:

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PWB	(503) 823-7368	Urban Forestry	(503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

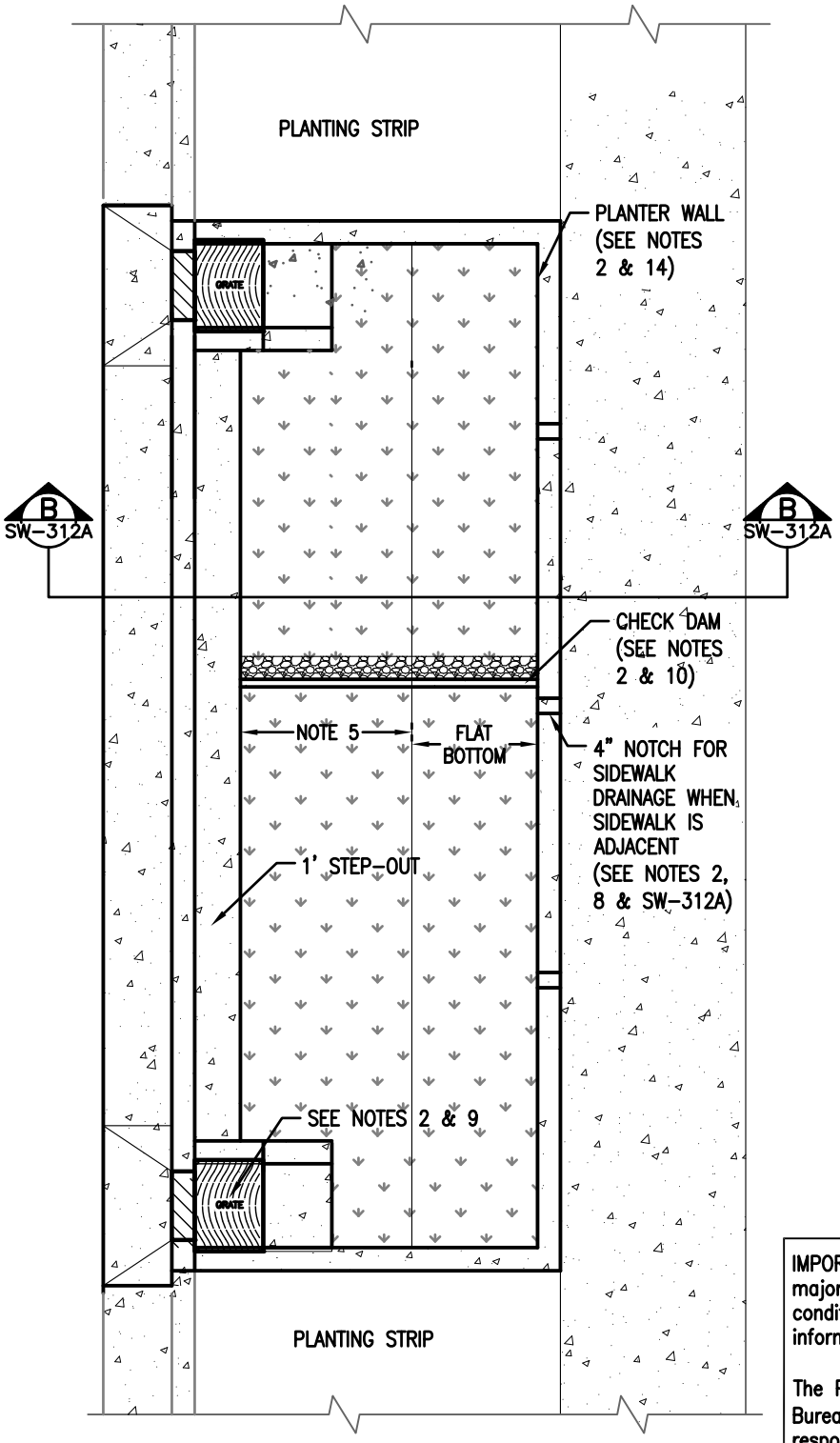
Plan View with Parking (2.5' Step-out) Planters

Bureau of Environmental Services

NUMBER

SW-311A

7-1-2016



PLAN VIEW

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, notch and wall corner.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Existing utility lines must be sleeved or relocated. Proposed utility lines to be located out of facility.
5. Slope 3:1. See section on SW-312A.
6. Longitudinal slope of planter matches the road, unless otherwise specified.
7. Area and Depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM)
8. Place one notch at low point of sidewalk. Space additional notches approximately 6ft. apart.

RELATED DETAILS AND RESOURCES:

9. Inlet and grate details SW-332, SW-335B and SW-336
10. Check Dam details SW-342 and SW-343
11. Special requirements for water lines, meters, and fire hydrants (see SW-316B)
12. Planting Template (see SW-315)
13. Curb and Gutter per PBOT standard drawing P-540.
14. Stormwater facility construction and blended soil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
15. Planter Wall Detail (See SW-313)

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

For more information contact:

PBOT	(503) 823-7884	BES	(503) 823-7761
PWB	(503) 823-7368	Urban Forestry	(503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

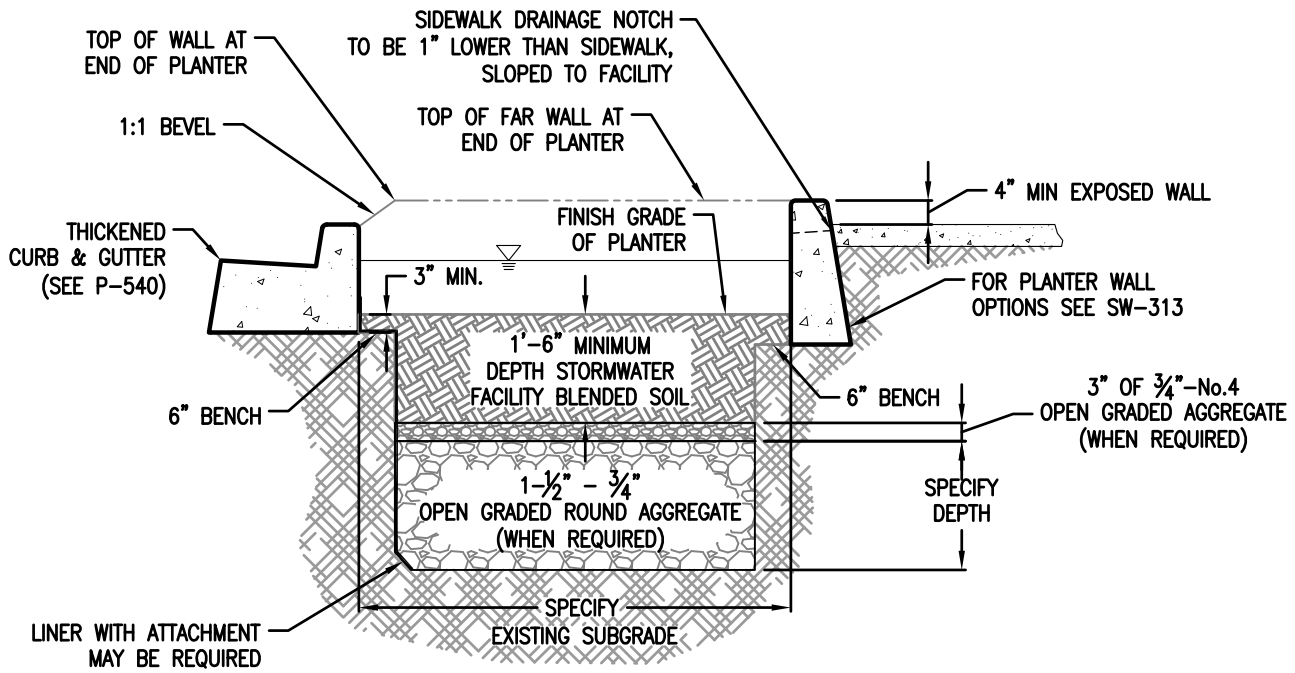
Plan View with Parking (1' Step-Out) Planters

Bureau of Environmental Services

NUMBER

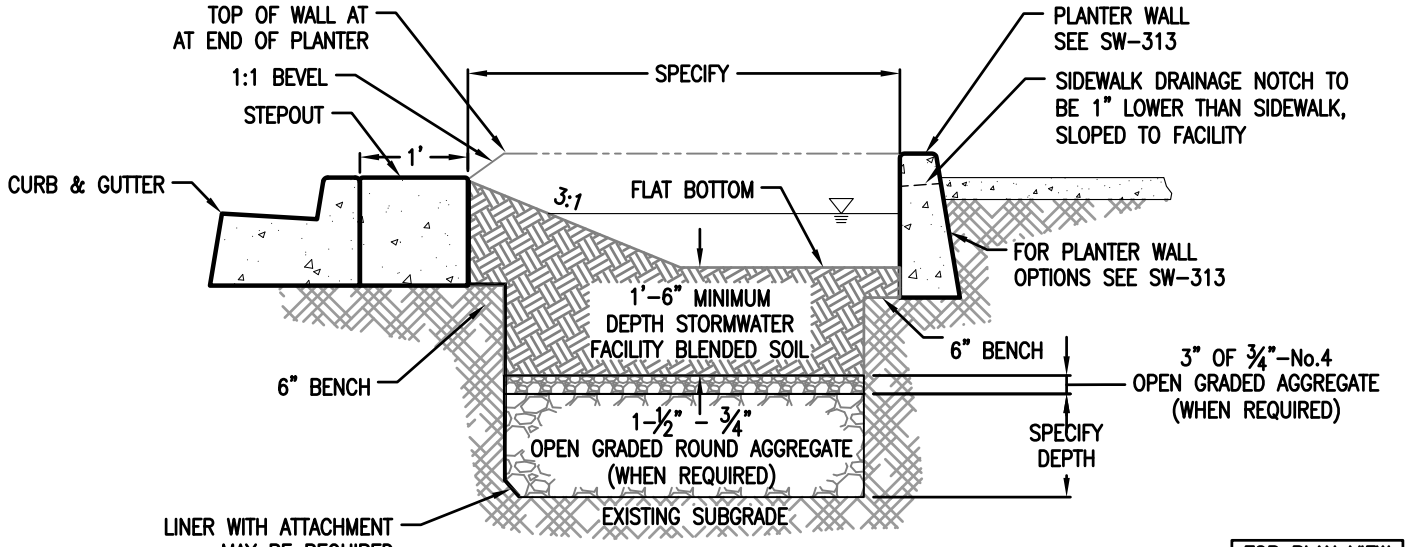
SW-311B

7-1-2016



SECTION A-A
PLANTER WITHOUT PARKING

FOR PLAN VIEW SEE SW-310



SECTION B-B
PLANTER WITH PARKING (1' Step-out)

FOR PLAN VIEW SEE SW-311B

DESIGNER INFORMATION

1. Show liner and perf-pipe in the Section view if they are required.
2. Maximize 9" of surface storage.
3. Minimun facility width is 30" from back of curb to face of planter wall.
4. Top of curb and top of sidewalk at approximately same elevation, unless stormwater facility retrofit.

CONSTRUCTION NOTE

In facilities that are unlined, fracture and loosen soil to a depth of 12" below grade before installing blended soil or aggregate. Do not till.

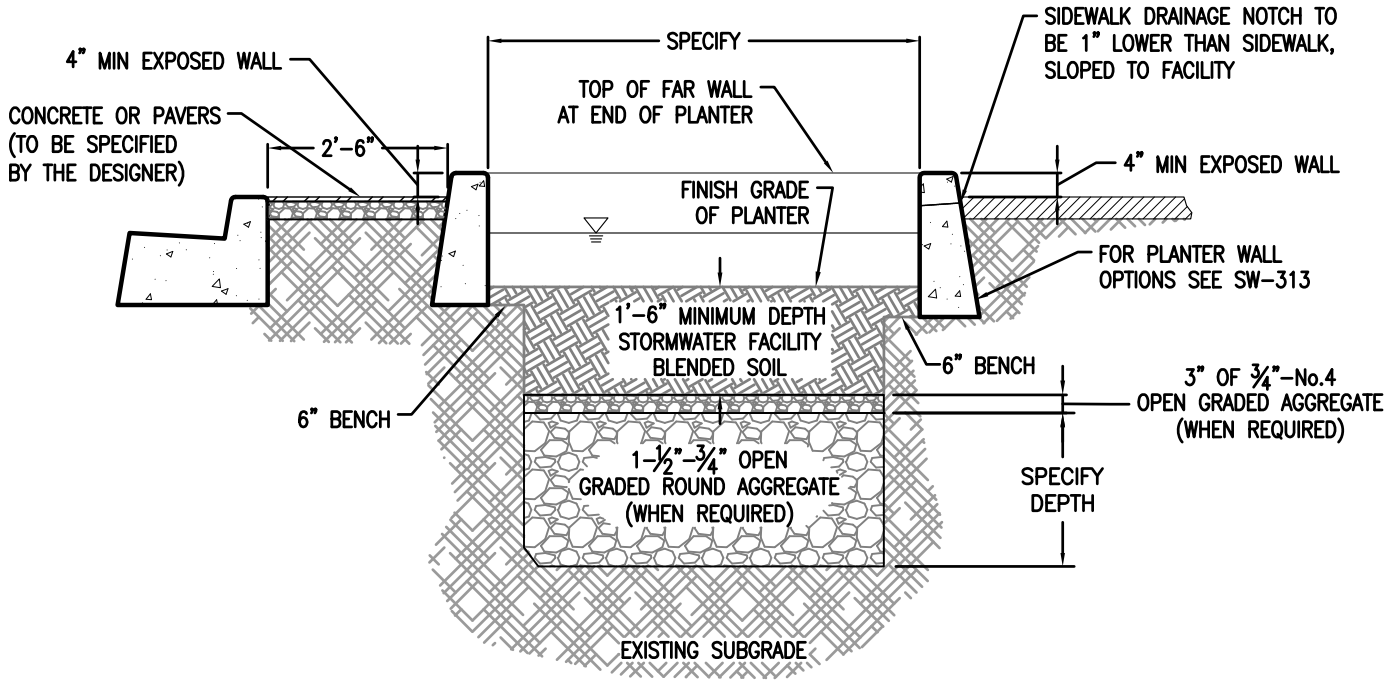
- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -
Section Views
Planters

Bureau of Environmental Services

NUMBER
SW-312A
7-1-2016



SECTION A-A

PLANTER WITH PARKING (2.5' STEP-OUT)

FOR PLAN VIEW
SEE SW-311A

DESIGNER INFORMATION

1. Show liner and perf-pipe in the Section view if they are required.
2. Maximize 9" of surface storage.
3. Typical facility width is 8' from back of curb to sidewalk.
4. Top of curb and top of sidewalk at approximately same elevation, unless stormwater facility retrofit.

CONSTRUCTION NOTE

In facilities that are unlined, fracture and loosen soil to a depth of 12" below grade before installing blended soil or aggregate. Do not till.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Section View (2.5' Step-out)

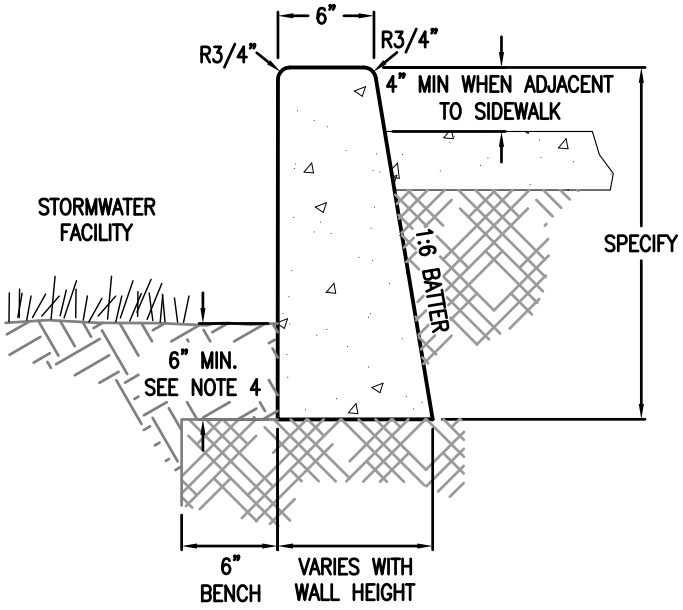
Planters

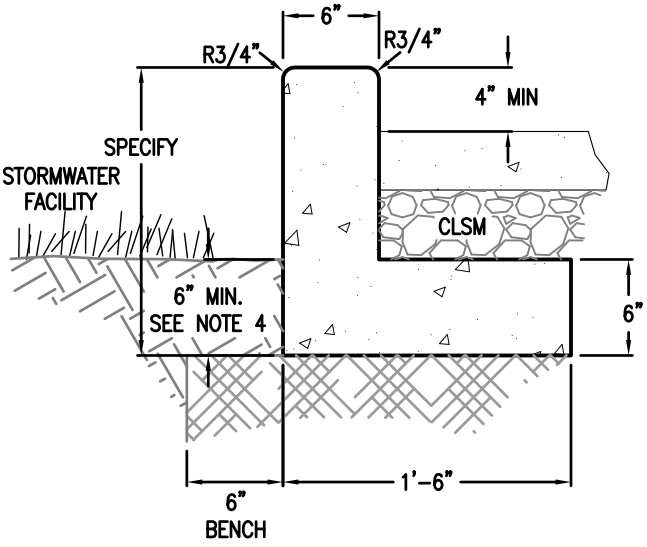
Bureau of Environmental Services

NUMBER

SW-312B

7-1-2016





DESIGNER INFORMATION

1. Special design considerations or structural review may be required for longer planter wall spans. Steel reinforcement or additional concrete check dams may be needed for stability.
2. Specify one of the above planter wall options based on site conditions.
3. Maintain 1:6 batter for walls and 4" minimum from top of wall to top of sidewalk.
4. If a liner is used, See SW–360.

CONSTRUCTION NOTE

Finish all exposed concrete surfaces. See Specs.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Planter Wall Details

Planters

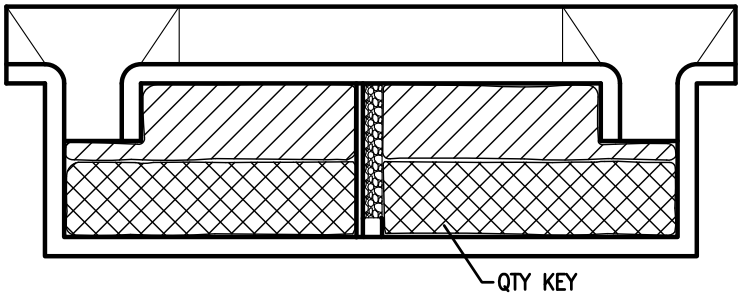
Bureau of Environmental Services

NUMBER

SW–313

7–1–2016

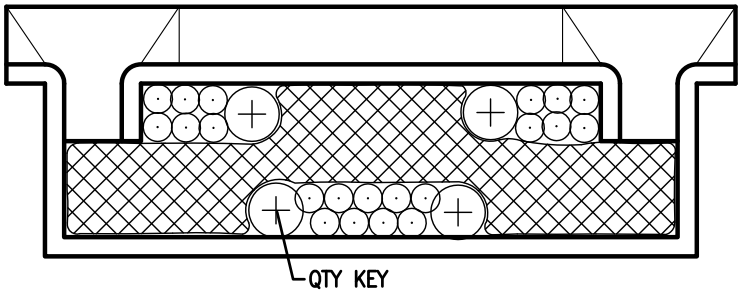
TEMPLATE 1



PLANT LEGEND 1

Symbol	Botanical Name Common Name
	Juncus patens Spreading rush
	Carex obnupta Slough sedge

TEMPLATE 2



PLANT LEGEND 2

Symbol	Botanical Name Common Name
	Carex obnupta Slough sedge
	Liriope muscari "Big Blue" Big blue lily turf
	Cornus sericea 'Kelseyi' Kelsey dogwood

SAMPLE PLANT LEGEND				SQ. FOOT AREA – ZONE A	X
SYMBOL	BOTANIC NAME	COMMON NAME	SIZE	SPACING	QTY. ZONE A
	Xxxxx xxxxx	xxxxx	X	X	X
	Xxxxx xxxxx	xxxxx	X	X	X

INSTRUCTIONS

1. Choose a template and alter it to design. These are examples of approved planting templates. Other planting plans may be approved.
2. Plant lists and on–center spacing requirements are found in Section 2.4.1 of the City of Portland Stormwater Management Manual.
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–363 for plant spacing.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Landscape Planting Templates

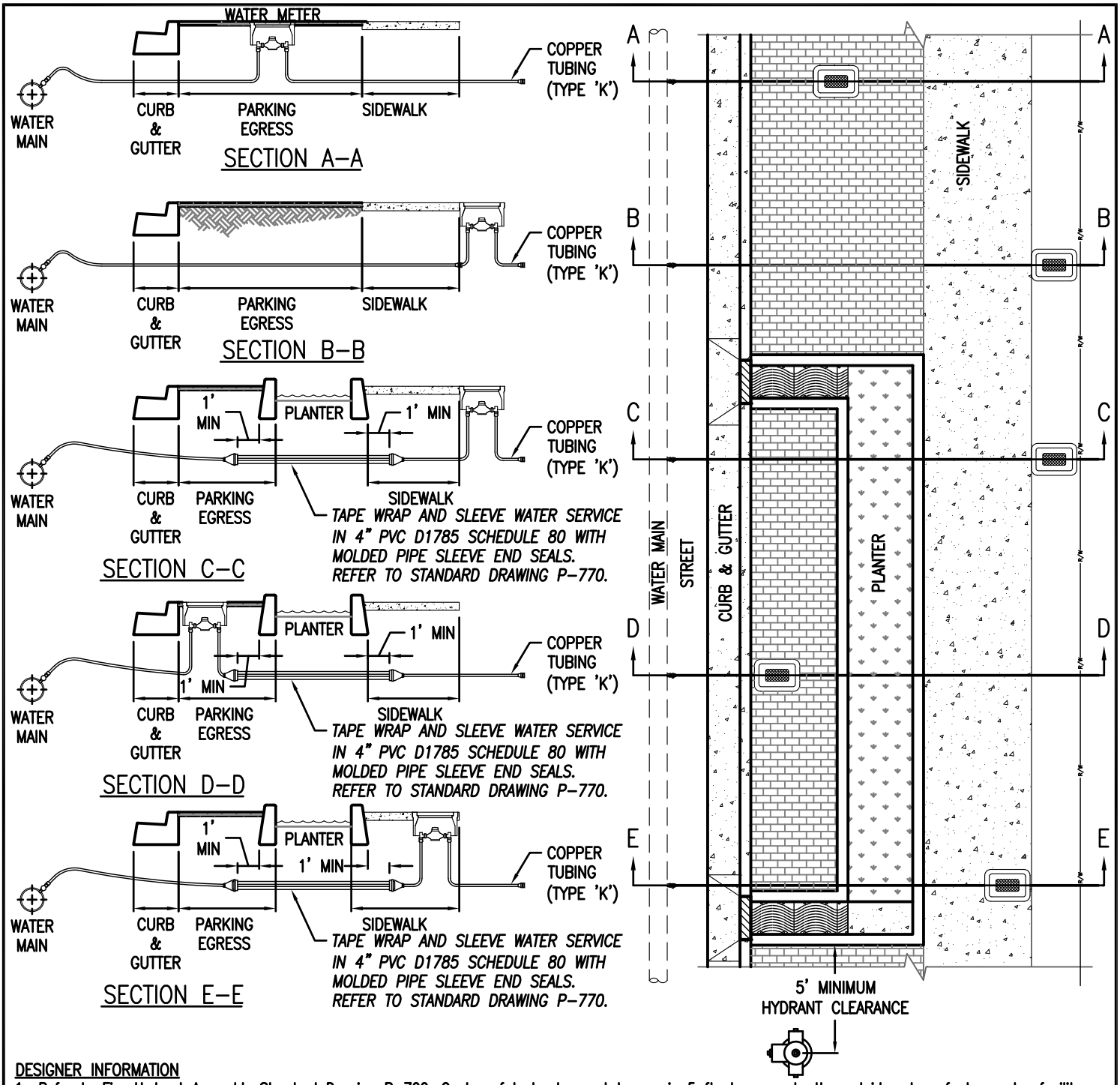
Planters

Bureau of Environmental Services

NUMBER

SW–315

7–1–2016



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P–700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A. Option B or C can be used only if a minimum of 3' is available between the back of sidewalk and the Right–of–Way line. Option D and E can only be used for an existing service and when other options are infeasible, where a minimum of 1' is available between the back of sidewalk and the Right–of–Way line, and it requires a Design Exception from PBOT to be obtained by the project owner. In addition, for Option D, 3' minimum parking egress area is required for placement of 1' or smaller water meter, and 5' minimum for placement of 1.5" and 2" water meter.
3. Refer to 1" Service Assembly Standard Drawing P–780. For larger services or other appurtenances, contact PWB development services at (503) 823–7368. Water service line must be 2 ft min. from bottom of stormwater facility blended soil.
4. Maintain 2 ft skin–to–skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross–section views are not required on construction plans.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Meter & Hydrant Locations

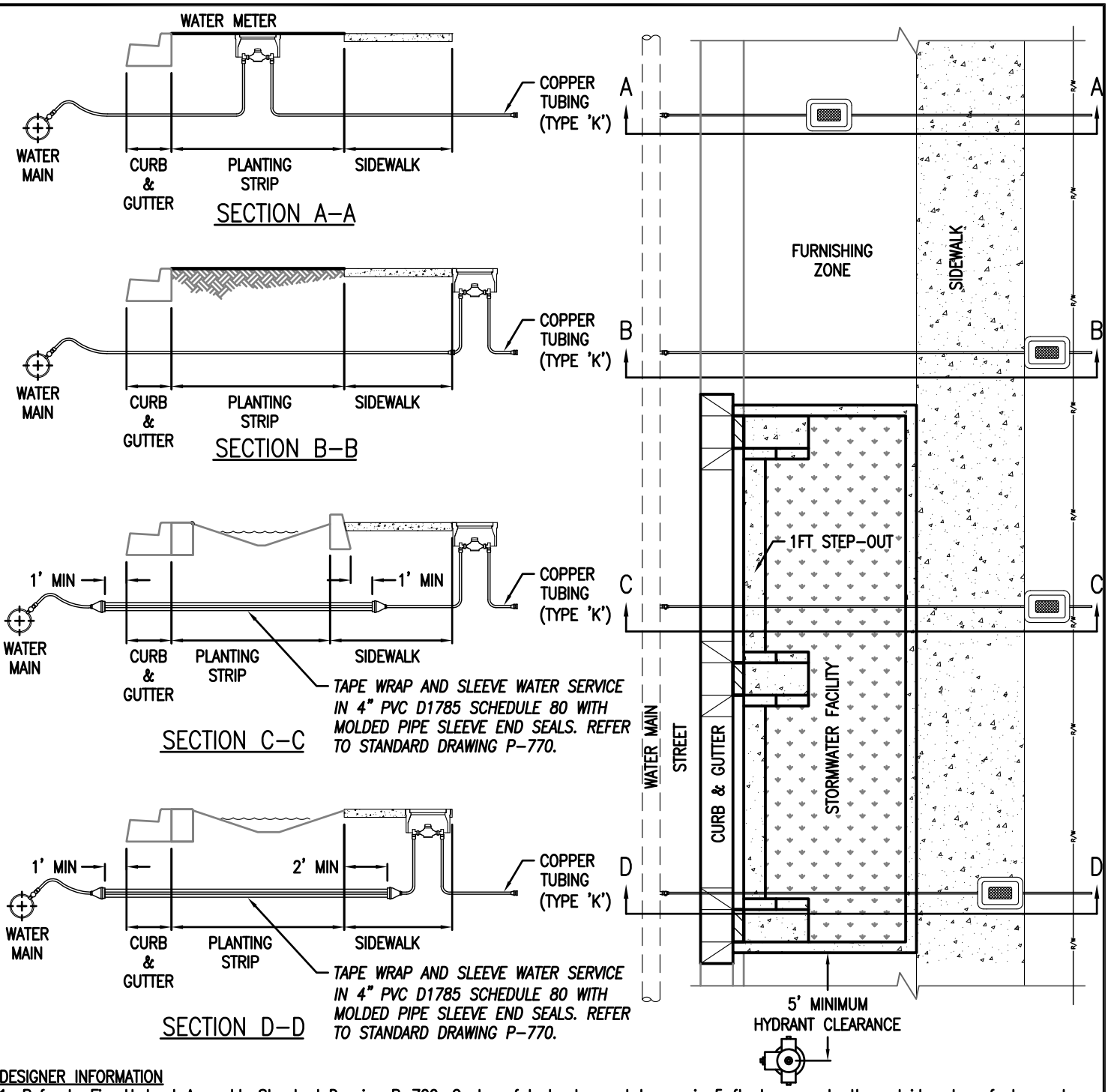
Planters

Bureau of Environmental Services

NUMBER

SW–316A

7–1–2016



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P–700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A. Option B or C can be used only if a minimum of 3' is available between back of sidewalk and the Right–of–Way line. Option D can only be used for an existing service when other options are infeasible, where a minimum of 1' is available between the back of sidewalk and the Right–of–Way line, and it requires a Design Exception from PBOT, to be obtained by the project owner.
3. Refer to 1" Service Assembly Standard Drawing P–780. For larger services or other appurtenances, contact PWB development services at (503) 823–7368. Water service line must be 2 ft min. from bottom of stormwater facility blended soil.
4. Maintain 2 ft skin–to–skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross–section views are not required on construction plans.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Meter & Hydrant Locations

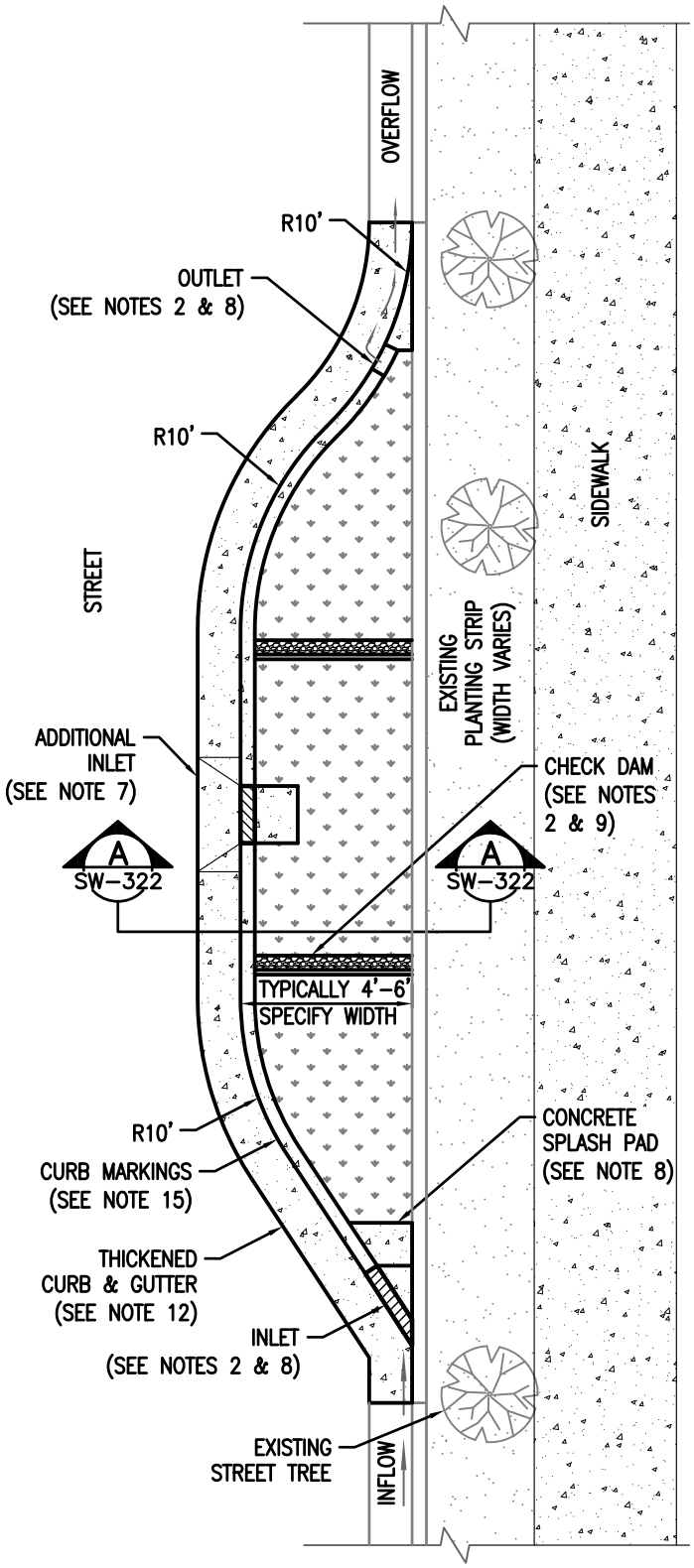
Planter with 1' Step–out

Bureau of Environmental Services

NUMBER

SW–316B

7–1–2016



PLAN VIEW

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, planter corner and sidewalk notches.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Proposed utility lines to be located out of facility.
5. Longitudinal slope of planter matches the road.
6. Area and Depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
7. Additional inlets in facilities over 25 feet in length per BES or site-specific requirements.

RELATED DETAILS AND RESOURCES:

8. Inlet and outlet details SW-331, SW-332, SW-333 and SW-334
9. Check Dam details SW-342 and SW-343
10. Special requirements for water lines, meters, and fire hydrants (see SW-316)
11. Planter Planting Template (see SW-323)
12. Thickened Curb and Gutter (see PBOT standard drawing P-540)
13. Stormwater facility construction and blended soil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
14. Planter wall detail (see SW-313)
15. Pavement markings see PBOT standard drawing P-434

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

For more information contact:

PBOT	(503) 823-7884	BES	(503) 823-7761
PWB	(503) 823-7368	Urban Forestry	(503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

In-Street Plan View

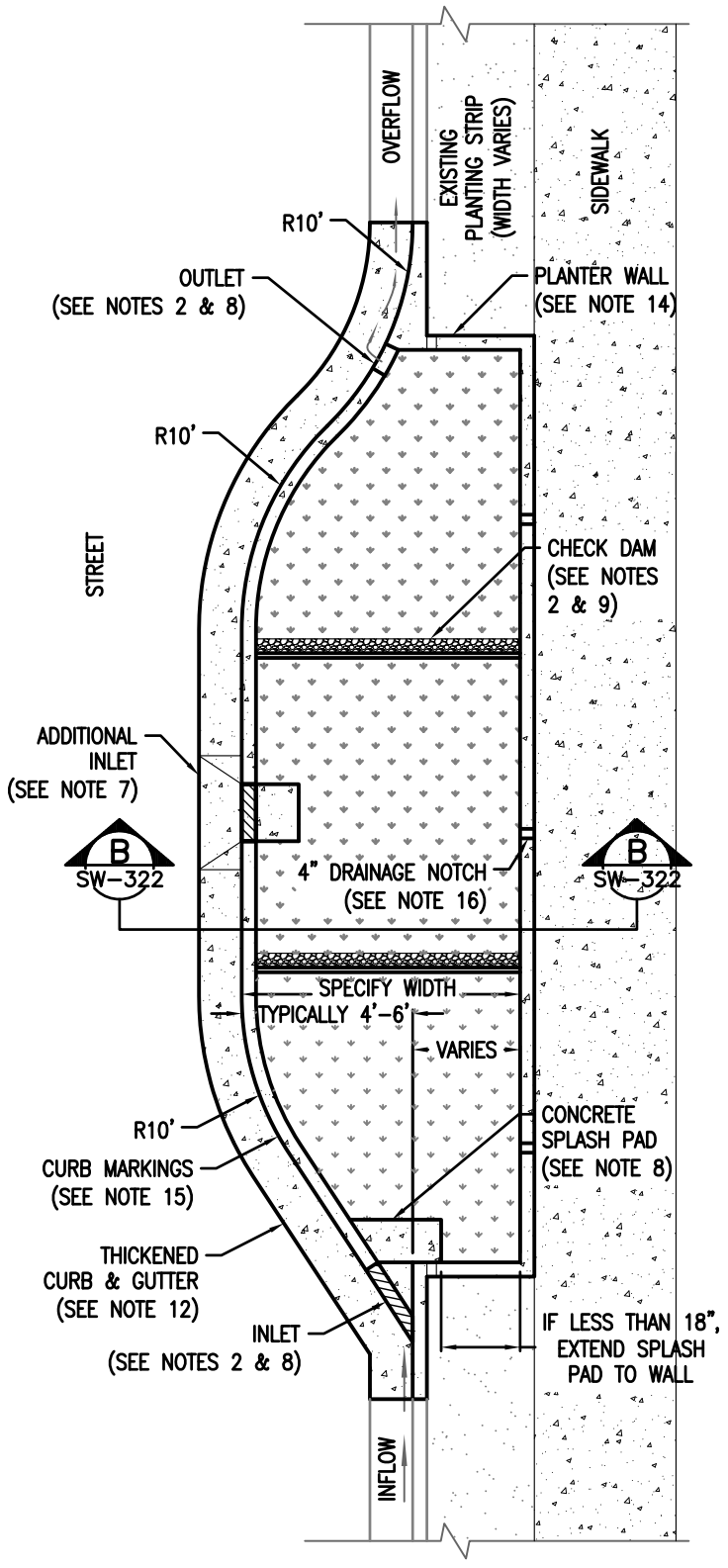
Curb Extensions

Bureau of Environmental Services

NUMBER

SW-320

7-1-2016



PLAN VIEW

- DRAWING NOT TO SCALE -

DESIGNER INFORMATION:

1. Adapt this plan view example to your engineered design. Maximize surface storage.
2. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, planter corner and sidewalk notches.
3. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
4. Existing utility lines must be sleeved or relocated. Proposed utility lines to be located out of facility.
5. Longitudinal slope of planter matches the road.
6. Area and depth of facility are based upon engineering calculations and right-of-way constraints. See Chapter 2 of the City of Portland Stormwater Management Manual (SWMM).
7. Additional inlets in facilities over 25 feet in length per BES or site-specific requirements.

RELATED DETAILS AND RESOURCES:

8. Inlet and outlet details SW-331, SW-332, SW-333 and SW-334
9. Check Dam details SW-342 and SW-343
10. Special requirements for water lines, meters, and fire hydrants (see SW-324)
11. Planter Planting Template (see SW-323)
12. Thickened Curb and Gutter per PBOT standard drawing P-540
13. Stormwater facility construction and blended soil requirements see City of Portland Standard Construction Specifications, sections 00415 and 01040.14(d)
14. Planter wall detail (see SW-313)
15. Pavement Markings (see PBOT standard drawing P-434)
16. 4" Sidewalk-Drainage Notch (see SW-322): Place one notch at the low point of the sidewalk and place additional notched approximately 6' apart.

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

For more information contact:

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PWB	(503) 823-7368	Urban Forestry	(503) 823-4489

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

In-Planting-Strip Plan View

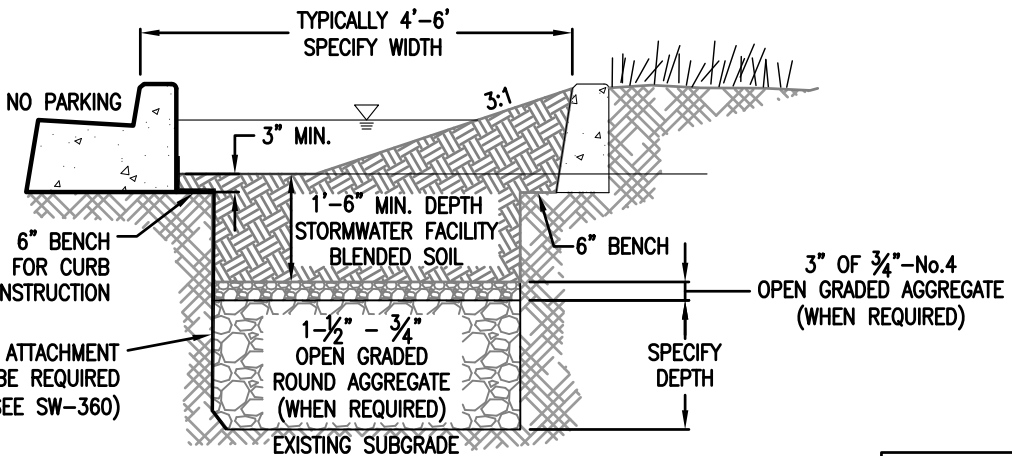
Curb Extensions

Bureau of Environmental Services

NUMBER

SW-321

7-1-2016

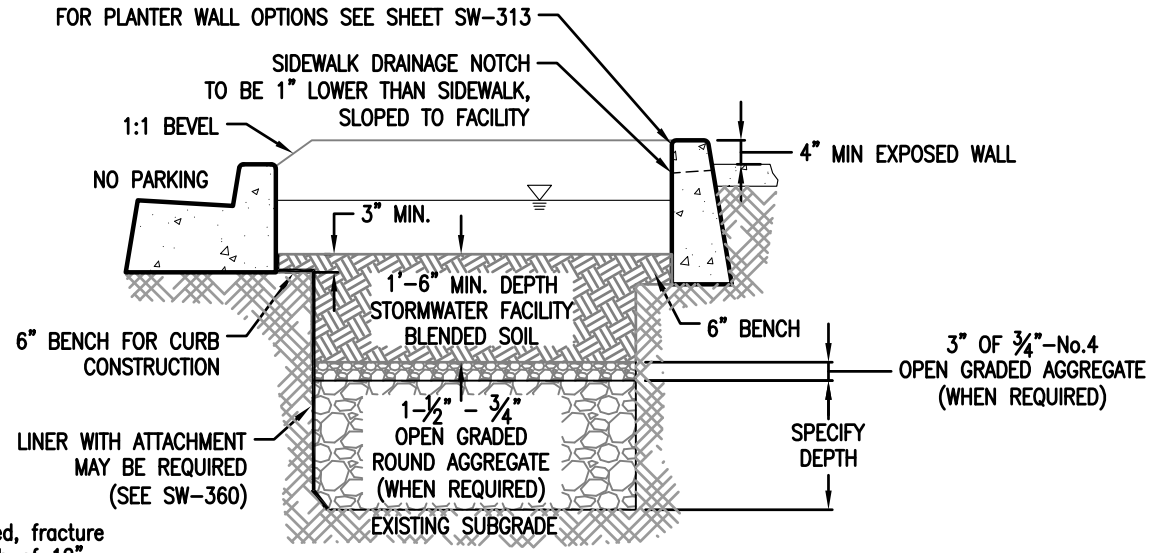


SECTION A-A

FOR PLAN VIEW
SEE SW-320

CONSTRUCTION NOTE

In facilities that are unlined, fracture and loosen soil to a depth of 12" below grade before installing belnded soil or aggregate. Do not till.



SECTION B-B
(WITH PLANTER WALL)

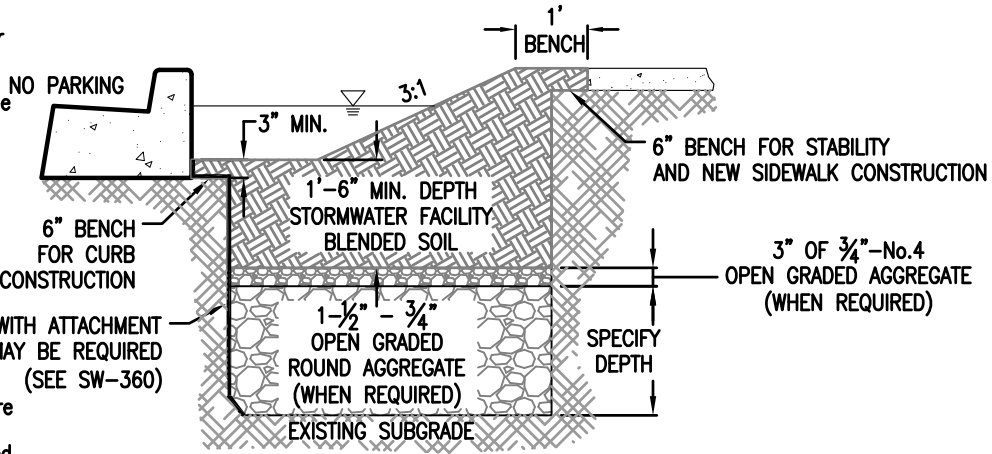
FOR PLAN VIEW
SEE SW-321

CONSTRUCTION NOTE

In facilities that are unlined, fracture and loosen soil to a depth of 12" below grade before installing belnded soil or aggregate. Do not till.

NOTES:

1. See SW-330 and SW-332 for inlet.
2. Show liner and perforated pipe in section, if required.
3. Maximum 10" of surface storage.



SECTION B-B
(WITHOUT PLANTER WALL)

FOR PLAN VIEW
SEE SW-321

CONSTRUCTION NOTE

In facilities that are unlined, fracture and loosen soil to a depth of 12" below grade before installing belnded soil or aggregate. Do not till.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Section Views

Curb Extensions

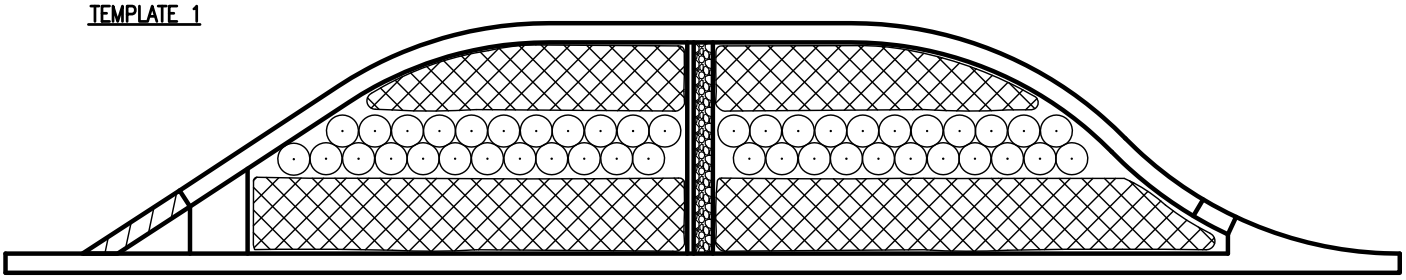
Bureau of Environmental Services

NUMBER

SW-322

7-1-2016

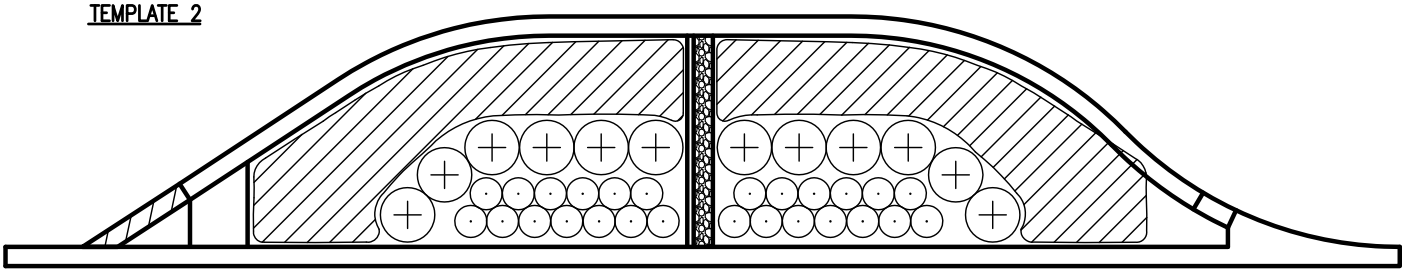
TEMPLATE 1



PLANT LEGEND 1

Symbol	Botanical Name / Common Name
▨	*Carex obnupta* / Slough sedge
⊙	*Juncus patens* / Spreading rush

TEMPLATE 2



PLANT LEGEND 2

Symbol	Botanical Name / Common Name
▨	*Juncus patens* / Spreading Rush
⊙	*Carex morrowii 'Ice Dance'* / Ice Dance Sedge
⊕	*Spiraea x bumalda 'Goldflame'* / Goldflame spirea

SAMPLE PLANT LEGEND				SQ. FOOT AREA – ZONE A	X
SYMBOL	BOTANIC NAME	COMMON NAME	SIZE	SPACING	QTY. ZONE A
▨	Xxxxx xxxxx	xxxxx	X	X	X
⊕	Xxxxx xxxxx	xxxxx	X	X	X

INSTRUCTIONS

1. Choose a template and alter it to design. These are examples of approved planting templates. Other planting plans may be approved.
2. Plant lists and on–center spacing requirements are found in Section 2.4.1 of the City of Portland Stormwater Management Manual.
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–363 for plant spacing.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Landscape Planting Templates

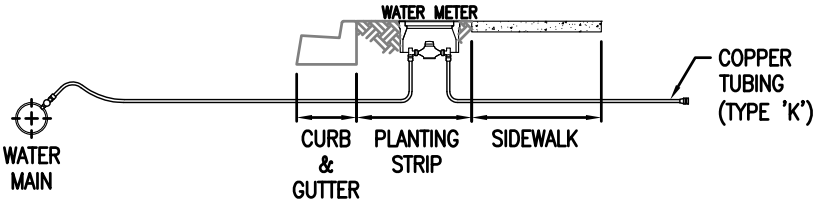
Curb Extensions

Bureau of Environmental Services

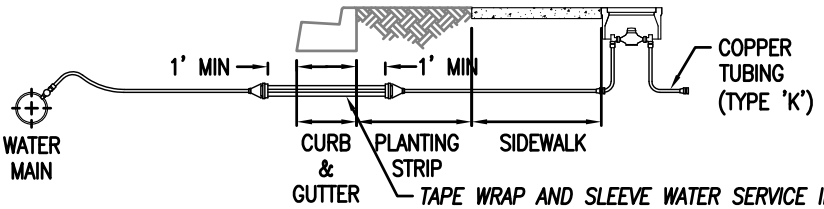
NUMBER

SW–323

7–1–2016

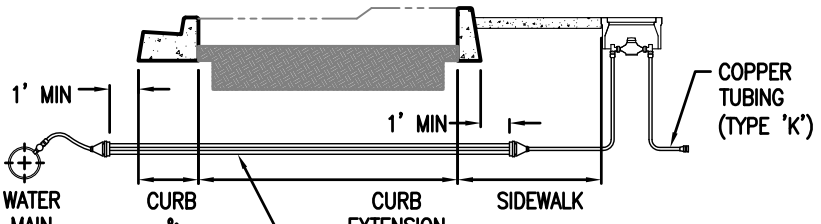


SECTION A–A



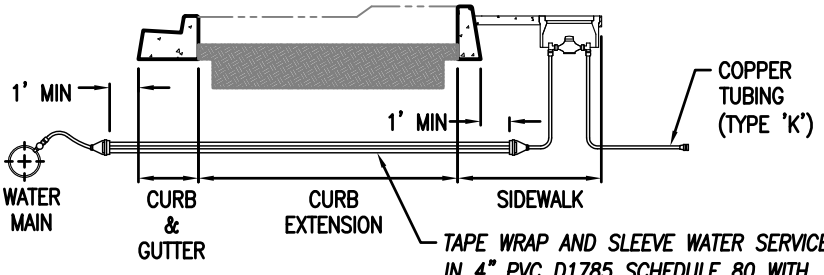
SECTION B–B

TAPE WRAP AND SLEEVE WATER SERVICE IN 4" PVC D1785 SCHEDULE 80 WITH MOLDED PIPE SLEEVE END SEALS. REFER TO STANDARD DRAWING P–770.



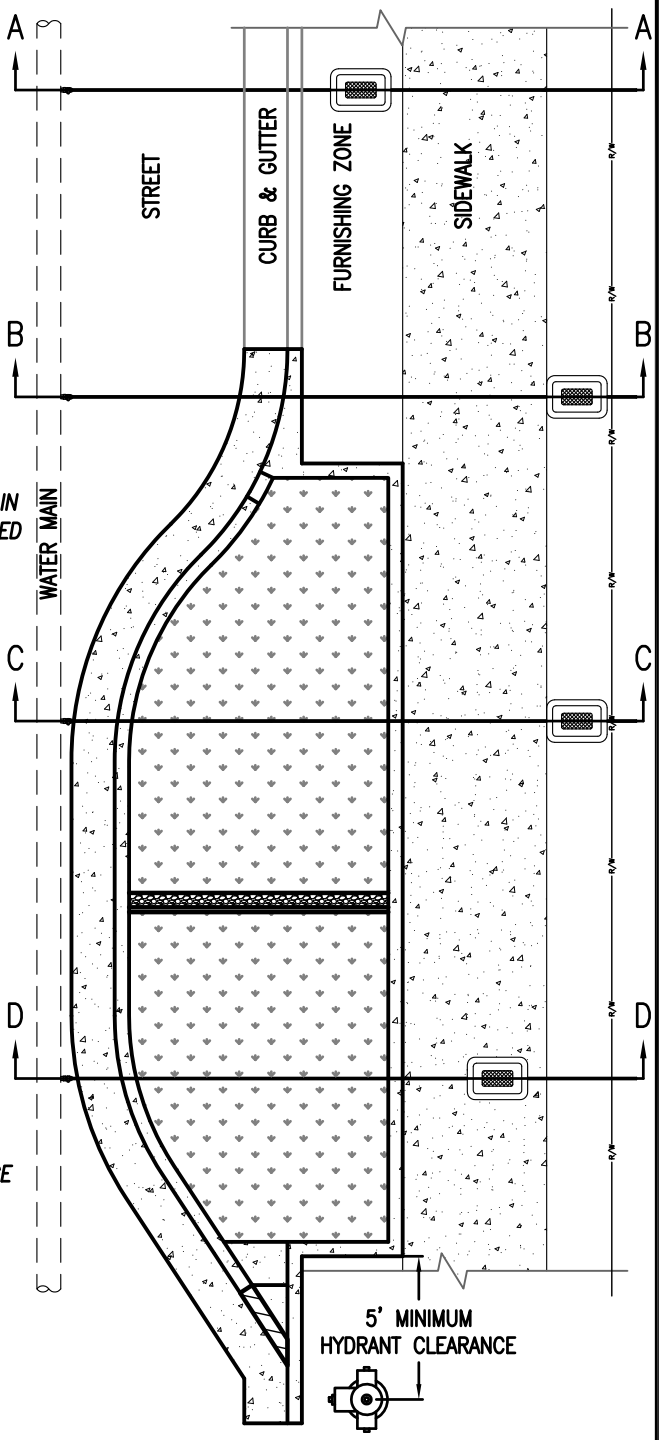
SECTION C–C

TAPE WRAP AND SLEEVE WATER SERVICE IN 4" PVC D1785 SCHEDULE 80 WITH MOLDED PIPE SLEEVE END SEALS. REFER TO STANDARD DRAWING P–770.



SECTION D–D

TAPE WRAP AND SLEEVE WATER SERVICE IN 4" PVC D1785 SCHEDULE 80 WITH MOLDED PIPE SLEEVE END SEALS. REFER TO STANDARD DRAWING P–770.



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P–700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A, if Furnishing Zone is a minimum of 3' wide. Option B or C can be used only if a minimum of 3' is available between the back of sidewalk and the Right–of–Way line. Option D can only be used for an existing service when other options are infeasible, where a minimum of 1' is available between the back of sidewalk and the Right–of–Way line, and it requires a Design Exception from PDOT to be obtained by Project Engineer.
3. Refer to 1" Service Assembly Standard Drawing P–780. For larger services or other appurtenances, contact PWB development services at (503) 823–7368. Water service line must be 2 ft min. from bottom of stormwater facility imported soil blend.
4. Maintain 2 ft skin–to–skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross–section views are not required on construction plans.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Meter & Hydrant Locations

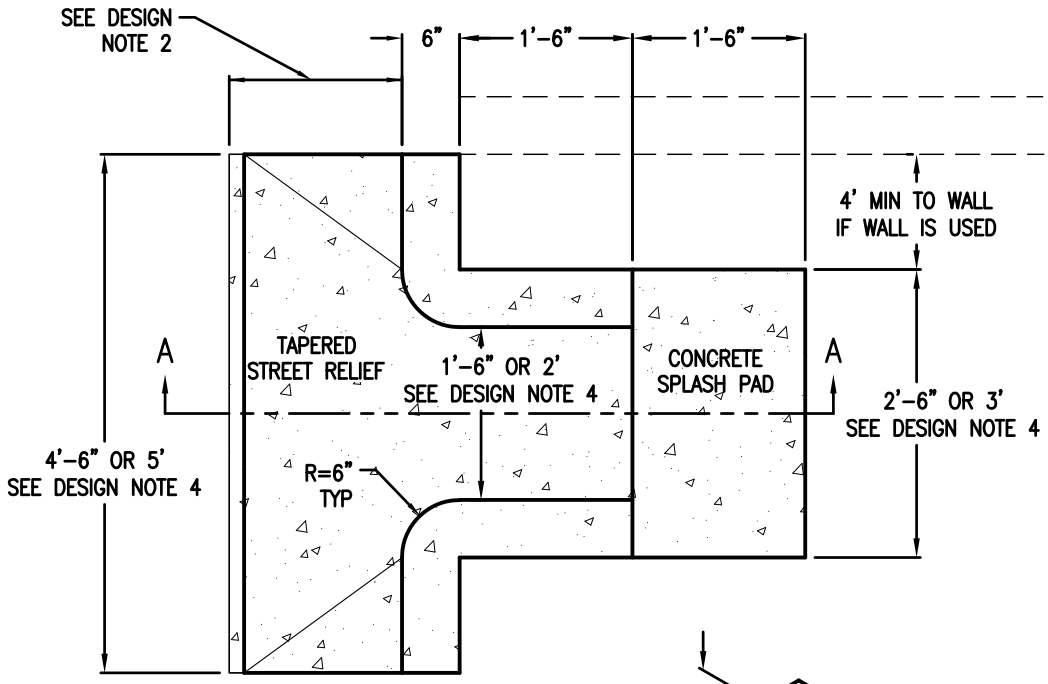
Curb Extensions

Bureau of Environmental Services

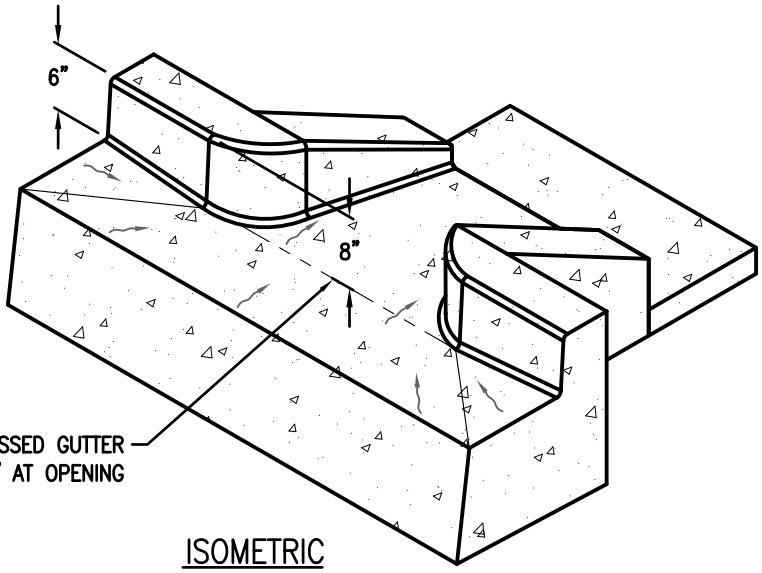
NUMBER

SW–324

7–1–2016



PLAN



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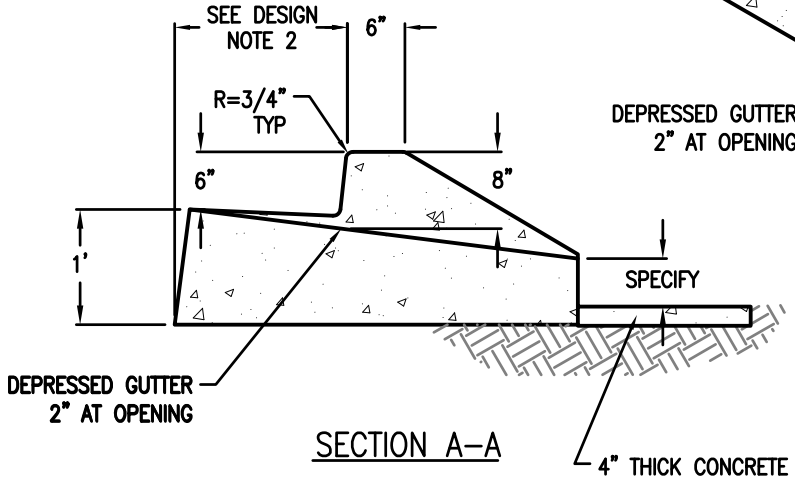


SECTION A–A

DESIGNER INFORMATION

1. For use with stormwater facilities with side slopes.
2. Refer to Standard Drawing P–540. Match gutter pan of adjacent curb and gutter.
3. Metal Inlet assembly, SW–332, required on high traffic streets.
4. Inlets on slopes greater than 5% may require 2 foot wide throat.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Concrete Inlet with Wingwalls

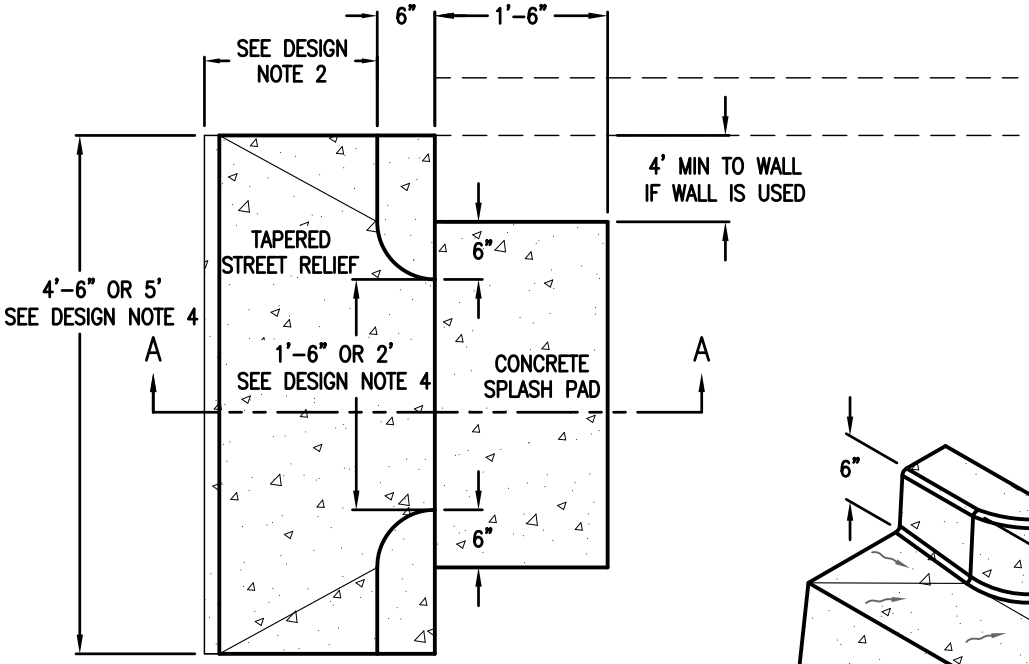
Curb Inlets

Bureau of Environmental Services

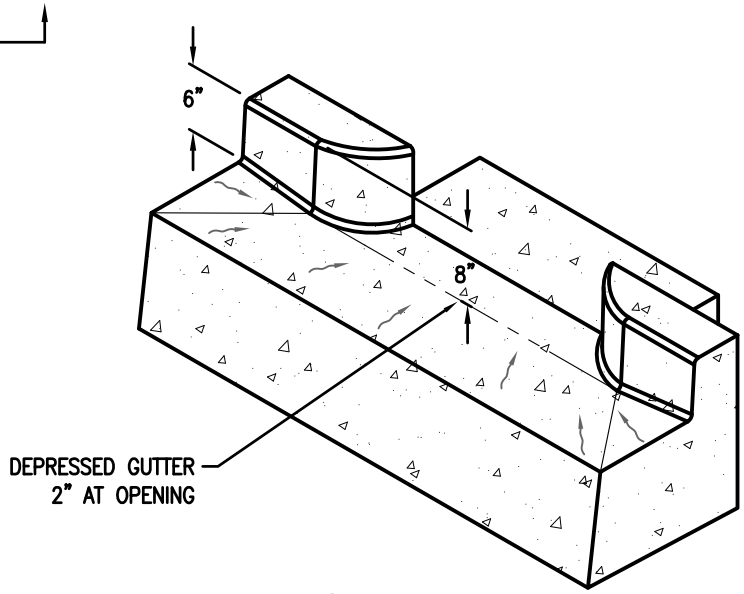
NUMBER

SW–330

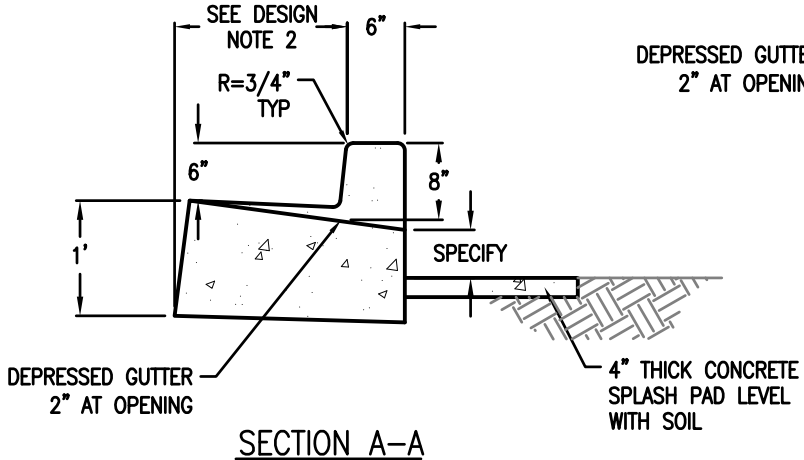
7–1–2016



PLAN



ISOMETRIC



SECTION A–A

CONSTRUCTION NOTES

1. Concrete splash pad elevation shall be level with soil inside planter.
2. Splash pad shall be six inches wider than inlet opening on both sides.

DESIGNER INFORMATION

1. For use with planters. If planter inlet is adjacent to planter wall, then include wall in detail.
2. Refer to Standard Drawing P–540. Match gutter pan of adjacent curb and gutter.
3. Metal Inlet assembly, SW–332, required on high traffic streets.
4. Inlets on slopes greater than 5% may require 2 foot wide throat.
5. If there is a drop from inlet to splash pad, Metal Inlet Assembly, SW–332, is required

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Concrete Inlet

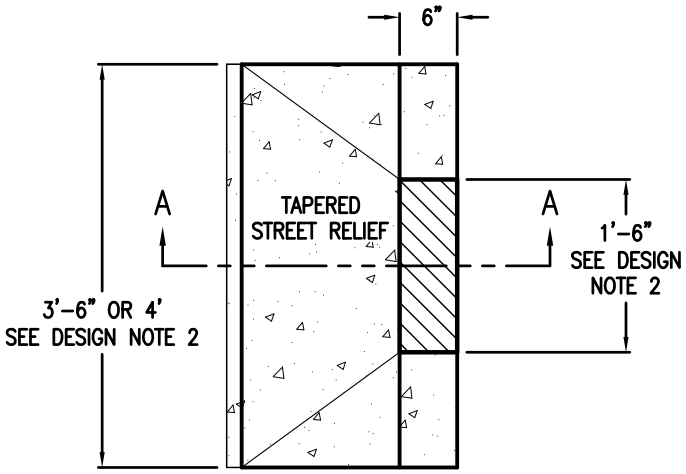
Curb Inlets

Bureau of Environmental Services

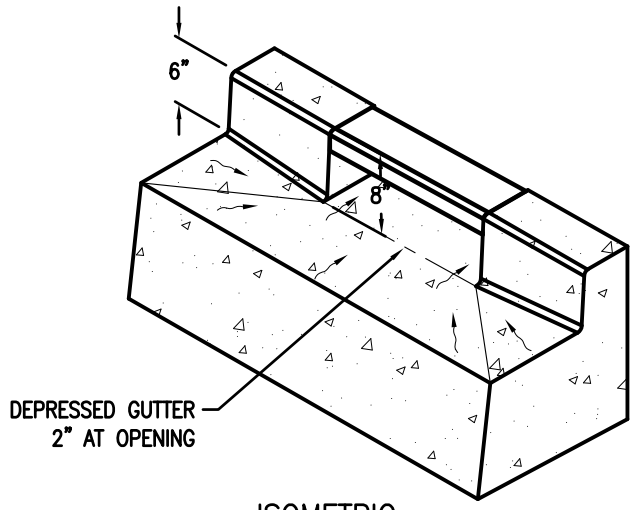
NUMBER

SW–331

7–1–2016



PLAN



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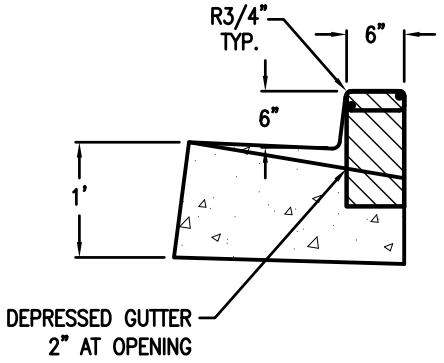


SECTION A-A

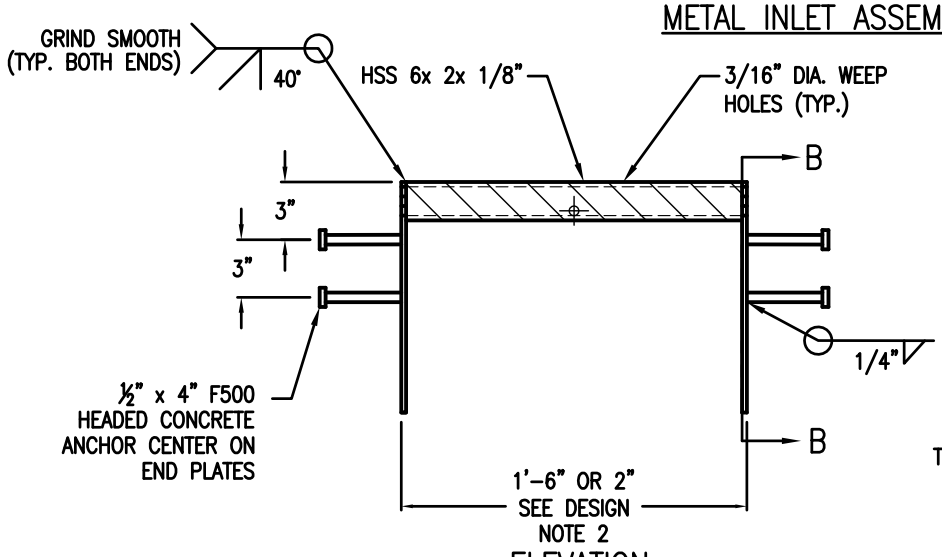
CONSTRUCTION NOTES:

1. Headed concrete anchors shall meet the requirements of ASTM A-108.
2. HSS 6 x 2 x 1/8 tube shall meet the requirements of ASTM A-500 Grade B.
3. End Plates shall meet the requirements of ASTM A-36.
4. Entire assembly shall be Hot-Dip Galvanized in accordance with ASTM A-123.

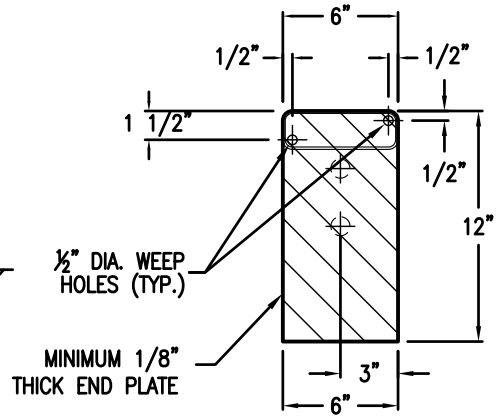
DESIGNER INFORMATION:

1. Refer to Standard Drawing p-540. Match gutter of adjacent curb and gutter.
2. Metal inlet width can be modified to 2' if site conditions require a 2' interior inlet width.

METAL INLET ASSEMBLY



ELEVATION



SECTION B-B

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Metal Inlet

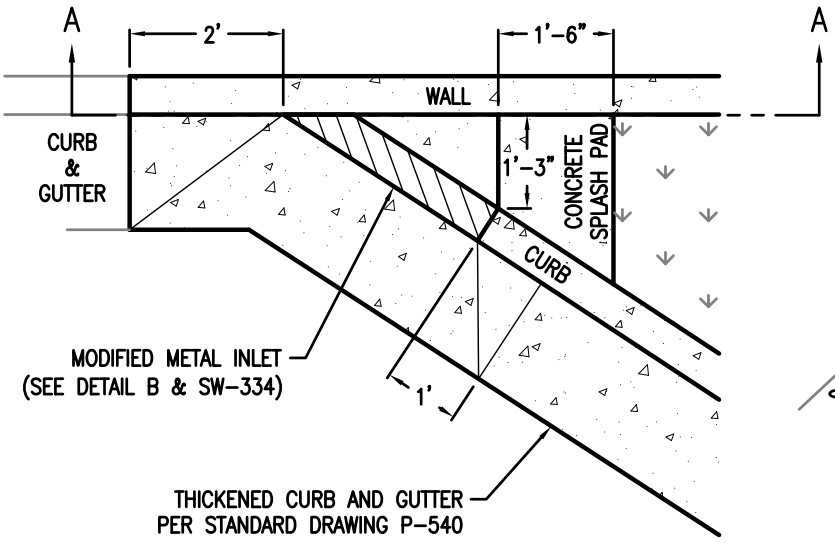
Curb Inlets

Bureau of Environmental Services

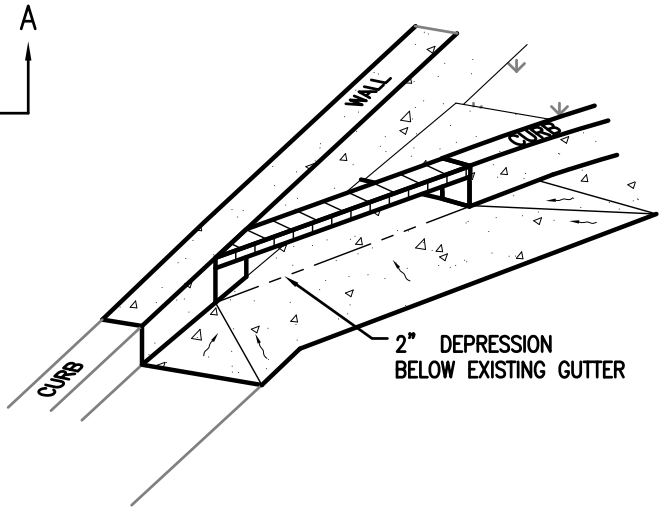
NUMBER

SW-332

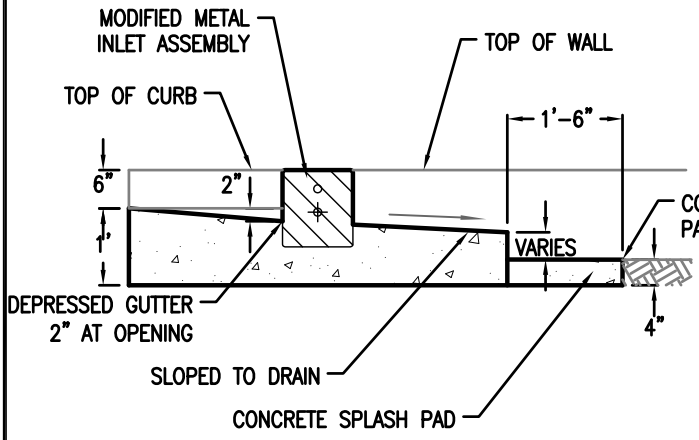
7-1-2016



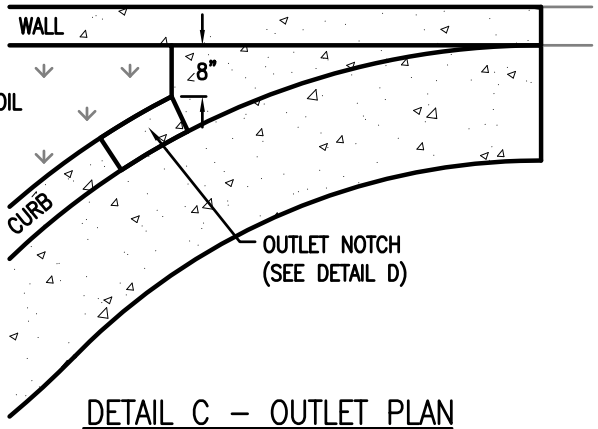
DETAIL A – INLET PLAN



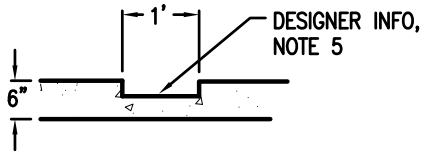
DETAIL B – INLET PERSPECTIVE



SECTION A–A



DETAIL C – OUTLET PLAN



DETAIL D – OUTLET NOTCH

DESIGNER INFORMATION:

1. Additional concrete inlets, SW–331, can be added if necessary (preferably immediately downstream of each check dam to minimize potential backflow).
2. Sawcut beyond facility and transition existing curb to new curb and gutter at 1" per foot as necessary.
3. Inlet may be modified to maximize flow entry to stormwater facility.
4. Modify inlet and outlet design as needed for site.
5. Ensure outlet notch elevation is 2" below lowest inlets and sidewalk notches.
6. Concrete splash pad required at all inlets.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Inlet & Outlet for Curb Extensions

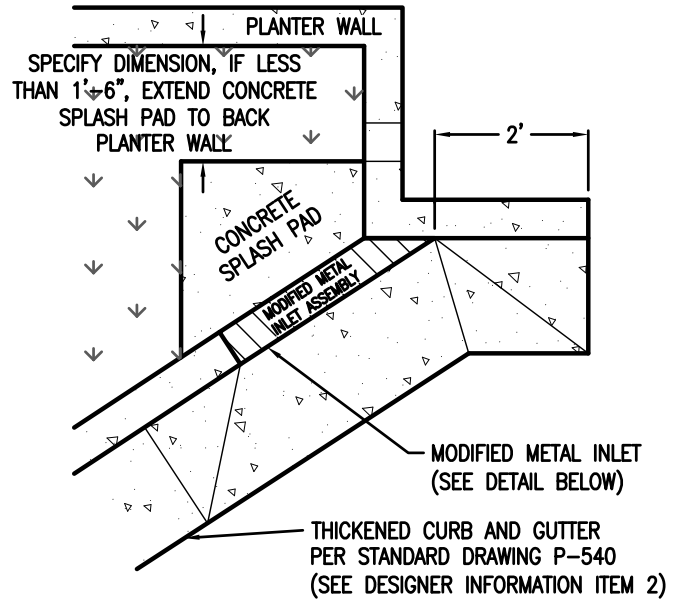
Curb Inlets

Bureau of Environmental Services

NUMBER

SW–333

7–1–2016



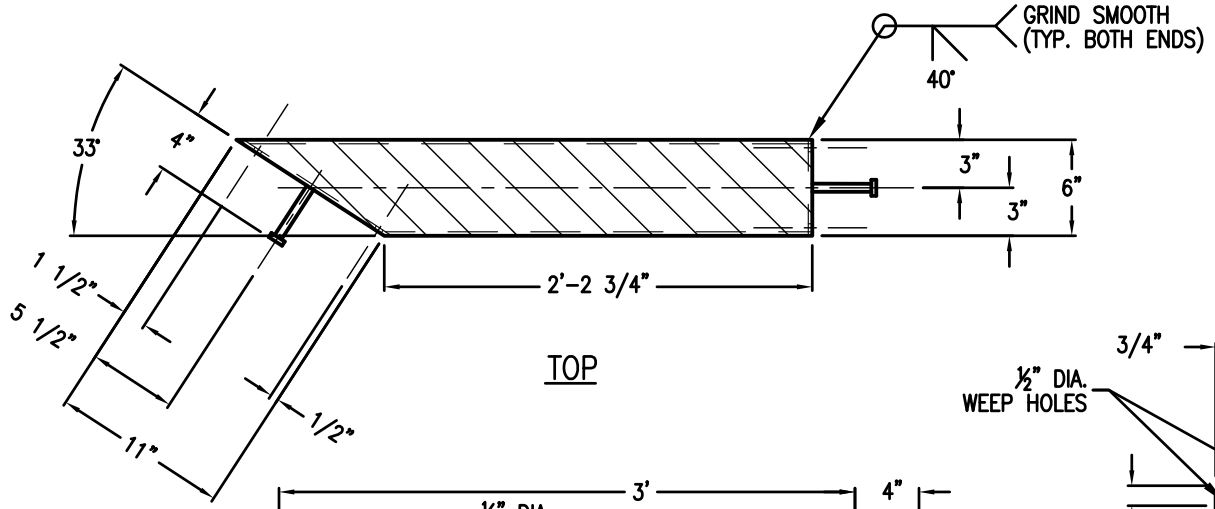
PLAN

DESIGNER INFORMATION:

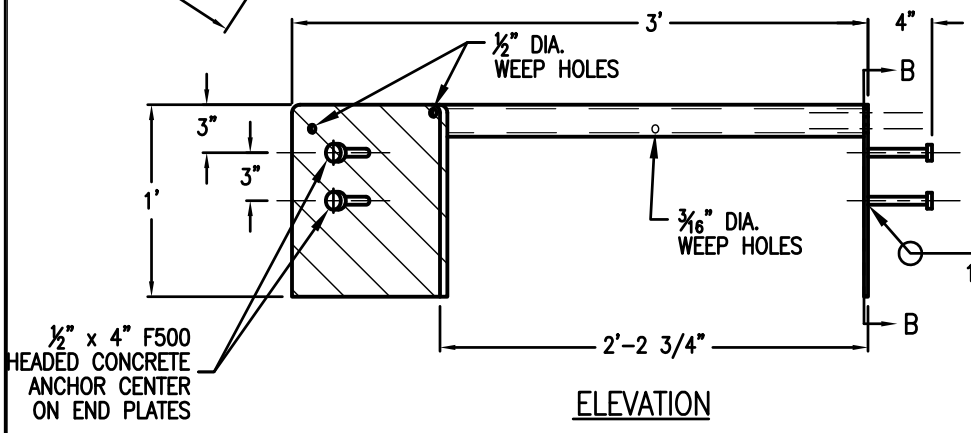
1. Splash pad is required at all inlets.
2. Refer to Standard Drawing P-540. Match gutter pan of adjacent curb and gutter.
3. Design vertical wheel load is 8.5kips (1/2 of tandem axle weight specified in FHWA-HOP-06-105).

CONSTRUCTION NOTES:

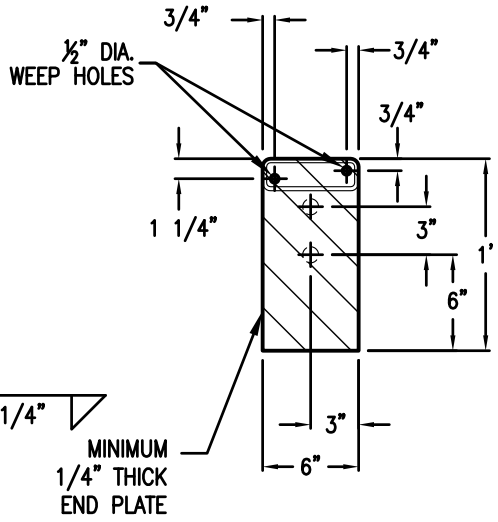
1. Headed concrete anchors shall meet the requirements of ASTM A-108.
2. HSS 6 x 2 x 1/4 Tube Channel shall meet the requirements of ASTM A-500 Grade B.
3. End Plates shall meet the requirements of ASTM A-36.
4. Entire assembly shall be Hot-Dip Galvanized in accordance with ASTM A-123.



TOP



ELEVATION



SECTION B-B

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Modified Metal Inlet Assembly

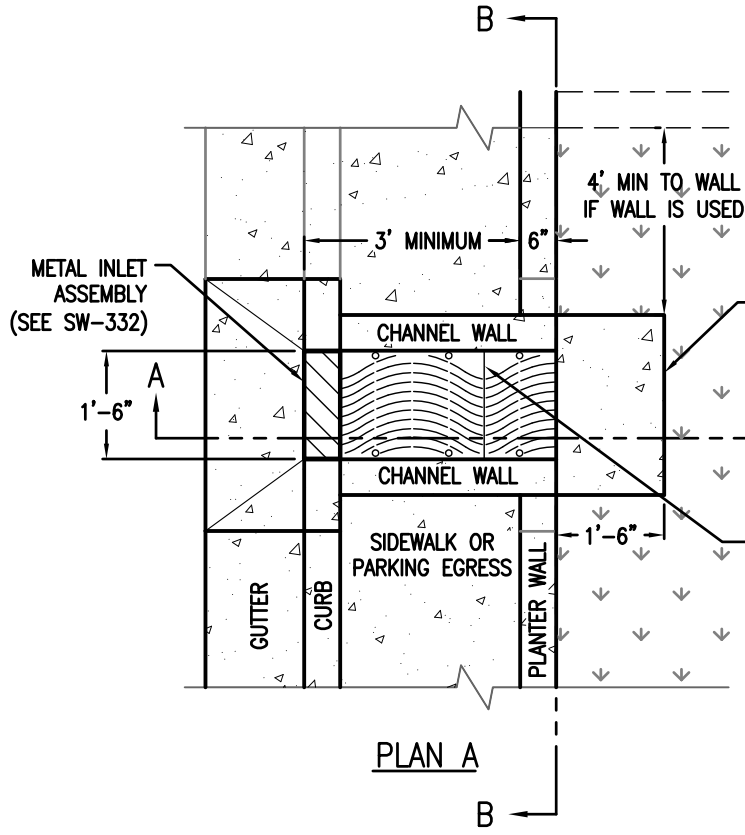
Curb Inlets

Bureau of Environmental Services

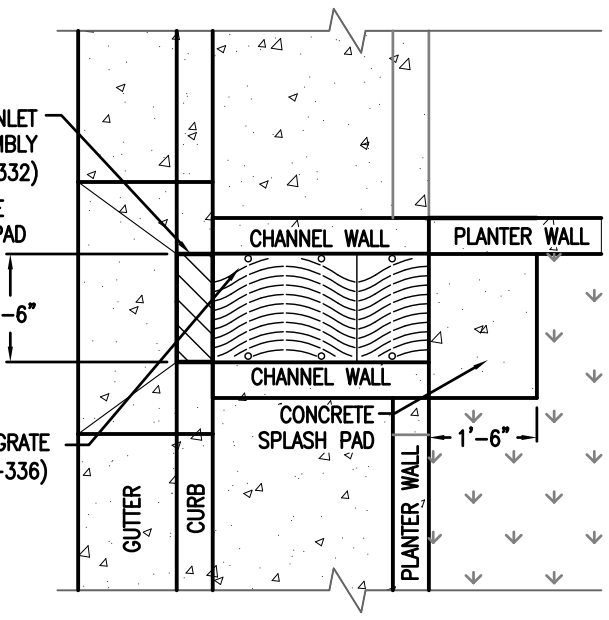
NUMBER

SW-334

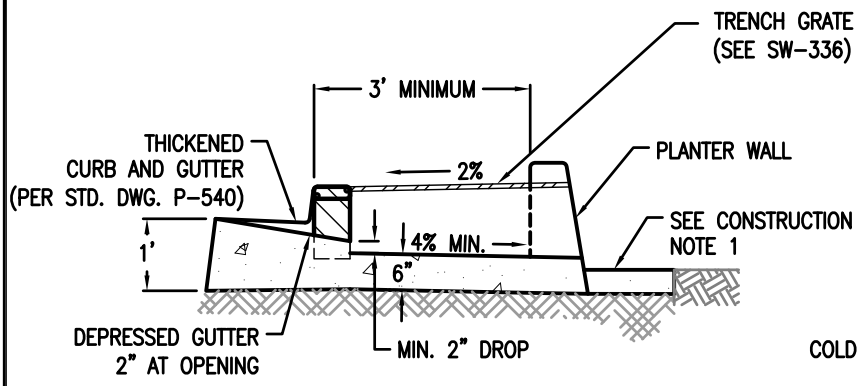
7-1-2016



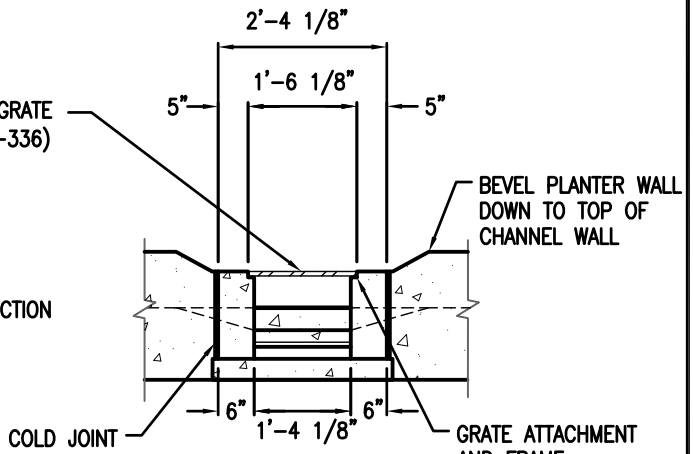
PLAN A



PLAN B, AT SIDE WALL



SECTION A-A



SECTION B-B

DESIGNER NOTES:

1. Inlet channel slope may vary where appropriate. Steeper slopes are better for keeping inlet free of debris.

CONSTRUCTION NOTES:

1. 4" thick concrete splash pad elevation shall be level with soil inside planter.
2. Concrete splash pad shall be 6" wider than channel opening on both sides.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Channel & Grate Details

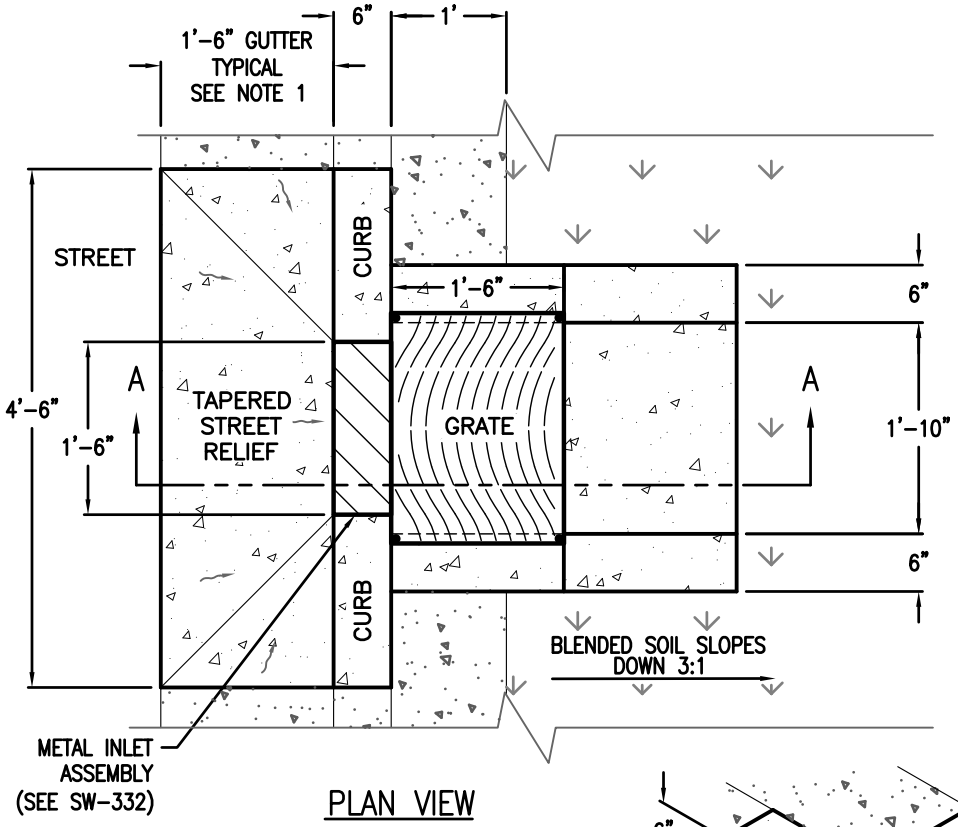
Curb Inlets

Bureau of Environmental Services

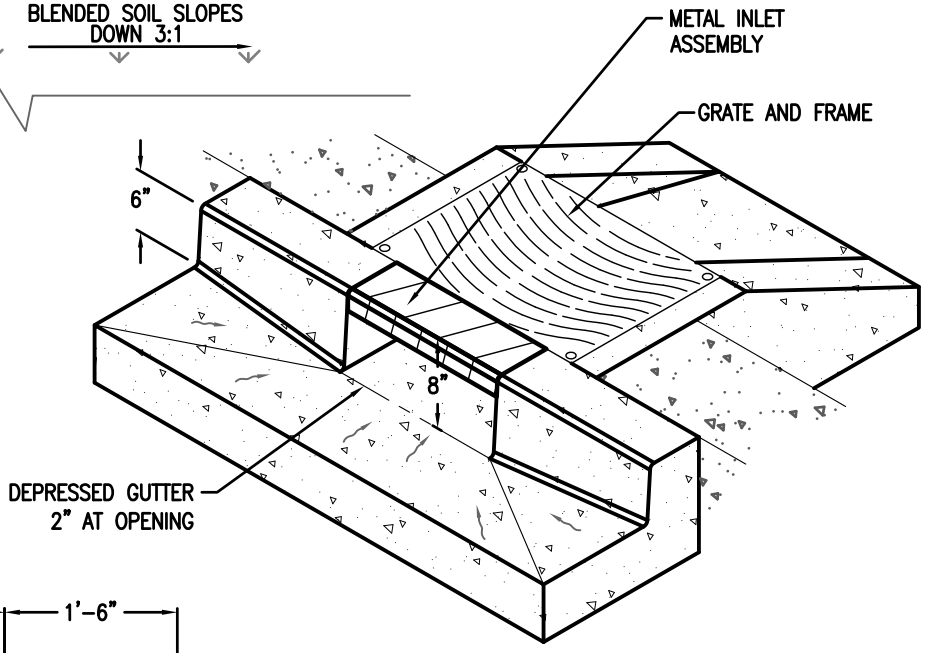
NUMBER

SW-335A

7-1-2016



PLAN VIEW



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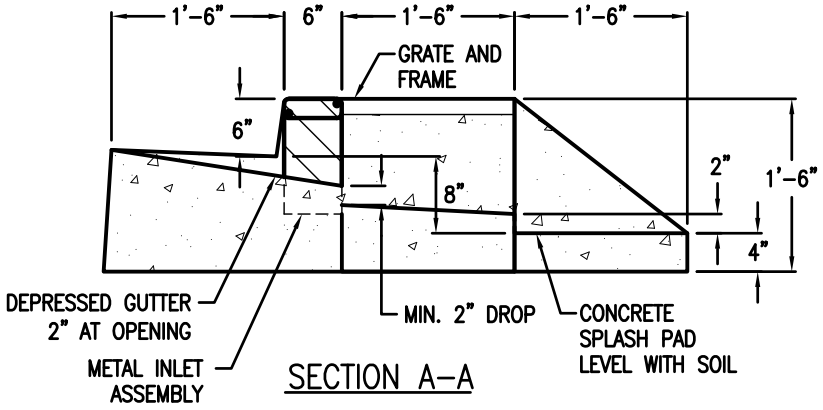


SECTION A-A

CONSTRUCTION NOTES:

1. Reference Standard Drawing P-540.

DESIGNER INFORMATION:

1. If Inlet used with swale stormwater facility modify plan and isometric views

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Inlet, Channel & Grate Details (Step-Out)

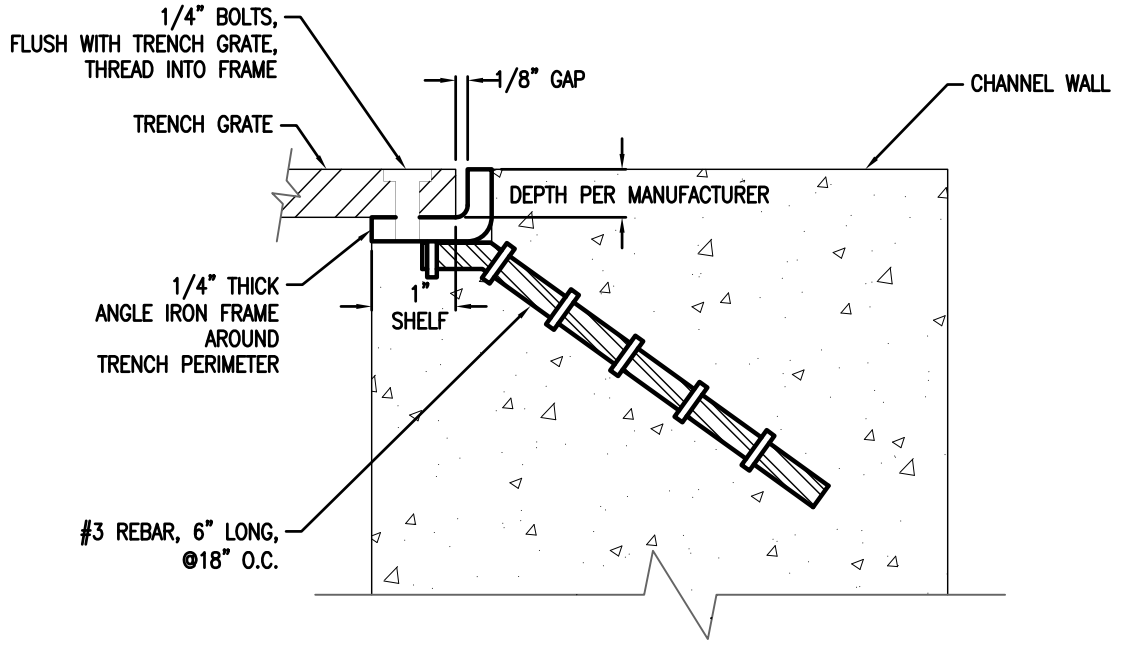
Curb Inlets

Bureau of Environmental Services

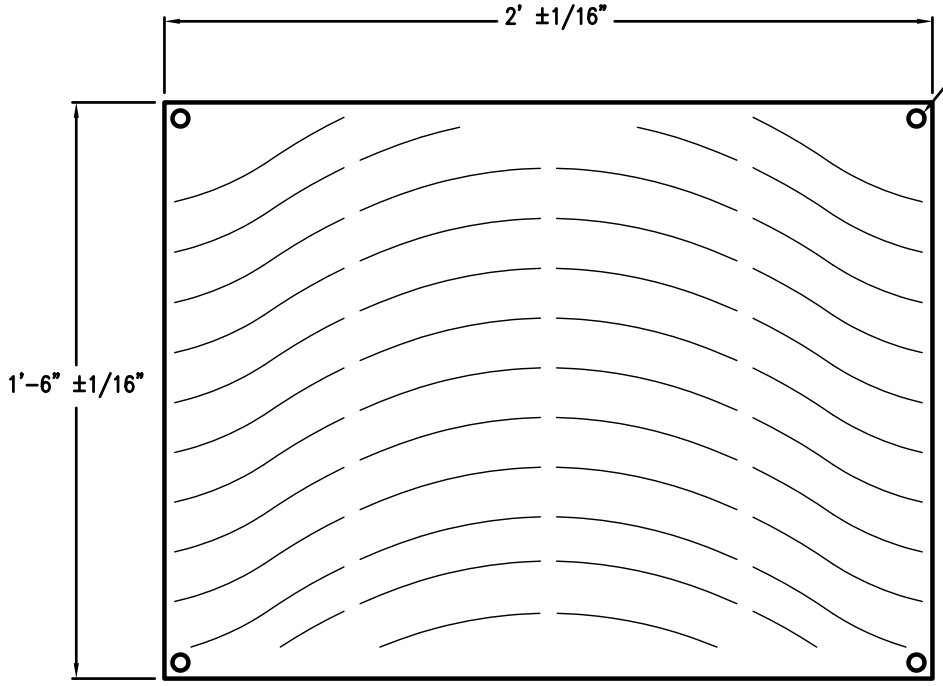
NUMBER

SW-335B

7-1-2016



FRAME AND GRATE ATTACHMENT DETAIL



CONSTRUCTION NOTES:

1. Cast iron, natural finish.
2. No opening greater than 3/8".
3. Protect threaded holes in frame from clogging during frame installation.
4. Grate to be rated for H-20 loading, with a non-slip surface having a static coefficient of friction between 0.60 and 1.0 per ASTM C1020. Grates on inclines greater than 4% shall have a coefficient of 0.80 to 1.0.
5. Grate to be ADA compliant.

TRENCH GRATE

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Grate & Frame Details

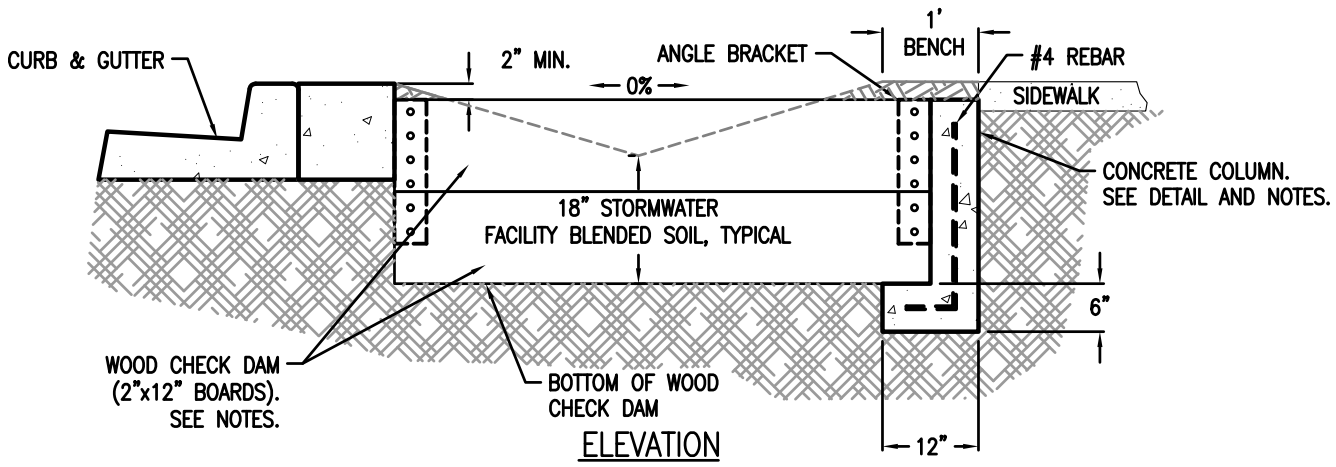
Check Dams

Bureau of Environmental Services

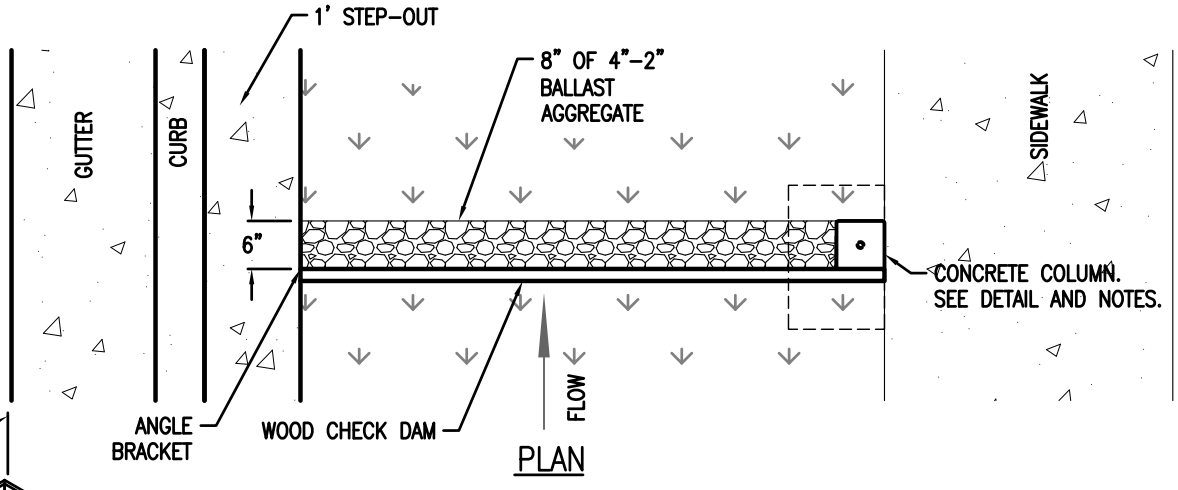
NUMBER

SW-336

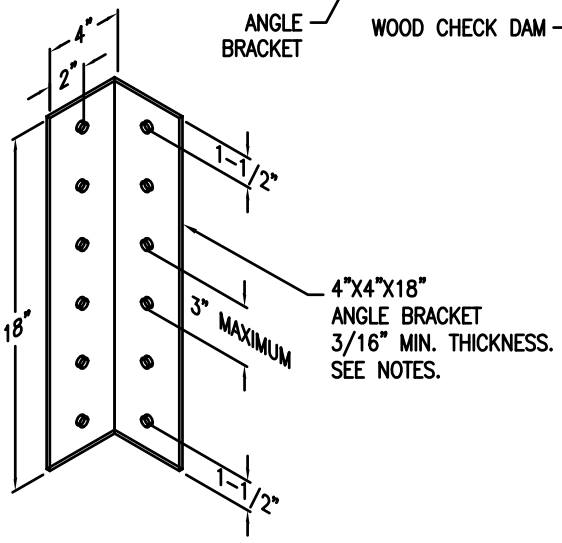
7-1-2016



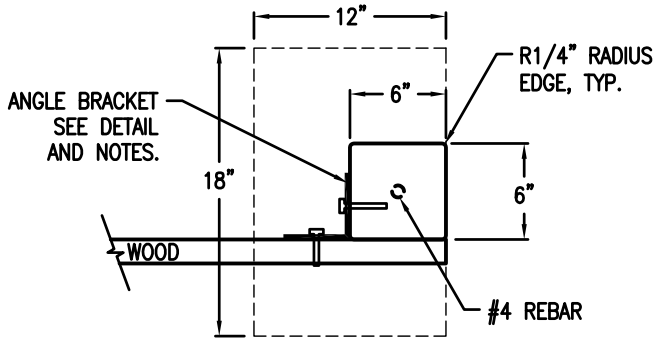
ELEVATION



PLAN



ANGLE BRACKET DETAIL



CONCRETE COLUMN DETAIL

DESIGNER INFORMATION

1. Provide elevations and stationing and/or dimensioning for check dams, where applicable.
2. Ensure that check dam elevations do not cause stormwater to overflow to sidewalk or back in roadway.

CONSTRUCTION NOTES

1. Concrete to be 3000 psi.
2. Lumber to be a naturally rot-resistant wood (e.g. cedar). Manufactured products can be used with approval. No chemically treated wood will be allowed. Boards shall be free from holes or loose knots and cut to fit width of facility without gaps.
3. All fasteners and bracket to be stainless steel or aluminum.
4. Top of bracket to be no higher than top of check dam.
5. Minimum 5/16" dia. bolts, 3 bolts/bracket into concrete and 4 bolts/bracket into wood (2 bolts into each board).
6. Use clear silicone caulk or other approved product between check dam boards and along brackets as watertight seal.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Wood Check Dam for Swales

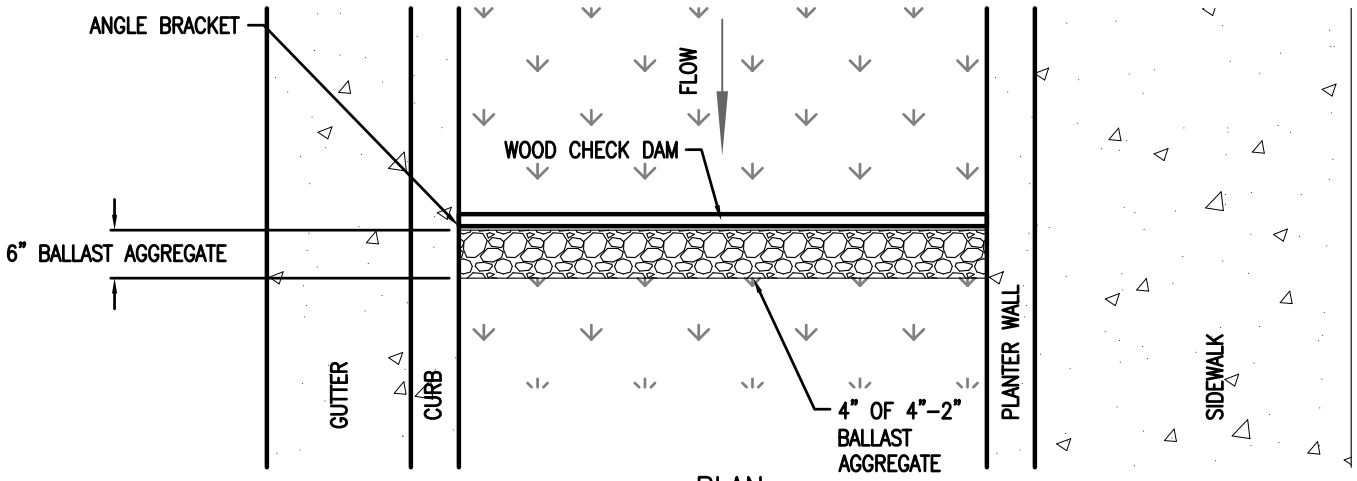
Check Dams

Bureau of Environmental Services

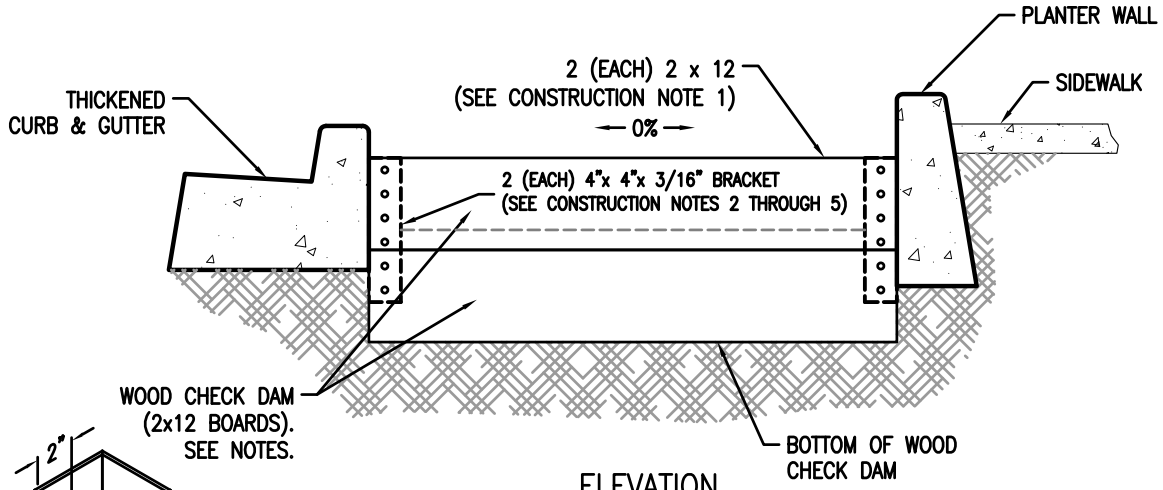
NUMBER

SW-341

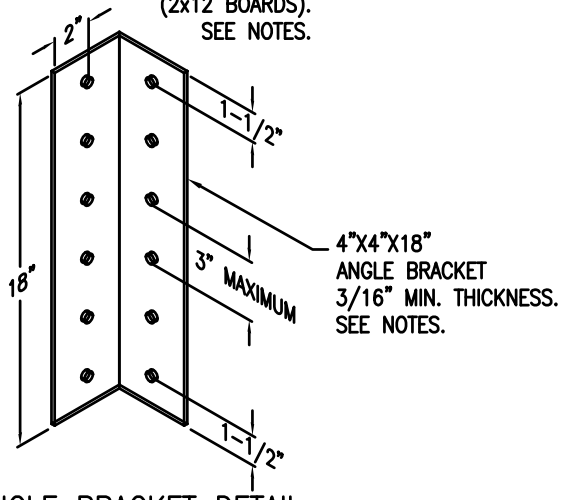
7-1-2016



PLAN



ELEVATION



ANGLE BRACKET DETAIL

DESIGNER INFORMATION

1. Provide elevations and stationing and/or dimensioning for check dams.
2. Top of checkdam (tcd) elevation to be whichever is lowest: 1" below the elevation of the upstream inlet elevation 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 check dam.
3. Ensure that check dam elevations do not cause stormwater to overflow to sidewalk.
4. Provide 1' curb–side step–out if planter is adjacent to parking, modify detail as needed.

CONSTRUCTION NOTES

1. Lumber to be a naturally rot–resistant wood (e.g. cedar). Manufactured products can be used with approval. No chemically treated wood will be allowed.
2. All fasteners to be stainless steel or aluminum.
3. 4"x 4"x 18" angle bracket, minimum 3/16" thick, stainless steel, or aluminum.
4. Top of bracket to be no higher than top of check dam.
5. Minimum 5/16" dia. bolts, 3 bolts into concrete, 2 bolts into each board

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Wood Check Dam for Planters

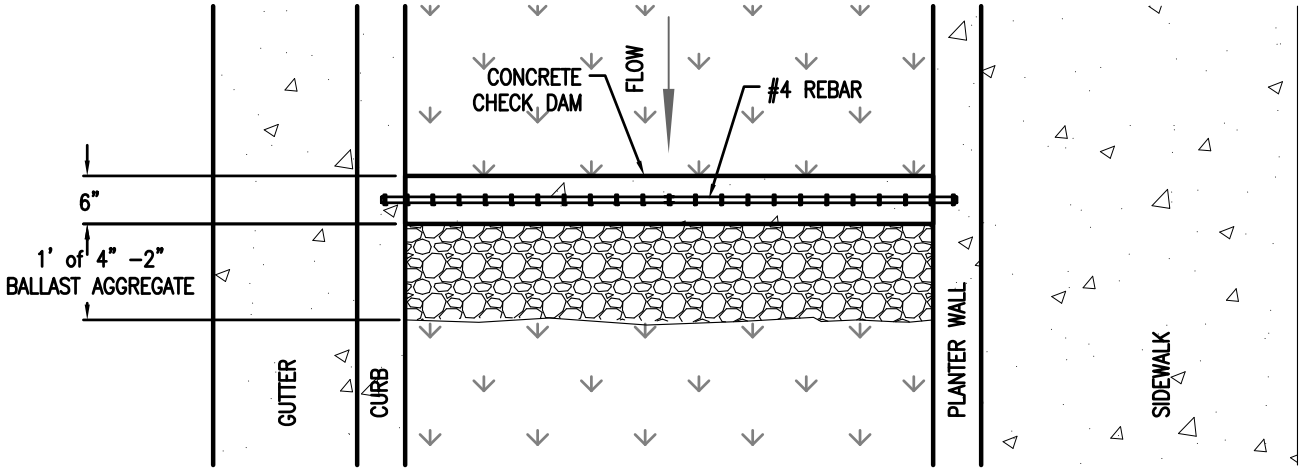
Check Dams

Bureau of Environmental Services

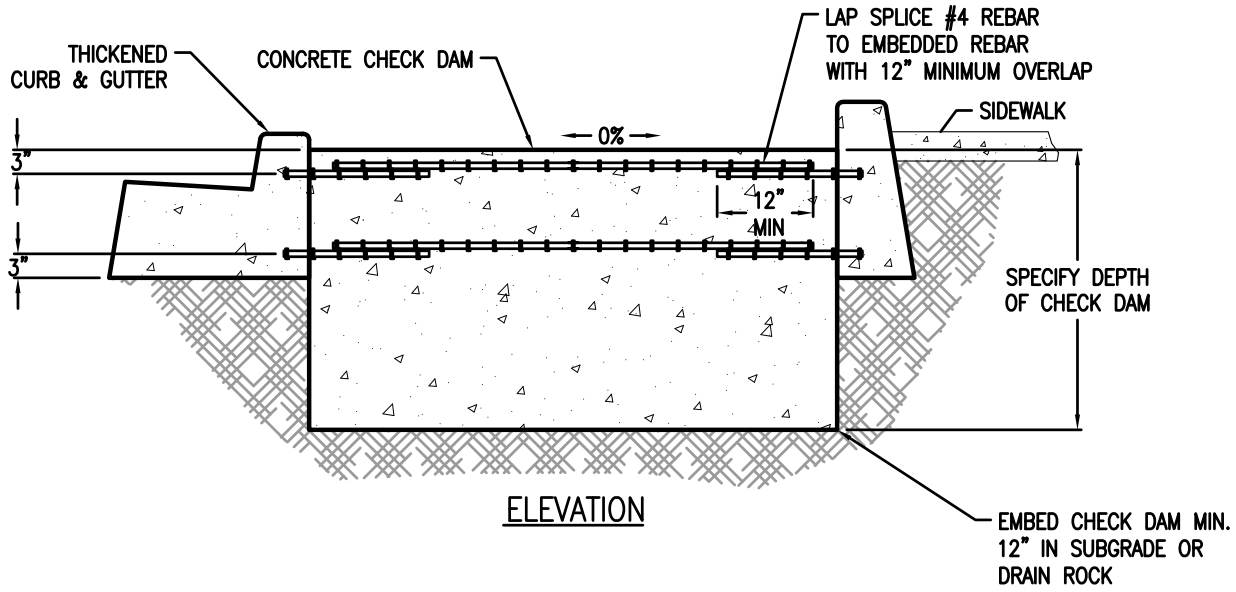
NUMBER

SW–342

7–1–2016



PLAN



ELEVATION

DESIGNER INFORMATION

1. Provide elevations and stationing and/or dimensioning for check dams.
2. Top of checkdam (tcd) elevation to be whichever is lowest: 1" below the elevation of the upstream inlet elevation 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 check dam.
3. Ensure that check dam elevations do not cause stormwater to overflow to sidewalk.
4. Provide 1' curb-side step-out if planter is adjacent to parking, modify detail as needed.

CONSTRUCTION NOTE

1. Concrete to be 3,000 psi.
2. Embed #4 rebar 3" into curb and planter wall.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Concrete Check Dam for Planters

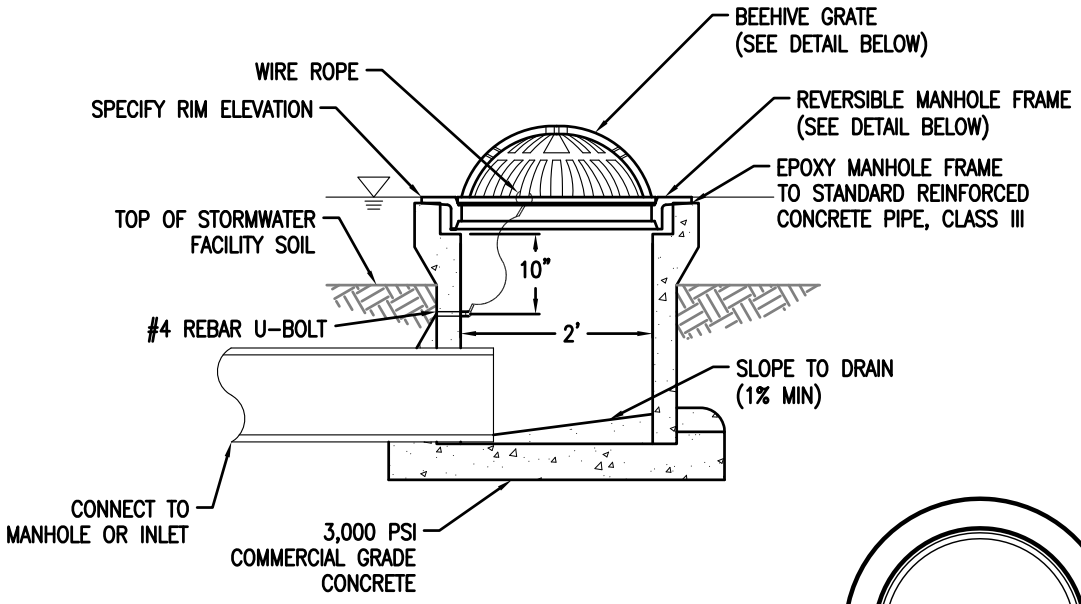
Check Dams

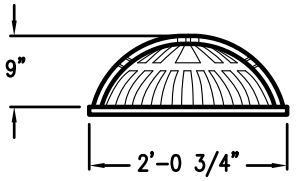
Bureau of Environmental Services

NUMBER

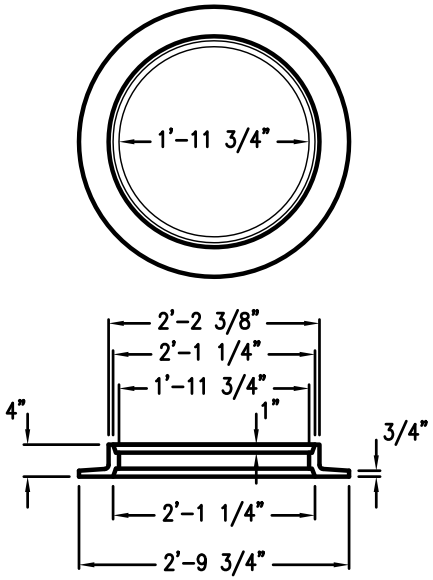
SW-343

7-1-2016





BEEHIVE GRATE



24"x4" REVERSIBLE MANHOLE FRAME

DESIGNER INFORMATION

1. If connecting to a combination sewer manhole installation of a "swing-check type backwater valve" or approved equal is required to prevent odor emissions.
2. Size inlet based on calculated flows & manufacturers recommendations.

CONSTRUCTION NOTES

1. Secure grate in place with 54" of wire rope. Loop ends of wire rope around U-bolt and grate. Crimp each end of wire rope with ferrule.
2. Drill 2" deep holes into pipe and epoxy #4 rebar U-bolt (2"x 4") in holes.
3. Grate to be cast iron, ASTM A48 CL30.
4. Beehive rim elevation to be 1" lower than sidewalk notches, top of planter wall, top of slope, outlet 'notch or upstream notch, whichever is lowest.
5. Wire rope between 1/8"-3/16" diameter, stainless steel, 7 strands of 19 wires.

- DRAWING NOT TO SCALE -

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

- Green Streets -

Beehive Inlet Grate

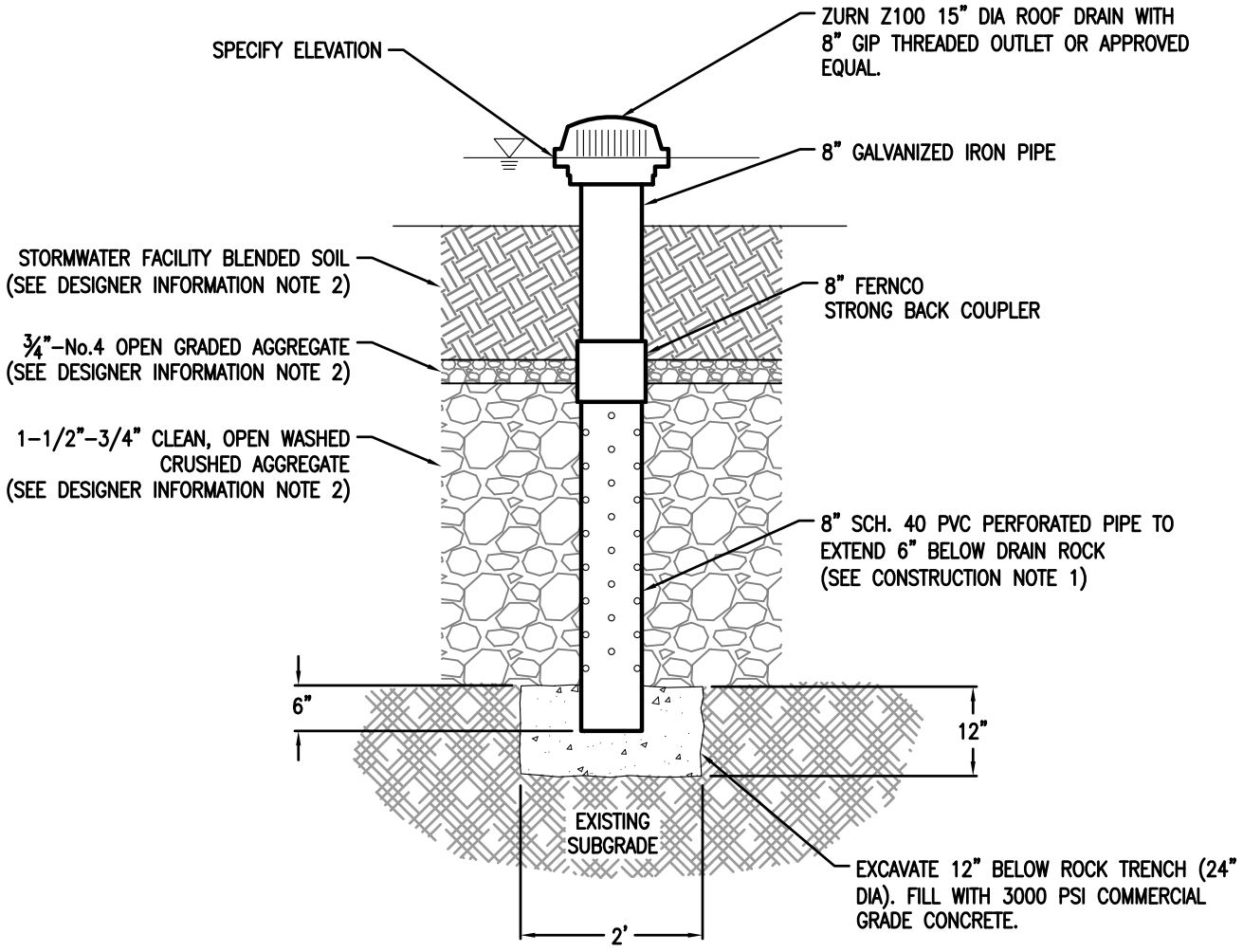
Overflow Inlets

Bureau of Environmental Services

NUMBER

SW-350

7-1-2016



DESIGNER INFORMATION

1. Show overflow drain in swale, planter or curb extension section. Separate swale, planter or curb extension section views may not be needed.
2. Dimension stormwater facility blended soil and rock layers per your design.

CONSTRUCTION NOTE

1. Perforate 8" Schedule 40 PVC with ½" holes, 90 degrees around pipe, rows 2" apart. Offset holes in rows by 45°.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Overflow Drain

Overflow Inlets

Bureau of Environmental Services

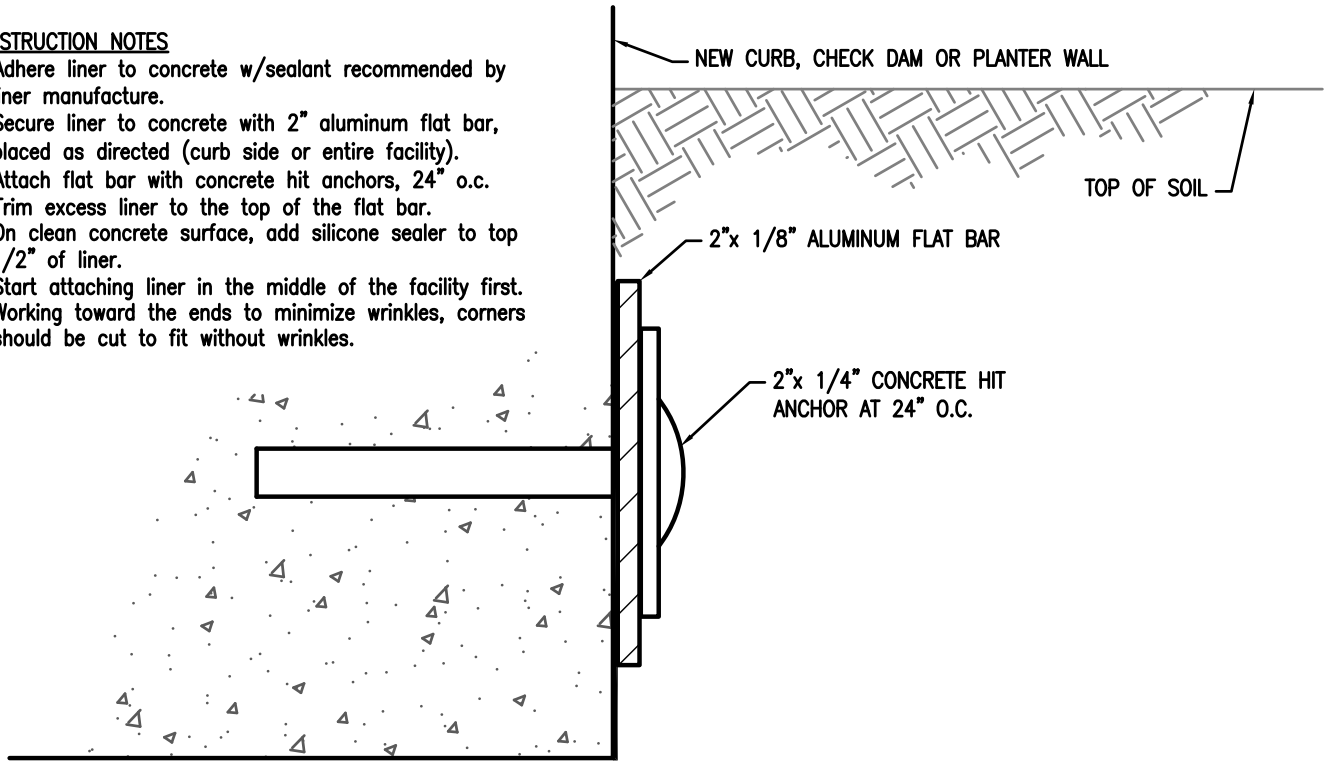
NUMBER

SW–351

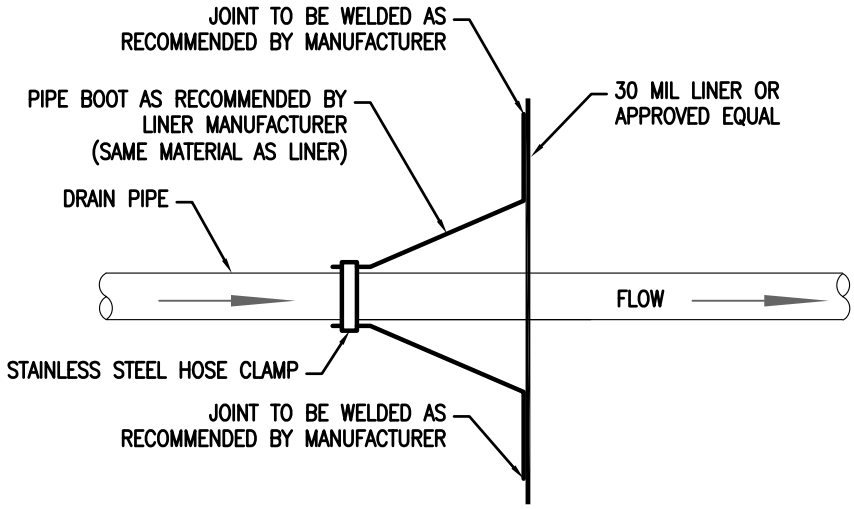
7–1–2016

CONSTRUCTION NOTES

1. Adhere liner to concrete w/sealant recommended by liner manufacture.
2. Secure liner to concrete with 2" aluminum flat bar, placed as directed (curb side or entire facility).
3. Attach flat bar with concrete hit anchors, 24" o.c.
4. Trim excess liner to the top of the flat bar.
5. On clean concrete surface, add silicone sealer to top 1/2" of liner.
6. Start attaching liner in the middle of the facility first. Working toward the ends to minimize wrinkles, corners should be cut to fit without wrinkles.



LINER ATTACHMENT



PIPE BOOT

DESIGNER INFORMATION

1. Liner materials to be HDPE. Liner to extend from top of blended soil to the bottom of excavation.
2. 3" of concrete is required on all sides of attachment. Adjust sidewalk depth as necessary.
3. Liner required when face of new curb is less than 2' from OD of adjacent water main.
4. Liner required on neighborhood collectors and higher street classifications.
5. Liner may be required on local streets with transit routes, higher traffic volumes, or when a facility is adjacent to travel lane at the discretion of the City Engineer.
6. In the Columbia South Shore Well Field Wellhead Protection Area or areas with contaminated soils the facility must be completely lined with a 40 mil liner unless facility's bottom and sides are monolithic concrete.
7. Liners may be required near basements or other underground structures.
8. Trees allowed in lined facilities only at the discretion of City of Portland staff.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Liner Attachment & Pipe Boot Detail

Additional Details

Bureau of Environmental Services

NUMBER

SW–360

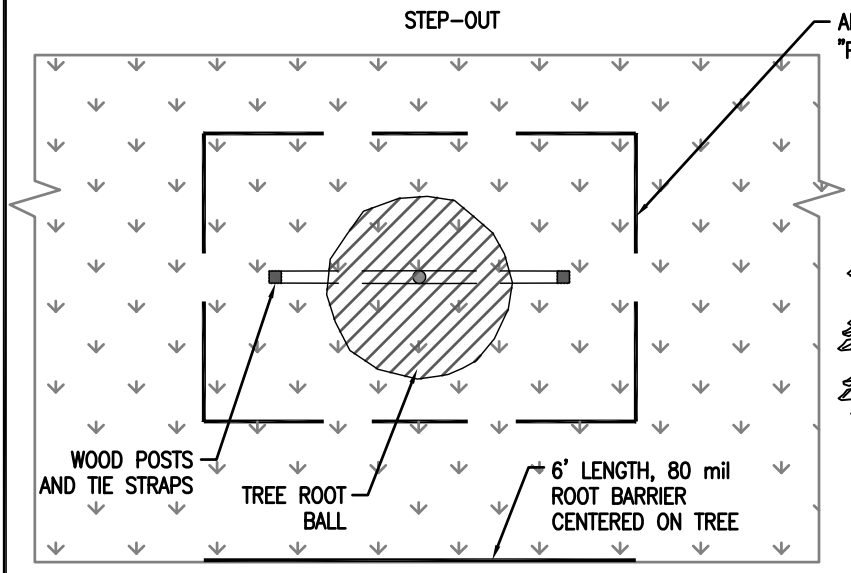
7–1–2016

DESIGNER INFORMATION:

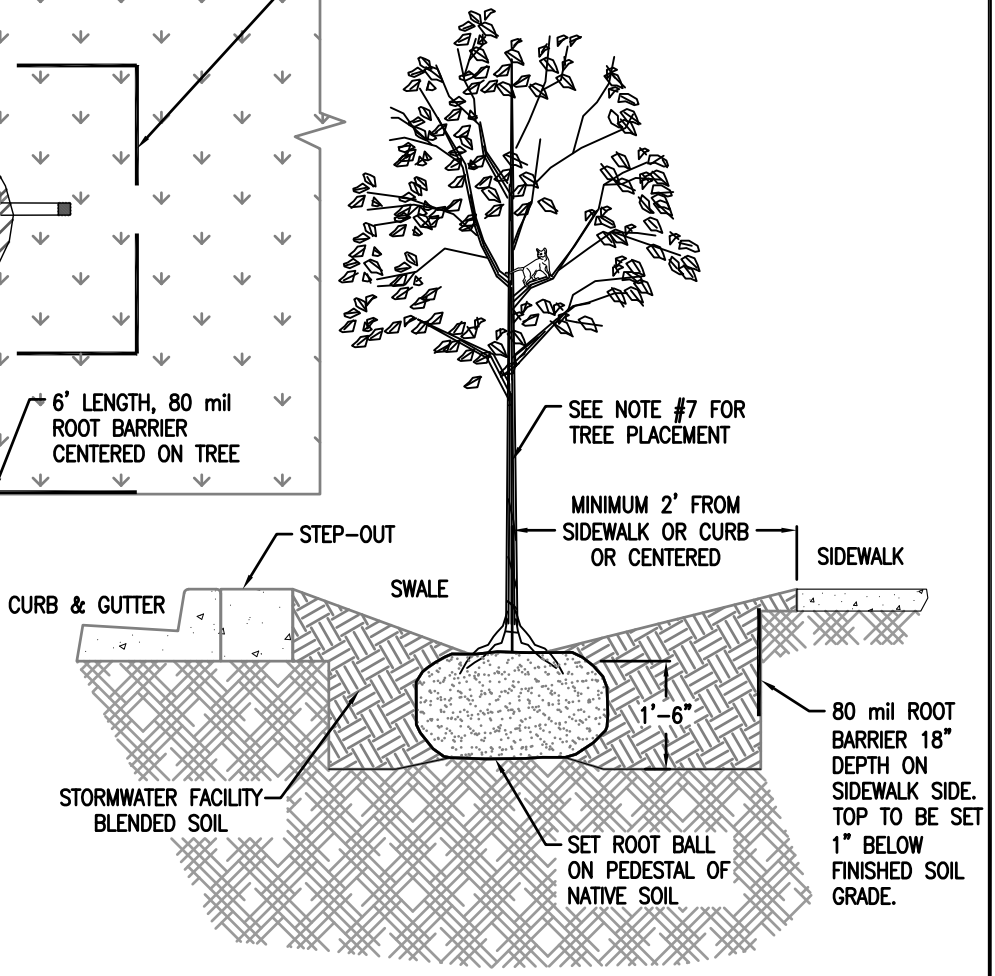
1. Refer to Standard Drawing P–581 for tree planting instructions.
2. Distance between trees varies: 20ft–30ft on center per Urban Forestry requirements.
3. Stormwater facility construction and blended soil requirements, see City of Portland Standard Construction Specifications sections 00415 and 01040.14(d).
4. All proposed tree species must be approved by Urban Forestry (503–823–8733).
5. Include Tree Well and Street Tree views on plans.
6. Include liner and call–out if used, see Swale Section SW–301.
7. Trees shall be centered in the planting zone/tree well.
8. Planting zone/tree well shall be located to align new tree trunk with street trees in adjacent planting strip, unless otherwise shown on plan and approved by BES and Urban Forestry.

CONSTRUCTION NOTES:

1. Contact Urban Forestry for tree installation assistance and permitting at (503) 823–8733.
2. To the maximum extent possible set root ball on "pedestal" of native/undisturbed soil to avoid settling.
3. Set trunk flare two inches above the finished soil surface.
4. Remove all twine, wire, root bags, burlap, and all other nursery materials from tree prior to backfilling.



PLAN VIEW



STREET TREE IN SWALE

IMPORTANT: Location of trees must meet clearance requirements established by the City of Portland. Utility conflicts and existing conditions can effect tree placement. Locate utilities prior to installing trees.

For specific clearance requirements contact:

PBOT	(503) 823–7884
PWB	(503) 823–7368
BES	(503) 823–7761
Urban Forestry	(503) 823–8733

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Tree Well Detail
Without Rock Storage

Bureau of Environmental Services

NUMBER

SW–361

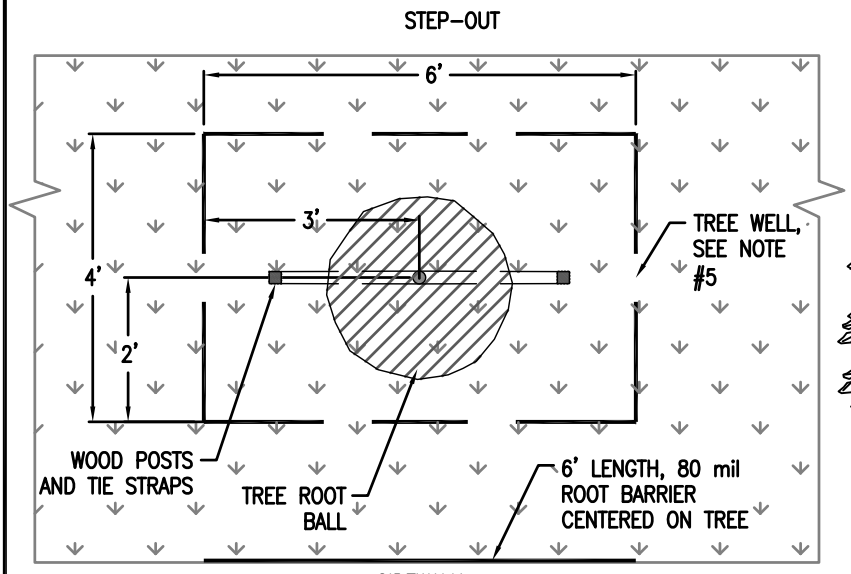
7–1–2016

DESIGNER INFORMATION:

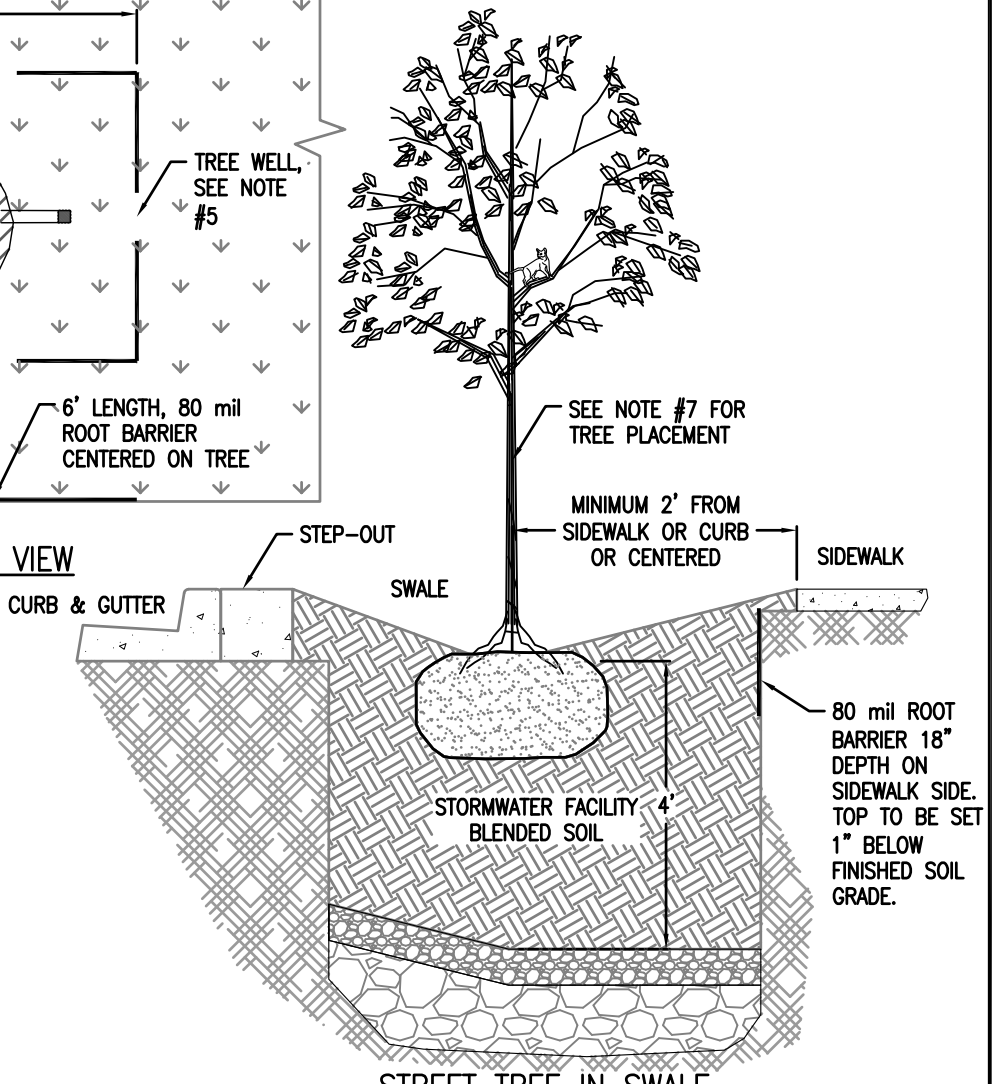
1. Refer to Standard Drawing P–581 for tree planting instructions.
2. Distance between trees varies: 20ft–30ft on center per Urban Forestry requirements.
3. Stormwater facility construction and blended soil requirements, see City of Portland Standard Construction Specifications sections 00415 and 01040.14(d).
4. All proposed tree species must be approved by Urban Forestry (503–823–8733).
5. Include Tree Well and Street Tree views on plans.
6. Include liner and call–out if used, see Swale Section SW–301.
7. Trees shall be centered in the planting zone/tree well.
8. Planting zone/tree well shall be located to align new tree trunk with street trees in adjacent planting strip, unless otherwise shown on plan and approved by BES and Urban Forestry.
9. Tree well required when tree is located over rock storage.

CONSTRUCTION NOTES:

1. Contact Urban Forestry for tree installation assistance and permitting at (503) 823–8733.
2. Set trunk flare two inches above soil surface.
3. Remove all twine, wire, root bags, burlap, and all other nursery materials from tree prior to backfilling.



TREE WELL PLAN VIEW



STREET TREE IN SWALE

IMPORTANT: Location of trees must meet clearance requirements established by the City of Portland. Utility conflicts and existing conditions can effect tree placement. Locate utilities prior to installing trees.

For specific clearance requirements contact:

PBOT	(503) 823–7884
PWB	(503) 823–7368
BES	(503) 823–7761
Urban Forestry	(503) 823–8733

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

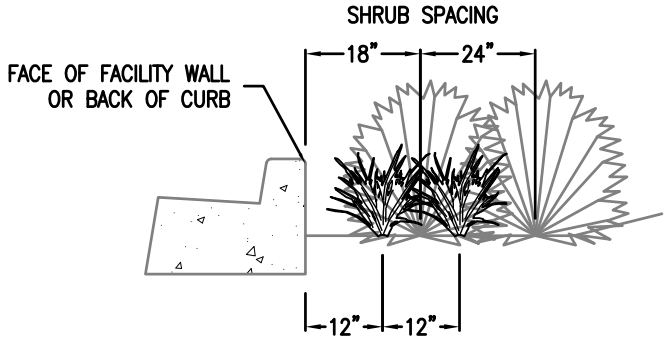
Tree Well Detail With Rock Storage

Bureau of Environmental Services

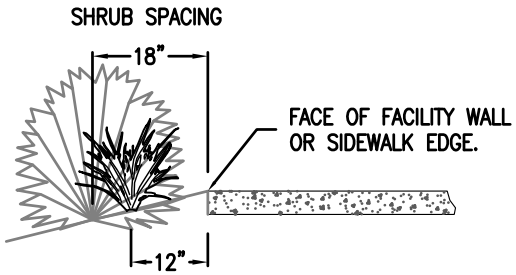
NUMBER

SW–362

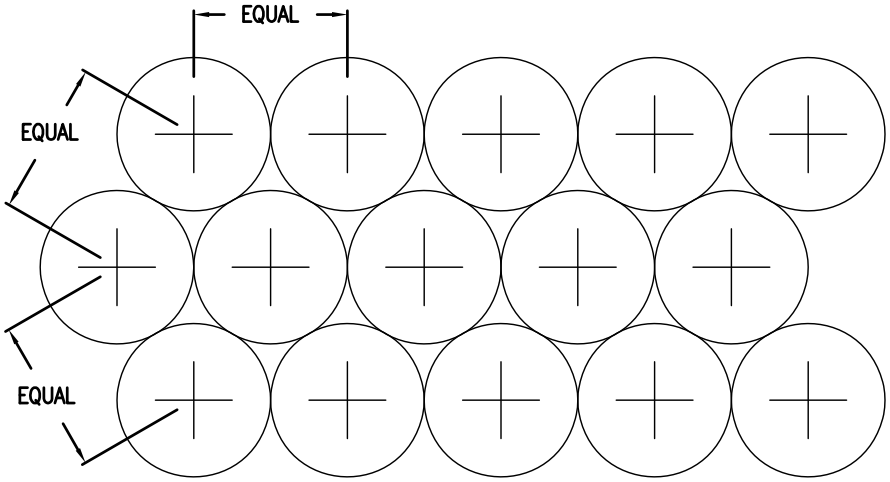
7–1–2016



STREET SIDE OF FACILITY
ELEVATION VIEW



SIDEWALK SIDE OF FACILITY
ELEVATION VIEW



PLAN VIEW

HERBACEOUS AND GROUNDCOVER SPACING

DESIGNER INSTRUCTIONS

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:
   a. Herbaceous plants and groundcovers: 12" from center of plant to face of facility wall, back of curb or sidewalk edge.
   b. 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.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Herbaceous Plants, Groundcovers & Shrubs

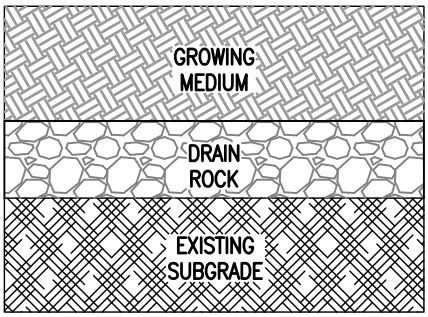
Plant Spacing

Bureau of Environmental Services

NUMBER

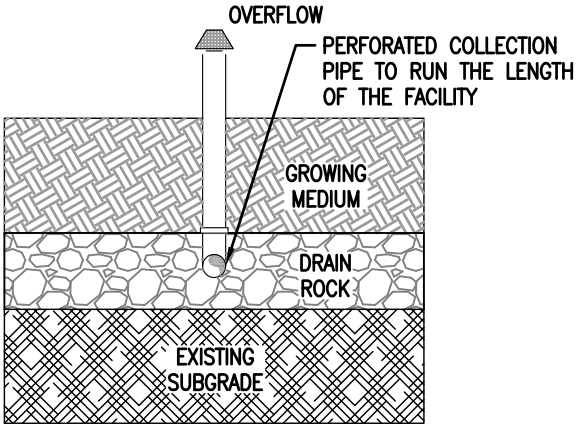
SW–363

7–1–2016



INFILTRATION

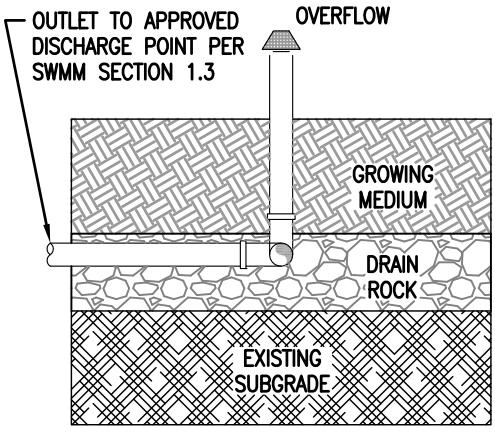
STORMWATER HIERARCHY CATEGORY 1



HYBRID

STORMWATER HIERARCHY CATEGORY 2

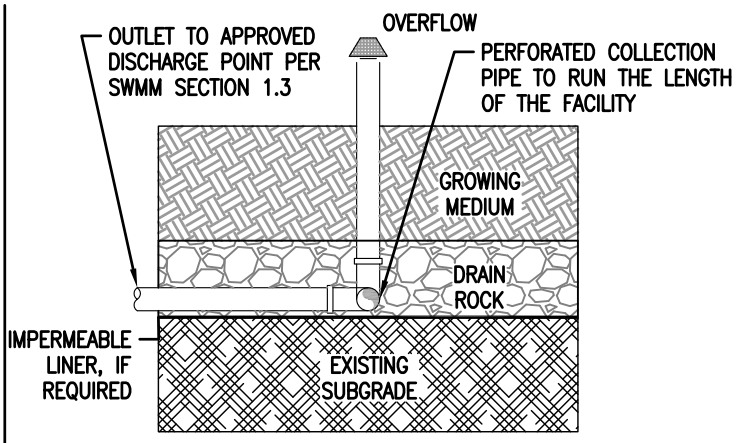
OVERFLOW DIRECTED TO DRAIN ROCK.



PARTIAL INFILTRATION

STORMWATER HIERARCHY CATEGORY 3 or 4

OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN WITHIN DRAIN ROCK

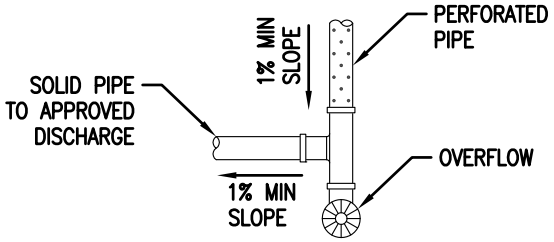


LINED

STORMWATER HIERARCHY CATEGORY 3 or 4

OVERFLOW AND UNDERDRAIN REQUIRED.
SET UNDERDRAIN AT BASE OF DRAIN ROCK LINER.

NOTE: Hybrid facilities must be registered as a UIC designed under the presumptive approach.



PLAN VIEW

PIPE W/ UNDERDRAIN & DISCHARGE POINT

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Facility Overflow Configurations

Bureau of Environmental Services

NUMBER

SW–364

7–1–2016

2.3.6 Infiltration and Soil Requirements

This section presents information about depth to groundwater investigations, infiltration testing, and the specification for the blended soil used in vegetated stormwater facilities.

Depth to Groundwater Investigation

Several areas within the City of Portland have known shallow groundwater. Within areas of known or suspected shallow groundwater, additional information about the depth to groundwater (DTW) may be required to ensure that a proposed underground injection control (UIC) system meets minimum separation distances between the bottom of a UIC and seasonal high groundwater. Minimum separation distances are required by Oregon Department of Environmental Quality (DEQ) under UIC requirements. The minimum separation distance between the bottom of the UIC and seasonal high groundwater is 5 feet.

When a public or private UIC is proposed within areas of known or suspected shallow groundwater, a site specific investigation may be required to determine the seasonal high depth to groundwater. A DTW investigation may be required for areas where the estimated depth to seasonal high groundwater is estimated to be less than 50 feet of ground surface. To identify areas of shallow groundwater within the City please consult the map which the City of Portland derived from the Estimation of Depth to Ground Water and Configuration of the Water Table in the Portland, Oregon Area, prepared by the United States Geological Survey (USGS). This map is available online in two locations:

- Through www.PortlandMaps.com.
- Through USGS mapping at http://or.water.usgs.gov/projs_dir/puz/.

Depth to Groundwater Investigation Requirements

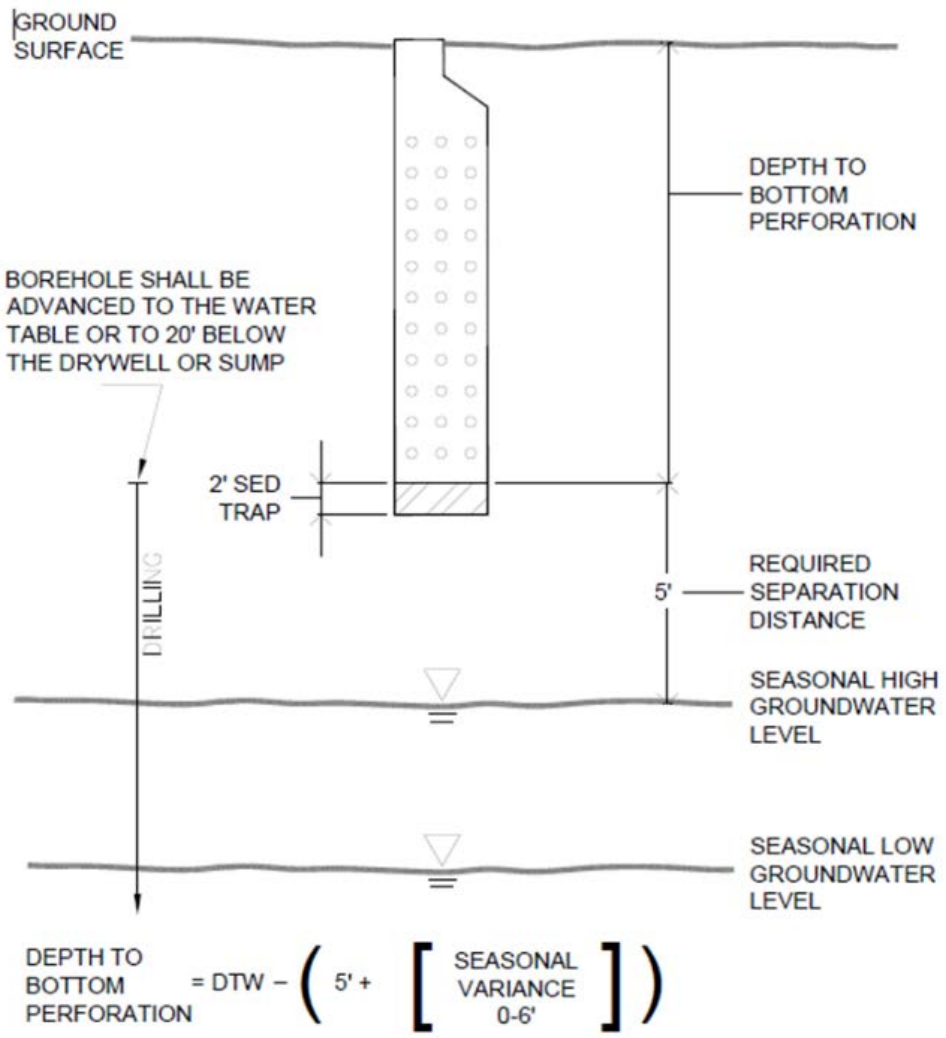
The DTW investigation requires sufficient time to plan for and perform the necessary steps to collect a reliable measurement, including obtaining permits, performing utility locates, borings, piezometer/well installation, collection of water level measurements, and decommissioning of the monitoring well. The DTW investigation, including design, installation oversight, water measurements, and decommissioning, must be performed by an Oregon licensed registered geologist (RG), certified engineering geologist (CEG), or professional engineer (PE) with experience in hydrogeologic investigations and well design and installation; the investigation may include either the installation of a temporary piezometer(s) or

groundwater monitoring well(s). The qualified professional is responsible for developing an appropriate scope of work to document the DTW, including:

- Determining the number and location(s) of the DTW measurements needed to address project objectives. It is recommended, but not required, to have each piezometer or well location surveyed to a datum.
- Determining the appropriate method for obtaining DTW measurements (e.g., piezometer or monitoring well).
- Determining the appropriate depth of the boring(s). Boring depth must be a minimum of 20 feet deeper than the proposed UIC depth.
- Observing and describing soils encountered during drilling.
- Developing an appropriate well or piezometer design.
- Ensuring that construction and abandonment of piezometer or monitoring well complies with Oregon Administration Rules 690-240.
- Obtaining depth to groundwater measurements (see Figure 2-32 for an illustration of the process). If groundwater is not encountered (e.g. saturated conditions are not observed, no water seeps are observed) within 20 feet of the proposed bottom of the UIC, a piezometer or monitoring well does not need to be installed.
- Estimating the measured DTW to be representative of the "groundwater seasonal high," based on available data and best professional judgment.
- Documenting the procedures used and the results of the DTW investigation.
- Submitting a signed and stamped DTW investigation report.

To the extent practicable, DTW measurements should be obtained in the immediate vicinity (less than or equal to 75 feet) of the proposed UIC. If high-quality shallow groundwater level data is available (e.g., piezometer, monitoring well, drinking water well, irrigation well) within 200 feet of the proposed UIC location, this data may be considered in lieu of site-specific data.

Figure 2-32. Depth to Groundwater Investigation



Piezometer/Well Borehole Drilling and Installation

Continuous soil sampling is recommended to allow detailed characterization of subsurface soil and identification of groundwater depth. The RG, CEG, or PE must prepare and submit a detailed boring log of subsurface conditions. Soil boring logs should be in accordance with the *Standard Practice for Description and Identification of Soils* (Visual-Manual Procedure) (ASTM D2488-00). Borings must be advanced to the groundwater level, or to a minimum of 20 feet below the proposed total depth of the UIC or 10 feet below a proposed UIC of 5 feet or less. If water is encountered in the boring, it must be noted on the drilling log.

The appropriate drilling method should be selected by the RG, CEG, or PE in conjunction with the driller, based on anticipated site-specific geologic and hydrogeologic conditions, anticipated boring depth, site accessibility, availability of equipment, and piezometer/well design. All equipment placed into the boreholes must be properly decontaminated prior to use.

Any investigation-derived material (e.g., soil cutting, water, personal protective gear) generated during drilling activities must be properly contained, characterized, and disposed in accordance with applicable state and federal regulations. Soil and water disposal must be documented.

Depth to Water Measurements

Following piezometer/well installation, water levels must be allowed to equilibrate for a minimum of 24 hours in fine-grained soils. After the water level has stabilized, an electronic water level indicator or a weighed tape should be used to measure the depth to water. Measurements should be made relative to ground surface and to the nearest 1/8 inch (~0.01 feet). The observer must make at a minimum two measurements over a period of about 15 minutes to show the results are static.

Estimating Depth to Seasonal High Groundwater

The site-specific DTW measurement must be used to estimate the depth to seasonal high groundwater. Seasonal water-table fluctuations were evaluated in the *Estimation of Depth to Ground Water and Configuration of the Water Table in the Portland, Oregon Area* report, prepared by the USGS and used to determine the seasonal correction factor (SCF). The SCF represents a long-term measurement of the seasonal water-table fluctuations. The SCF was set at 6 feet, using the USGS estimated mean of observed seasonal water table fluctuations for the unconsolidated sedimentary aquifer. To correct for seasonal variation, the SCF used to estimate depth to seasonal high groundwater is applied during periods of seasonal groundwater lows (late fall) and water level transition (summer and winter months). In March through May (seasonal high groundwater), no correction is added.

To correct site-specific DTW measurements to seasonal high DTW estimates, the following correction should be made:

$DTW_{SH} = DTW_{SS} - SCF$

Where: DTW_{SH} = Estimated seasonal high depth to groundwater (feet)

DTW_{SS} = Measured site-specific depth to groundwater (time specific)

SCF = Seasonal correction factor

6 feet for measurements June through February

0 feet for measurements in March through May

If water is not encountered in the soil boring, advanced 20 feet below the proposed UIC completion depth, it must be documented on the boring log and in the investigation report. In this case, the depth to water is assumed to be outside the range of seasonal fluctuation; the minimum required separation distance for the proposed bottom of the UIC to seasonal high groundwater is therefore met by default. The borehole may be decommissioned immediately, in accordance with OAR 690-240.

Decomissioning

Borings, piezometers, temporary wells, and wells must be abandoned in accordance with OAR 690-240. Specific decommissioning procedures must be determined by a licensed driller and the registered geologist or professional engineer.

Minimum Requirements for DTW Investigation Report

The DTW Investigation report must contain, but is not limited to:

- A copy of the State of Oregon Monitoring Well Log Report or Geotechnical Hole Report, as appropriate.
- A map showing the final location of each well or piezometer and tax lot boundaries.
- Latitude and longitude of each well or piezometer.
- Description of field procedures (drilling method, sampling method, development method, depth to groundwater measurements, etc.).
- Measured water level to the nearest hundredth of a foot.
- Detailed soils log prepared by, or under the direct supervision of, the RG, CEG, or PE.

- Construction diagram for each well/piezometer.
- Summary of groundwater depth measurements (depth measured, elevation, date, time).
- Discussion/basis for estimation of seasonal high depth to groundwater measurement.
- Construction and investigation reports stamped and signed by the RG, CEG, or PE.

Depth to Groundwater Investigation Report Submittal and Usage

Two copies of the OWRD well or piezometer construction report and the signed and stamped DTW investigation report must be submitted with the development permit application to the City and to DEQ with the UIC rule authorization application, which can be obtained at http://www.deq.state.or.us/wq/uic/forms.htm.

The corrected site-specific depth to seasonal high groundwater must be used to verify that the proposed UIC will meet the separation distances set by DEQ to obtain rule authorization for private UICs or ensure compliance under the City's WPCF permit. If separation distances cannot be met, an alternative design must be developed that meets separation distance requirements.

Infiltration Testing

To properly size and locate stormwater management facilities, it is necessary to characterize the soil infiltration conditions at the location of the proposed facility. All projects that propose onsite infiltration must evaluate existing site conditions and determine:

- If the infiltration rate is adequate to support the proposed stormwater management facility (satisfied through the Simplified Approach Infiltration Test), or
- The design infiltration rate prior to facility design (satisfied through Presumptive or Performance infiltration testing conducted by a qualified professional).

The following sections provide the approved standard infiltration testing specifications.

Minimum Number of Required Tests

The number of required infiltration tests may vary by type of development proposal or by design approach.

Land Division

- A total of two infiltration tests for every 10,000 square feet of lot area available for new or redevelopment.
- An additional test for every 10,000 square feet of lot area available for new or redevelopment.
- At least one test for any potential street facility.
- One test for every 100 lineal feet of infiltration facility.
- No more than five tests are required per development (at the discretion of the qualified professional assessing the site, as well as the City of Portland).

Tests performed for a proposed land division can be used at the building permit stage as long as the results of the test are submitted with the separate applications and were conducted within twenty-four months prior to the date the plans were submitted for review.

Building Permits

- The Simplified Approach requires one infiltration test for every proposed facility.
- The Presumptive and Performance Approaches require at least one test for any proposed street facility; require one test for every 100 lineal feet of proposed

infiltration facility; and the number of tests is at the discretion of the qualified professional assessing the site, as well as the City of Portland.

Where multiple types of facilities are used, it is likely that multiple tests will be necessary, since an infiltration test can test only a single location. It is highly recommended to conduct an infiltration test at each stratum used. BES staff may require additional testing. If additional testing is required during plan review, the applicant must provide 24-hour notice to BES staff and specify the time and location that the test will take place.

Simplified Approach Infiltration Test Requirements

The Simplified Approach provides a design approach that can be used by a nonprofessional for design of simple stormwater systems on small projects. This method, the Simplified Approach Infiltration Test, is applicable only to projects on private property with less than 10,000 square feet of new or redeveloped impervious area (see Section 2.2.1). The results of infiltration testing must be documented on the Simplified Approach Form (see Section 2.4.3).

On a site with steep slopes or shallow groundwater, BES may require a geotechnical report in order to evaluate the suitability of the proposed facility and its location. BES staff may also require an encased falling head or a double-ring infiltrometer infiltration test (see below for instructions) in order to verify that the facilities designed under the Simplified Approach are appropriate.

The Simplified Approach Infiltration Test cannot be used to find a design infiltration rate. The intent of the Simplified Approach Infiltration Test is to determine whether or not the local infiltration rate is adequate (2 inches/hour or greater) for the predesigned stormwater facilities described in Section 2.3 (infiltration swales, basins, planters, drywells, and trenches). The Simplified Approach Infiltration Test does not need to be conducted by a licensed professional.

Simplified Approach Infiltration Test Procedure

1. A Simplified Approach Infiltration Test is required at the location of where the facility is proposed or within the immediate vicinity. The test must be conducted in the twenty-four months prior to the date the plans are submitted for review.
2. Excavate a test hole to the depth of the bottom of the infiltration system. The test hole can be excavated with small excavation equipment or by hand using a shovel, auger, or post hole digger. If a layer hard enough to prevent further excavation is encountered, or if noticeable moisture/water is encountered in the

soil, stop and measure this depth from the surface and record it on the Simplified Approach Form. Proceed with the test at this depth.

3. Fill the hole with water to a height of about 6 inches from the bottom of the hole, and record the exact time it takes for the water to draw down to the bottom of the test pit. Check the water level at regular intervals (every 1 minute for fast-draining soils to every 10 minutes for slower-draining soils) for a minimum of 1 hour or until all of the water has infiltrated. Record the distance the water has dropped from the top edge of the hole for each time interval.
4. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to accurately portray the soil's ability to infiltrate at different levels of saturation. The third test provides the best measure of the infiltration rate at saturated conditions.
5. For each test pit required, submit all three testing results with the date, duration, drop in water height, and conversion into inches per hour.

If the result from the third round of testing is greater than 2.0 inches per hour, the applicant can proceed with Simplified Approach facility design (where applicable). The Simplified Approach requires one infiltration test for every proposed facility. If the applicant would like to use an infiltration rate for design purposes, a Presumptive or Performance Infiltration Test must be conducted.

Presumptive and Performance Infiltration Test Requirements

The Presumptive Approach (Section 2.2.2) or Performance Approach (Section 2.2.3) must be used for all public and private developments where the Simplified Approach is not applicable. The qualified professional must exercise judgment in the selection of the infiltration test method. The three infiltration testing methods used to determine a design infiltration rate are:

- Open pit falling head.
- Encased falling head.
- Double-ring infiltrometer.

Where satisfactory data from adjacent areas using similar infiltration testing methods is available that demonstrates infiltration testing is not necessary, the infiltration testing requirement may be waived by the BES design reviewer. A recommendation for forgoing infiltration testing must be submitted in a report which includes supporting data and is stamped and signed by the project geotechnical engineer or project geologist.

Testing Criteria

- Testing must be conducted or overseen by a qualified professional. This professional must be a Professional Engineer (PE) or Registered Geologist (RG) licensed in the State of Oregon.
- The depth of the test must correspond to the facility depth. If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within 4 feet of the bottom of the planned infiltration system, the testing should be conducted within that confining layer. Based on DEQ requirements and conformance with any required Depth to Groundwater Investigation Requirements, the boring log must be continued to a depth adequate to show separation between the bottom of the infiltration facility and the seasonal high groundwater level. (The boring depth will vary, based on facility depth.)
- Tests must be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location. The test must be conducted in the twenty-four months prior to the date the plans were submitted for review.
- Infiltration testing should not be conducted in engineered or undocumented fill.

Factors of Safety

Table 2-2 lists the minimum allowable factors of safety applied to field obtained infiltration rates for use in stormwater system design under the Presumptive and Performance design approaches. To obtain the infiltration rate used in design, divide the infiltration rate measured in the field by the factor of safety. The factor of safety used in design should be chosen by collaboration between the geotechnical engineer or geologist overseeing the infiltration testing and the civil engineer designing the stormwater management system. Determination of the factor of safety should include consideration of project specific conditions such as soil variability, testing methods, consequences of system failure, complexity of proposed construction, etc.

Table 2-2. Minimum Allowable Factor of Safety

Test Method	Minimum Required Factor of Safety
Open Pit Falling Head	2
Encased Falling Head	2
Double-Ring Infiltrometer	1

Presumptive and Performance Infiltration Testing Instructions

The following sections provide instructions for completing the open pit falling head infiltration test, the encased falling head infiltration test, and the double-ring infiltrometer infiltration test.

Open Pit Falling Head Procedure

The open pit falling head procedure is performed in an open excavation and therefore is a test of the combination of vertical and lateral infiltration.

1) Excavate a hole with bottom dimensions of approximately 2 feet wide by 2 feet deep into the native soil to the elevation of the proposed facility bottom. The test can be conducted in a machine-excavated pit or a hand-dug pit using a shovel, post hole digger, or hand auger. If smooth augering tools or a smooth excavation bucket are used, scratch the sides and bottom of the hole with a sharp pointed instrument, and remove the loose material from the bottom of the test hole.
2) Fill the hole with clean water a minimum of 12 inches, and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to presoak the native material.
3) Determine how the water level will be accurately measured. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit are convenient reference points. The tester and excavator should conduct all testing in accordance with OSHA regulations.
4) After the presaturation period required by #2 above, refill the hole with water to 12 inches and record the draw-down time. Alternative water head heights may be used for testing provided the presaturation height is adjusted accordingly and the water head height used in infiltration testing is no more than 50 percent of water head height in the proposed stormwater system during the design storm event. Measure the water level to the nearest 0.01 foot (⅛ inch) at 10-minute

intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower draining soils) or until all of the water has drained. In faster draining soils (sands and gravels), it may be necessary to shorten the measurement interval in order to obtain a well defined infiltration rate curve. Constant head tests may be substituted for falling head tests at the discretion of the professional overseeing the infiltration testing.

5) Repeat the infiltration test until the change in measured infiltration rate between two successive trials is no more than 10 percent. The trial should be discounted if the infiltration rate between successive trials increases. At least three trials must be conducted. After each trial, the water level must be readjusted to the 12 inch level. Enter results into the data table (see Table 2-3 for an example infiltration test table and Table 2-4 for a blank table).

6) The average infiltration rate over the last trial should be used to calculate the design infiltration rate without a factor of safety applied. Alternatively, the infiltration rate measured over the range of water head applicable to the project stormwater system design may be used at the discretion of the professional overseeing the testing. The final rate must be reported in inches per hour.

7) Upon completion of the testing, the excavation must be backfilled.

8) For very rapidly-draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, approximate the area over which the water is infiltrating, measure the rate of water discharging into the test pit (using a water meter, bucket or other device), and calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches). A maximum infiltration rate of 20 inches per hour can be used in stormwater system design with this type of infiltration test..

Encased Falling Head Procedure

The encased falling head procedure is performed with a 6-inch diameter casing that is embedded approximately 6 inches into the native soil. The goal of this field test is to evaluate the vertical infiltration rate through a 6-inch plug of soil, without allowing any lateral infiltration. The test is not appropriate in gravelly soils or in other soils where a good seal with the casing cannot be established.

1) Embed a solid 6-inch diameter casing into the native soil at the elevation of the proposed facility bottom (see Figure 2-33). Ensure that the embedment provides a good seal around the pipe casing so that percolation will be limited to the 6-

inch plug of the material within the casing. This method can also be used when testing within hollow stem augers, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger.

2) Fill the pipe with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth for at least 4 hours (or overnight if clay soils are present) to presoak the native material. Any soil that sloughed into the hole during the soaking period should be removed. In sandy soils with little or no clay or silt, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

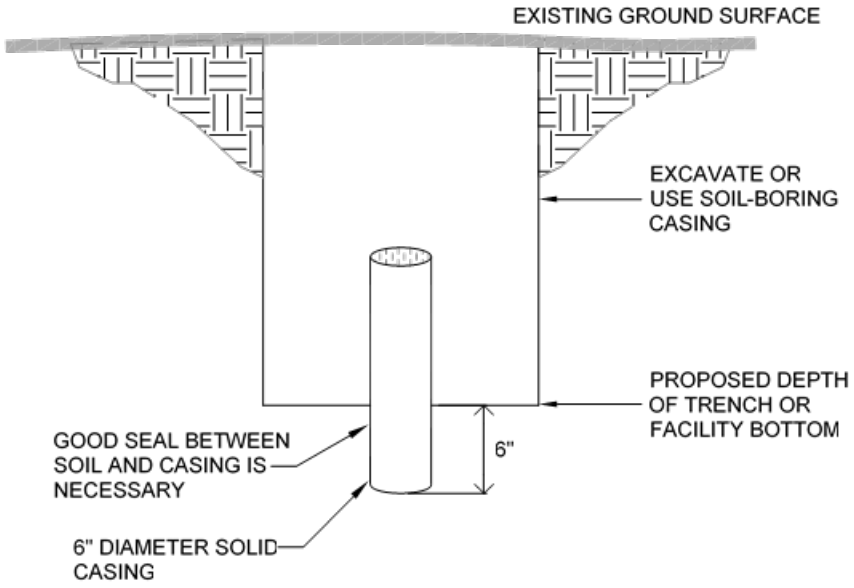
3) To conduct the first trial of the test, fill the pipe to approximately 12 inches above the soil and measure the water level to the nearest 0.01 foot (⅛ inch). Alternative water head heights may be used for testing provided the presaturation height is adjusted accordingly and the water head height used in infiltration testing is 50 percent or less than the water head height in the proposed stormwater system during the design storm event. The level should be measured with a tape or other device with reference to a fixed point. The top of the pipe is often a convenient reference point. Record the exact time.

4) Measure the water level to the nearest 0.01 foot (⅛ inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. In faster draining soils (sands and gravels), it may be necessary to shorten the measurement interval in order to obtain a well defined infiltration rate curve. Constant head tests may be substituted for falling head tests at the discretion of the professional overseeing the infiltration testing. Successive trials should be run until the percent change in measured infiltration rate between two successive trials is minimal. The trial should be discounted if the infiltration rate between successive trials increases. At least three trials must be conducted. After each trial, the water level is readjusted to the 12 inch level. Enter results into the data table (see Table 2-3 for an example infiltration test data table and Table 2-4 for a blank data table).

5) The average infiltration rate over the last trial should be used to calculate the unfactored infiltration rate. Alternatively, the infiltration rate measured over the range of water head applicable to the project stormwater system design may be used at the discretion of the professional overseeing the testing. The final rate must be reported in inches per hour.

6) Upon completion of the testing, the casing should be pulled and the test pit backfilled.

Figure 2-33. Encased Falling Head Illustration



Double-Ring Infiltrometer Test

The double-ring infiltrometer test procedure should be performed in accordance with ASTM 3385-94. The test is performed within two concentric casings embedded and sealed to the native soils. The outer ring maintains a volume of water to diminish the potential of lateral infiltration through the center casing. The volume of water added to the center ring to maintain a static water level is used to calculate the infiltration rate. The double-ring infiltrometer is appropriate only in soils where an adequate seal can be established.

Infiltration Test Report Requirements

If an Infiltration Test Report is required under the Simplified Approach, it must be submitted within two weeks of BES staff request. For Presumptive and Performance Approaches, the Infiltration Test Report must be attached to the project's Stormwater Management Report. The following information must be included in the Infiltration Testing Report:

- Statement of project understanding (proposed stormwater system).
- Name, contact information, professional license information and qualifications of the person conducting the infiltration test.
- Summary of subsurface conditions encountered, including soil textures and the depth that they were found.
- Summary of pre-saturation timing.
- Summary of infiltration testing including location and number of tests and testing method used. Discussion of how the tests were performed (i.e. pipe type or diameter or test pit dimensions).
- Infiltration testing results in inches per hour for each interval as well as the average for the entire testing period
- Recommended design infiltration rate.
- Groundwater observations within exploration and an estimate of the depth to seasonal high groundwater.
- Site plan showing location of infiltration tests.
- Boring or test pit logs. Boring or test pit logs will be required when an applicant's proposal relies on the presence of specific subsurface strata that allows infiltration. The logs must include an associated soil classification consistent with ASTM D2488-00, Standard Practice for Classification for Description and Identification of Soils (Visual-Manual Procedure). The logs must also include any additional pertinent subsurface information, such as soil moisture conditions, depth and description of undocumented or engineered fill, soil color and mottling conditions, soil stiffness or density, and approximate depth of contact between soil types.
- A summary of the Infiltration Test Data Tables (see Table 2-3 for an example data table and see Table 2-4 for a blank data table).

Table 2-3. Example Infiltration Test Table

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

Table 2-4. Infiltration Test Data Table

Location:			Date:		Test Hole Number:
Depth to bottom of hole:			Dimension of hole:		Test Method:
Tester's Name: Tester's Company: Tester's Contact Number:					
Depth (feet):			Soil Texture:		
Presaturation Start Time: Presaturation End Time:					
Time:	Time Interval (minutes):	Measurement, (feet):	Drop in water level, (feet):	Infiltration rate, (inches per hour):	Remarks:

Blended Soil Specification for Vegetated Stormwater Systems

Public facilities must use the Vegetated Stormwater Facility Blended Soil specification taken from the *City of Portland Standard Construction Specifications*, as amended or corrected. Public facilities, either in the public right-of-way or on property, are required to use the specification from the most current version of the *City of Portland Standard Construction Specifications*. Facilities include swales, planters, curb extensions, and basins. As of the adoption of the 2016 SWMM, the most current specification is located in 01040.14 (d) (1) and was made effective on November 11, 2015.

Private facilities must use a blended soil that supports healthy plants growth. Testing and submittals are not required for private facilities unless they are requested by the Bureau permitting the work.

2.4 Submittal Requirements

Stormwater requirements on development-related improvements and projects go through a variety of review and permitting processes. The required submittals may vary by type of review (e.g. land use versus building permit) or sizing methodology (e.g. Simplified Approach versus Presumptive Approach). The following requirements are minimum standards that must be met in order for BES staff involved with land use/early assistance cases, building permits, and public works permits to determine if the development proposal meets the requirements of this manual.

2.4.1 Landscape Submittal Requirements

Landscape specifications and plans are required with all permits that include at least one vegetated stormwater facility. The only exception is where a contract with the Bureau of Environmental Services Watershed Revegetation Program is confirmed. For facility specific requirements including plant density and size requirements see Section 2.3.4. For template planting plans for Green Streets, see typical details in Section 2.3.5.

Landscape specifications and plans must address all elements that ensure plant survival and overall stormwater facility functional success. At a minimum, landscape specifications and plans must include:

- A planting plan that indicates existing vegetation to be preserved, the location of all landscape elements, and the size, species and location of all proposed plantings. The plant species should be selected and placed in accordance with proper delineation of Zone A (wet zone) and Zone B (moderate to dry zone), where appropriate.
- A plant list or table, including botanic and common names, size at time of planting, quantity, spacing, type of container, evergreen or deciduous, and other information related to the facility-specific planting, in accordance with landscape industry standards.
- Trees identified for the tree credit clearly labeled (if applicable). A Tree Credit Worksheet must be submitted if requesting tree credit.
- A soil analysis for the stormwater facility growing medium (required for all public facilities and may be required for private facilities). A soil analysis is not required for single-family residential sites. The source of the growing medium must be provided. The location of all stockpiles must be indicated

on plans, including erosion protection measures per the City's Erosion Control Manual.

- The method of irrigation to be used for the establishment period and for the permanent long-term. Public stormwater management facilities must be designed so permanent long-term irrigation systems are not needed.

Tree Credit Worksheet

Trees may reduce the size of required stormwater facilities or even eliminate stormwater management requirements on small project proposals. Tree Credit can be used with any design approach (see Section 2.3.4.3 for information on tree credit uses and limitations). The Tree Credit Worksheet contains the information needed to apply tree credit to stormwater requirements and consists of the following sections:

- Information on new trees.
- Information on existing trees.
- Information on allowable tree credit.

Planting Zones and Plant Lists

The following sections provide guidance and requirements for planting vegetation in stormwater management facilities.

Planting Zones

Within a stormwater management facility, a planting zone indicates different areas of stormwater inundation (see Figure 2-34). Plants recommended or required for specific stormwater management facilities have different tolerances for inundation.

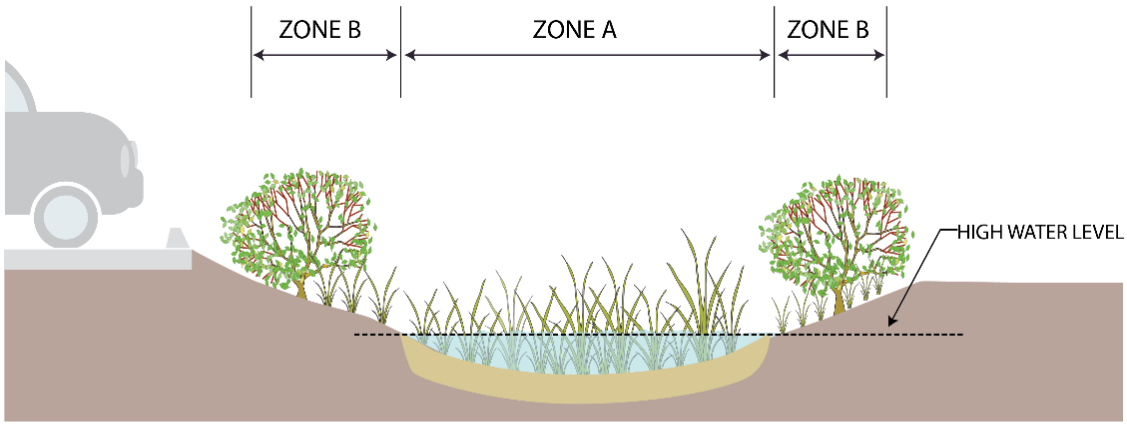
Zone A: Area of the facility defined as the bottom of the facility to the designed high water mark. This area has moist to wet soils and plants located here must be tolerant of mild inundation.

Zone B: Area of the facility defined as the side slopes from the designed high water line up to the edge of the facility. This area typically has dryer to moist soils, with the moist soils being located further down the side slopes. Plants here should be drought tolerant and help stabilize the slopes.

Areas outside of Zone A and Zone B or above the freeboard are not considered part of the facility and are not covered by these requirements

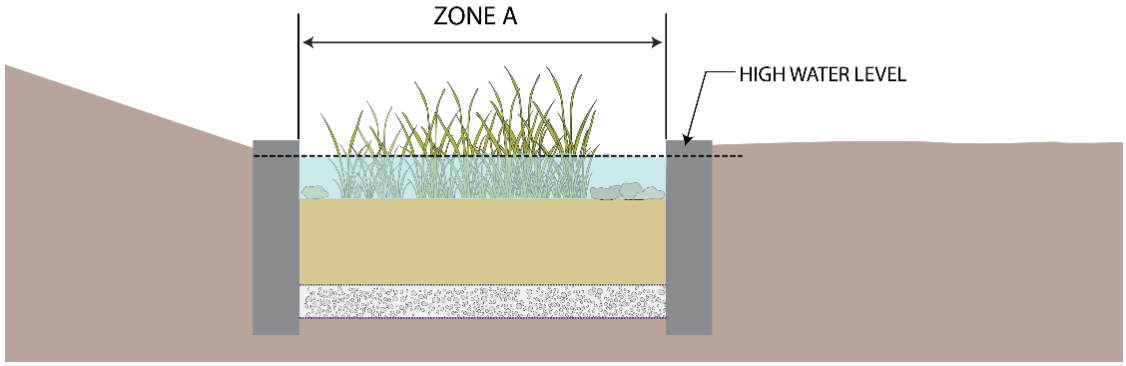
Figure 2-34. Planting Zones

Sloped Facility



City of Portland Environmental Services ES 1604

Flat-bottom Facility



City of Portland Environmental Services ES 1604

Plant Lists

For more information about a number of these plants, please visit the Portland Plant List. No plants off the Portland Nuisance Plant List area allowed in stormwater management facilities or drainageways (See Section 4.1 of the Portland Plant List). A number of other plants may be appropriate for private stormwater management facilities – see Section 2.4 (Deciduous Forested Wetlands and Floodplains), Section 2.5 (Scrub-Shrub Wetlands) and Section 2.6 (Marsh) of the Portland Plant List. Additionally, see the Bureau of Development Services Tree and Landscaping Manual for plant suggestions that also meet required landscaping and screening goals.

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

Private Stormwater Facilities Plant List

	Botanic Name	Common Name	Zone	Swale	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing
Herbaceous Plants	*Athyrium filix-femina*	Lady Fern	B	X		X	Y	N	36"	24"
	Bromus carinatus	California Brome Grass	A			X	Y	Y	18"	12"
	Bromus sitchensis	Alaska Brome	A			X	Y	Y	18"	12"
	Bromus vulgaris	Columbia Brome	A			X	Y	Y	18"	12"
	Carex deweyanna	Dewey Sedge	A	X	X	X	Y	Y	36"	12"
	Carex densa	Dense Sedge	A	X	X	X	Y	N	24"	12"
	Carex obnupta	Slough Sedge	A	X	X	X	Y	Y	4'	12"
	Carex rupestris	Curly Sedge	A	X	X	X	N	Y	14"	12"
	Carex stipata	Sawbeak Sedge	A	X	X	X	N	Y	20"	12"
	Carex testacea	New Zealand Orange Sedge	A	X	X	X	N	Y	24"	12"
	Carex vesicaria	Inflated Sedge	A	X	X	X	Y	Y	36"	12"
	Deschampsia cespitosa	Tufted Hair Grass	A/B	X	X	X	Y	Y	36"	12"
	Eleocharis acicularis	Needle Spike Rush	A	X	X	X	Y	Y	30"	12"
	Eleocharis ovata	Ovate Spike Rush	A	X	X	X	Y	Y	30"	12"
	Eleocharis palustris	Creeping Spike Rush	A			X	Y	Y	30"	12"
	Elymus glaucus	Blue Wild Rye	B	X		X	Y	Y	24"	12"
	Festuca occidentalis	Western Fescue Grass	A	X		X	Y	Y	24"	12"
	Festuca rubra	Red Fescue	B	X		X	Y	Y	24"	12"
	Glyceria occidentalis	Western Manna Grass	A			X	Y	Y	18"	12"
	**Helictotrichon sempervirens*	Blue Oat Grass	B	X		X	N	Y	24"	12"
	Iris douglasiana	Douglas Iris	B	X		X	Y	y	18"	12"

Private Stormwater Facilities Plant List

	Botanic Name	Common Name	Zone	Swale	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing
Herbaceous Plants	*Iris sibirica*	Siberian Iris	A	X	X	X	N	y	36"	12"
	Iris tenax	Oregon Iris	B	X		X	Y	y	18"	12"
	Juncus balticus	Baltic Rush	A	X	X	X	y	y	20"	12"
	Juncus effusus var. pacificus	Soft rush	A	X	X	X	Y	Y	36"	12"
	Juncus ensifolius	Dagger-leaf Rush	A	X	X	X	N	y	10"	12"
	**Juncus patens*	Spreading Rush	A	X	X	X	N	Y	36"	12"
	Juncus tenuis	Slender Rush	A	X	X	X	Y	Y	36"	12"
	**Liriope muscari 'Big Blue'*	Big Blue Liriope	A/B	X	X	X				
	Lupinus bicolor	Bicolor Lupine	B	X		X	Y	N	18"	12"
	Lupinus polyphyllus	Large-leaved Lupine	A/B	X		X	Y	N	36"	12"
	**Polystichum munitum*	Sword Fern	A/B	X		X	Y	Y	24"	24"
	Schoenoplectus americanus	American Bulrush	A	X	X	X	Y	Y	30"	12"
	Scripus microcarpus	Small Fruited Bulrush	A			X	Y	Y	24"	12"
	Scripus validus	Softstem Bulrush	A	X	X	X	N	y	5'	12"
	Sisyrinchium californicum	Yellow-eyed Grass	A/B	X	X	X	N	Y	6"	12"
	Symphyotrichum subspicatum	Douglas' Aster	B	X		X	Y	N	36"	12"
	Veronica liwanensis	Speedwell	A	X		X	N	y	2"	12"
Groundcovers	**Arctostaphylos uva-ursi*	Kinnickinnick	B	X		X	Y	Y	6"	12"
	**Berberis (Mahonia) repens*	Creeping Oregon Grape	B	X		X	Y	Y	12"	12"
	**Fragaria chiloensis*	Coastal Strawberry	B	X		X	Y	Y	6"	12"
	Fragaria vesca	Woodland Strawberry	B	X		X	Y	Y	10"	12"
	Fragaria virginiana	Wild Strawberry	B	X		X	Y	Y	10"	12"
	Sedum oreganum	Oregon Stonecrop	B	X			X	Y	4"	12"

Private Stormwater Facilities Plant List

	Botanic Name	Common Name	Zone	Swale	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing
Small Shrubs	*Baccaris pilularis 'Dwarf'*	Dwarf Coyote Bush	B	X		X	Y	Y	3'	24"
	**Berberis (Mahonia) aquifolium*	Oregon Grape	B	X		X	Y	Y	4'	3'
	**Berberis nervosa*	Dull Oregon Grape	B	X		X	Y	Y	24"	24"
	**Ceanothus velutinus*	Snowbrush	B	X		X	Y	Y	4'	3'
	**Cistus spp.*	Various rock rose species	A/B	X	X	X	N	Y	3'	3'
	Cornus sericea 'Kelseyii'	Kelsey Dogwood	B	X		X	N	N	24"	24"
	**Hebe spp.*	Various hebe species	B	X		X	N	Y	2-3'	2-3'
	**Ilex glabra 'Shamrock', 'Compacta'*	Inkberry	A/B	X	X	X	N	Y	4'	4'
	**Lavendula spp.*	Lavender species	B	X		X	N	Y	3'	24"
	**Lonicera nitida*	Box Honeysuckle	B	X		X	N	Y	4'	4'
	**Paxistima myrsinites*	Oregon Boxwood	B	X		X	Y	Y	3'	4'
	Rosa gymnocarpa	Baldhip Rose	B	X		X	Y	N	3'	3'
	Rosa nutkana	Nootka Rose	B	X		X	Y	N	8'	3'
	**Rosa pisocarpa*	Swamp Rose	A/B	X	X	X	Y	N	8'	3'
	**Spirea betulifolia*	Birchleaf Spirea	A/B	X	X	X	N	N	3'	24"
	**Spirea x bumalda cvs.*	Bumald Spirea	A/B	X	X	X	N	N	3'	24"
	**Spirea densiflora*	Sub-Alpine Spirea	A/B	X	X	X	N	N	3'	24"
	**Spirea japonica cvs.*	Various spirea cultivars	A/B	X	X	X	Y	N	3'	24"
	**Symphoricarpos alba*	Common Snowberry	B	X		X	Y	N	6'	3'
	**Therorhodion (Ledum) glandulosum*	Trapper's Tea	A/B	X	X	X	X	Y	1'-4'	2'
	**Thuja plicata dwarf and semi-dwarf species*	Semi-dwarf Western Red Cedar	A/B	X		X	Y	Y	3'	3'
	**Vaccinium ovatum*	Evergreen Huckleberry	A/B	X	X	X	Y	Y	3'	3'
	**Viburnum davidii*	David viburnum	A/B	X	X	X	Y	N	3'	3'

Private Stormwater Facilities Plant List

	Botanic Name	Common Name	Zone	Swale	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing
Large Shrubs	**Arbutus unedo*	Strawberry Tree	B	X		X	N	Y	10’	10’
	**Acer circinatum*	Vine Maple	A/B	X		X	Y	N	15'	10'
	**Amelanchier alnifolia*	Western Serviceberry	B	X		X	Y	N	20'	10'
	Ceanothus sanguineus	Oregon Redstem Ceanothus	B	X		X	Y	N	7'	4'
	**Ceanothus thyrsiflorus*	Blueblossom	B	X		X	Y	Y	6’	6’
	**Cornus sericea*	Red-twig Dogwood	A/B	X	X	X	Y	N	6'	4'
	**Euonymus japonicas*	Japanese euonymus	A/B	X		X	N	Y	6’	4’
	**Fragula (Rhamnus) californica*	Coffeeberry (sm. cultivars)	B	X		X	N	Y	6’	6’
	**Holodiscus discolor*	Oceanspray	B	X		X	Y	N	6'	4'
	**Ilex cornuta*	Chinese Holly	B	X		X	N	Y	10’	4’
	**Ilex crenata*	Japanese Holly	B	X		X	N	Y	8’	4’
	Lonicera involucrata	Black Twinberry	B	X		X	Y	N	5'	4'
	**Morella (Myrica) californica*	Pacific Wax Myrtle	A/B	X	X	X	Y	Y	10’	10’
	**Nandina domestica*	Heavenly Bamboo	A/B	X	X	X	N	Y	6’	3’
	Oemleria cerasiformis	Indian Plum	B	X		X	Y	N	6'	4'
	**Philadelphus lewisii*	Wild Mock Orange	B	X		X	Y	N	6'	4'
	**Physocarpus capitatus*	Pacific Ninebark	A/B	X	X	X	Y	N	10'	3'
	**Ribes sanguineum*	Red-Flowering Current	B	X		X	Y	N	8'	4'
	Rubus parviflorus	Thimbleberry	B	X		X	Y	N	8'	4'
	Rubus spectabilis	Salmonberry	A	X	X	X	Y	N	10'	4'
	Salix purpurea ‘Nana’	Blue Arctic Willow	B	X		X	N	N	8'	6'
	Salix stichensis	Sitka Willow	A	X	X	X	Y	N	20'	6'
	Sambucus nigra ssp. cerulea	Blue Elderberry	B	X		X	Y	N	10'	10'
	Sambucus racemose var. arborescens	Red Elderberry	B	X		X	Y	N	10'	10'
	**Spiraea douglasii*	Douglas’ Spirea	A/B	X	X	X	Y	N	7'	4'

Private Stormwater Facilities Plant List

	Botanic Name	Common Name	Zone	Swale	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing
Large Shrubs	**Thuja occidentalis*	American Arborvitae (Emerald)	B	X		X	N	Y	12’	3’
	**Viburnum cinnamomifolium*	Cinnamon Leaf Viburnum	B	X		X	N	Y	8’	8’
	Viburnum edule	Highbush Cranberry	A/B	X	X	X	Y	N	6'	4'
	**Viburnum tinus*	Laurustinus viburnum	A/B	X	X	X	Y	N	6’	5’
Trees	**Abies grandis*	Grand Fir	B			X	Y	Y	150'	-
	**Acer camperstre*	Hedge Maple	A/B				N	N	50’	-
	**Acer griseum*	Paperbark Maple	B	X		X	N	N	30'	-
	**Acer macrophyllum*	Big Leaf Maple	B	X		X	Y	Y	60'	-
	**Alnus rhombifolia*	White Alder	A/B				Y	Y	100’	-
	**Alnus rubra*	Red Alder	A	X		X	Y	N	80'	-
	Arbutus menziesii	Madrone	B			X	Y	N	35'	-
	**Calocedrus decurrens*	Incense Cedar	A/B	X	X	X	Y	Y	100’	-
	**Celtis occidentalis*	Common Hackberry	A/B	X	X	X	N	Y	100’	-
	**Celtis reticulate*	Western Hackberry	B	X		X	N	N	30’	-
	Crataegus douglasii	Black Hawthorn	A	X		X	Y	N	40'	-
	Crataegus gaylussacia (suksdorfii)	Suksdorf’s Hawthorne	A/B				Y	N	40’	-
	**Fraxinus latifolia*	Oregon Ash	A/B	X		X	Y	N	30'	-
	**Frangula purshiana*	Cascara	A/B	X	X	X	Y	N	30'	-
	**Gleditsia tricanthos*	Honeylocust	A/B				N	N	40’	-
	Malus fusca	Pacific Crabapple	A	X	X	X	Y	N	30'	-
	**Metasequoia glyptostroboides*	Dawn Redwood	B			X	N	N	80'	-
	**Nyssa sylvatica*	Tupelo, sour gum	A/B				N	N	75’	-
	**Populus tremuloides*	Quaking Aspen	A			X	Y	N	40'	-
	Prunus emarginata var. mollis	Bitter Cherry	A/B	X	X	X	Y	N	50'	-
	**Pseudotsuga menziesii*	Douglas Fir	B	X		X	Y	Y	200'	-

Private Stormwater Facilities Plant List

	Botanic Name	Common Name	Zone	Swale	Planter	Basin	NW Native	Evergreen	Potential Height	O.C. Spacing
Trees	**Quercus bicolor*	Swamp Oak	A/B				N	N	60’	-
	**Quercus chrysolepis*	Canyon Live Oak	A/B				Y	Y	40’	-
	**Quercus garryana*	Oregon White Oak	B	X		X	Y	N	100'	-
	**Quercus phellos*	Willow Oak	A/B				N	N	90’	-
	**Quercus wislizenii*	Interior Live Oak	A/B				N	Y	70’	-
	Salix hookeriana	Hooker's Willow	A/B	X	X	X	Y	N	15'	-
	Salix scouleriana	Scouler's Willow	A/B	X	X	X	Y	N	15'	-
	**Taxodium distichum*	Bald Cypress	A/B				N	N	100’	-
	**Thuja plicata*	Western Red Cedar	A			X	Y	Y	150'	-
	**Thuja plicata ‘Hogan’*	Hogan Western Red Cedar	A/B				Y	Y	50’	-
	**Tsuga hetrophylla*	Western Hemlock	A	X		X	Y	Y	125'	-
	Salix exigua var. Columbiana	Columbia Willow	A/B	X	X	X	Y	N	13'	-
	Salix lasiandra var. lasiandra	Pacific Willow	A	X	X	X	Y	N	13'	-

*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%

Public Stormwater Facility Plant List
(including Green Streets and Basins)

	Botanic Name	Common Name	Zone	NW Native	Evergreen	Potential Height	O.C. Spacing	Under Powerlines
Herbaceous Plants	*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 Bramble	A	N	Y	6"	12"	-
Accent Plants	*Carex morrowii 'Ice Dance'*	Ice Dance Japanese sedge	A/B	N	N	12"	12"	-
	Iris douglasiana	Douglas Iris	B	Y	N	18"	12"	-
Small Shrubs	*Berberis (Mahonia) repens*	Creeping Oregon Grape	B	Y	Y	18-24"	24"	-
	Cornus sericea 'Kelseyi'	Kelsey's dwarf red-twig dogwood	A/B	N	N	36"	24"	-
	Lavandula angustifolia 'Hidcote Blue'	Hidcote Blue English lavender	B	N	Y	24-36"	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"	-

Public Stormwater Facility Plant List
(including Green Streets and Basins)

	Botanic Name	Common Name	Zone	NW Native	Evergreen	Potential Height	O.C. Spacing	Under Powerlines
Small Shrubs	*Spiraea japonica 'Walbuma'*	Magic Carpet Japanese spirea	A/B	Y	N	24"	24"	-
	Spiraea japonica 'Goldmound'	Goldmound Japanese spirea	A/B	N	N	36"	24"	-
Trees	*Celtis occidentalis*	Common Hackberry		N	N	50’	-	N
	Frangula purshiana	Cascara Buckthorn, Cascara Sagrada		Y	N	25’	-	Y
	Gleditsia triacanthos var. inermis 'Impcole'	Imperial Thornless Honeylocust		N	N	35’	-	Y
	Gleditsia triacanthos var. inermis 'Skycole'	Skyline Thornless Honeylocust		N	N	50’	-	N
	Nyssa sylvatica	Black Tupelo		N	N	50’	-	N
	Prunus virginiana 'Canada Red'	Canada Red Chokecherry	A/B	N	N	25'	-	Y
	Quercus bicolor	Swamp White Oak		N	N	50’	-	N
	Quercus shumardii	Shumard Oak	A/B	N	N	50'	-	N
	Zelkova serrata ‘Green Vase’	Green vase Japanese zelkova		N	N	45’	-	N
	Zelkova serrata ‘Village Green’	Village Green Japanese zelkova		N	N	35’	-	Y

Minimum size is a # 1 Container for all plants, 2"- 3.5" caliper B&B for all trees.

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TREE CREDIT WORKSHEET

Trees may be able to reduce the size of required stormwater facilities. Small projects, such as residential additions or new detached structures (garages, sheds, accessory dwelling units), may be able to eliminate stormwater requirements through use of tree credit. Trees used for tree credit must be clearly labeled on the site plan and included on the Stormwater Operations & Maintenance Plan.

Tree Credit Applicability:

- For sites with more than 1,000 square feet of new or redeveloped impervious surface to manage, no more than 10% of the impervious area can be mitigated with through tree credit.
- Nuisance trees cannot receive stormwater tree credit.
- BES may require a certified arborists' report to verify suitable tree selection and preservation.
- Trees planted in stormwater facilities or used towards environmental zone mitigation cannot also receive tree credit.
- Trees (new or existing) must be located within 10 feet of impervious surfaces to qualify for tree credit.

CALCULATE TREE CREDIT

NEW TREES

New trees must be at least 1.5 caliper inches at the time of planting; new coniferous trees must be at least 5 feet tall.

TYPE OF TREE	NUMBER OF TREES	CREDIT PER TREE	TREE CREDIT (SF)
New coniferous trees		Multiply by 200 square feet	
New broadleaf trees		Multiply by 100 square feet	

EXISTING TREES

SMALL TREES *(Existing trees with caliper of 1.5 to 6 inches)*

	NUMBER OF TREES	CREDIT PER TREE	TREE CREDIT (SF)
Existing trees with caliper of 1.5 to 6 inches		Multiply by 200 square feet	

LARGE TREES *(Larger than 6 caliper inches)*

TYPE OF TREE	CALIPER SIZE *(in inches)*	DETERMINE CREDIT UNITS	CREDIT UNITS PER TREE *(Do not round up)*	CREDIT PER 6 CALIPER INCHES	TREE CREDIT (SF)
		Divide by 6		Multiply by 400 square feet	
		Divide by 6		Multiply by 400 square feet	
		Divide by 6		Multiply by 400 square feet	
		Divide by 6		Multiply by 400 square feet	
		Divide by 6		Multiply by 400 square feet	
		Divide by 6		Multiply by 400 square feet	
		Divide by 6		Multiply by 400 square feet	
		Divide by 6		Multiply by 400 square feet	
				TOTAL TREE CREDIT	

Continue on back

TREE CREDIT WORKSHEET

ALLOWABLE TREE CREDIT

For sites with less than 1,000 square feet of new or redeveloped impervious area, the Total Tree Credit is allowed. Stormwater runoff may go to the existing disposal location.

Allowable Tree Credit = Total Tree Credit ☐

For sites with over 1,000 square feet of new or redeveloped impervious area, a maximum of 10% of the new or redeveloped impervious area can be mitigated through tree credit.

TOTAL NEW OR REDEVELOPMENT IMPERVIOUS AREA (SF)	MAXIMUM TREE CREDIT	TOTAL ALLOWABLE TREE CREDIT (SF)
	Multiply by 0.10	

Allowable Tree Credit is the lesser of the Total Tree Credit or the Total Allowable Tree Credit

Allowable Tree Credit = ☐

2.4.2 Land Use Submittal Requirements

Land use review applications must include a conceptual Stormwater Management Plan that indicates how the site will meet stormwater management requirements (see Section 1.3.1). To meet zoning code requirements (Title 33 of Portland City Code) and use the available land most efficiently, the applicant must determine the proposed stormwater management facilities and any drainage reserve requirements and illustrate them on a site plan. The size and location of the proposed facilities will be assessed during the review process to ensure that adequate space is available with required setbacks. The facilities must also be located for proper overflow or access to an approved discharge location.

The Bureau of Environmental Services (BES) and the Bureau of Development Services (BDS) work cooperatively to review proposed plans during land use review to ensure stormwater management requirements are met. BES assesses the Stormwater Management Plan to determine if it meets the *Stormwater Management Manual* and Sewer and Drainage Facilities Design Manual requirements. BES provides the technical assessment information to BDS to determine if the land use review application meets zoning code approval criteria.

It is the applicant's responsibility to demonstrate that the stormwater hierarchy requirements are met. Some land use applications require more detailed information and more thorough planning and coordination with BES than others prior to land use approval. The determining factors are related to the type of land use review, the complexity of the proposed project, and the existing site conditions.

Land use applications that must address stormwater management can generally be divided into the following two categories:

- Those that verify adequacy of services, such as land divisions, planned developments, zone changes, and conditional uses.
- Those that verify the available area for stormwater management and in some cases the impact of the stormwater management system, such as environmental reviews; greenway reviews; design reviews; and adjustments to regulations such as setbacks, building coverage, and paved area.

Completing and documenting the first six steps presented in Section 2.1.2 will meet most, if not all, of the submittal requirements for the Stormwater Management Report and the BES land use review process.

The applicant must determine the anticipated stormwater management design approach (Simplified, Presumptive, or Performance) that will be used. When the

Presumptive or Performance Approach is used, the applicant must complete and submit the project overview and description, methodology, analysis, and engineering conclusions (described in the Stormwater Management Report outlined in Section 2.4.6) with submittal of the application.

To determine which category of the stormwater hierarchy (see Section 1.3.1) the project will meet, the applicant must establish if, and to what degree, onsite infiltration is feasible (see Section 2.3.6 for infiltration testing requirements). In addition to providing the justification necessary to select a category of the stormwater hierarchy, the results of the infiltration testing will contribute to decisions regarding type, size, and location of stormwater facilities.

Other Design Considerations:

- Perimeter landscaping requirements, limited available area meeting setback requirements, and the need for impermeable liners or watertight planter boxes may make stormwater facilities impractical along property lines.
- Elevation and topographic constraints must be evaluated to ensure that gravity flow is possible and plumbing code depth of cover requirements for pipes can be met.
- Coordination between the project engineer, architect, and landscape designer may be necessary to ensure that potential conflicts with construction methods and materials (geogrids, drains, footings, foundations, limitations on rooting depth imposed by planter box dimensions, impervious liners, etc.) are considered during the selection of trees and landscaping plantings.
- The landscape design should minimize potential impacts of plants and tree roots on stormwater facilities and utilities, including under drains, storm sewer, and rain drains.
- Tree preservation and tree planting must account for not only initial construction, but also the need for future maintenance of stormwater facilities and utilities.
- Arborist reports should address all stormwater facilities and utilities proposed to encroach in the root protection zones of trees required to be preserved.

When stormwater management is required, the applicant must provide adequate information to show that the proposed development can meet the stormwater requirements at the time of development. In general, this includes:

- A plant list or table, including botanic and common names, size at time of planting, quantity, spacing, type of container, evergreen or deciduous, and other information related to the facility-specific planting, in accordance with landscape industry standards.
- A site utility plan that includes stormwater management facilities with a proposed discharge location and drainageway protection requirements (if applicable).
- If public street improvements will be required as a condition of land use approval, a plan for managing stormwater from the street and identification of required right-of-way dedications (that include space for stormwater management facilities).
- A Stormwater Management Report (see Section 2.4.6) describing how the proposal complies with the stormwater hierarchy, including supporting documentation such as infiltration testing (see Section 2.3.6) and calculations, per the requirements of the appropriate design approach (see detailed requirements of the Simplified, Presumptive, and Performance approaches in Section 2.4.3, 2.4.4, or 2.4.5).
- Other requirements, depending on the site and complexity of the project. Examples include a grading plan, geotechnical report, and groundwater level testing (see Section 2.3.6).

The use of the Presumptive and Performance Approach (required for larger and/or complex projects) require the stormwater submittal to be prepared by a qualified professional, as outlined in Section 2.2. The Presumptive Approach submittal must include Presumptive Approach Calculator (PAC) printouts that demonstrate the stormwater facility engineering.

Issues that frequently delay Land Use Review applications

Land use applications that cannot be fully processed or approved often have the following deficiencies related to stormwater management:

- It is not clear whether infiltration is feasible on the site.
- It is not clear which category of the stormwater hierarchy is being met.

- A category of the stormwater hierarchy is chosen without proper justification.
- Access to an offsite stormwater discharge location (drainageway, storm sewer, or combined sewer) is not clearly shown.
- Drainageways are not identified and drainage reserves are not delineated.
- Site plan information is inaccurate or inadequate.
- The amount of land required to accommodate stormwater facilities is not accurately shown.
- Conflicts between stormwater facilities and property line or foundation setbacks are shown.
- Disturbance areas are undefined or inaccurate.
- Proposed and existing impervious areas are undefined or inaccurate.

To ensure a timely review, the land use review applicant is strongly encouraged to address these issues before submitting the land use application by following steps 1 through 5 in Section 2.1.2. This information should be included in the Stormwater Management Report and submitted with the land use application.

2.4.3 Simplified Approach Submittal Requirements

The Simplified Approach Form is designed to be used for private development proposals having less than 10,000 square feet of overall impervious area. Each individual tax lot is required to manage the stormwater it generates on the same lot to the maximum extent practicable and within accordance of the *Stormwater Management Manual*. Site conditions may require additional geotechincal or geological evaluation, which may require the Bureau of Environmental Services (BES) to prohibit the use of this Simplified Approach and require the applicant to utilize the Presumptive or Performance approach.

If total impervious area for the submitted development proposal is equal to or greater than 10,000 square feet or includes public or private street improvements, the Presumptive or Performance approach must be used, and a Stormwater Management Report will be required. For more information, refer to Sections 2.2.2 and 2.2.3, respectively.

If the proposal is unable to meet the requirements of the *Stormwater Management Manual*, the applicant must submit a Special Circumstances request; refer to the Section 1.5 for more information.

Some stormwater facilities have specific submittal requirements in addition to the design approach requirements. See the facility specific design requirements in Section 2.3.4.

If a site includes proposed encroachments into the drainage reserve or channel, the Drainage Reserve Encroachment Submittal Requirements will also apply (see Section 2.4.7).

How to prepare a Simplified Approach submittal

No application will be reviewed unless it is complete. All forms must be completely filled in. The minimum submittal requirements include:

- Simplified Approach Form.
- Tree Credit Worksheet (if tree credit is being utilized).
- Existing conditions site plan.
- Proposed site plan.
- Landscape plans.
- Operation and Maintenance Form and Plan.

Each of these items are described in more detail below.

Simplified Approach Form

The Simplified Approach Form must be completely filled out. The form includes tables for the required infiltration testing and instructions on how to perform an open pit test. See Section 2.3.6 for further details about infiltration testing and options. The form also provides the simplified sizing for the facilities. The Simplified Approach Form consists of the following sections:

- Project information.
- Infiltration testing.
- Proposed stormwater facility sizing.

Tree Credit Worksheet

Trees may reduce the size of required stormwater facilities or even eliminate stormwater management requirements on small project proposals. The Tree Credit Worksheet contains the information needed to apply tree credit to stormwater requirements and consists of the following sections:

- Information on new trees.
- Information on existing trees.
- Information on allowable tree credit.

Site Plans

Existing conditions and proposed site plans. Scaled site plans will include at minimum:

- Minimum scale of 1 inch to 10 feet.
- North arrow.
- Topography and elevations.
- Property lines and lot dimensions.
- Lot area and setbacks.
- Driveways and footprints of structures.
- Wells and septic systems.
- Easements.
- Utility Lines.
- Impervious Areas.
- Type, location, and size of stormwater facilities.
- Type, location, and size of conveyance features (if present or proposed).
- Existing and proposed surface drainage.
- Proposed stormwater discharge location.
- Width of right-of-way and curb height.

Cross-Section and Details of the proposed facility must be included with the plan set. Where sites are topographically varied, it may be imperative to show elevations of inlets, outlets, and discharge locations on the cross-section to show how gravity drainage will be met.

Landscape Plan

Landscape plans are required (see Section 2.4.1) with all permits that include at least one vegetated stormwater facility. For facility specific requirements including plant density and size requirements see Section 2.3.4.

Operations and Maintenance Form and Plan

The Operations and Maintenance Form (see Section 3.1.4) must be recorded with the appropriate County along with the O&M plan (see Section 3.1.1) prior to permit issuance.

How to submit a Simplified Approach Form and Application

Applications must be submitted concurrently with the development proposal for BES review. Inaccurate or incomplete applications will be returned and will cause a delay in review.

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

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SIMPLIFIED APPROACH FORM
PROJECT INFORMATION WORKSHEET

PROJECT INFORMATION

Permit Number: _____ **Phone:** _____

Name: _____ **Email:** _____

Site Address/R Number(s): _____

Development Description: _____

_____

Total New or Redeveloped Impervious Area: _____

Signature: _____ **Date:** _____

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 anywhere within the project area? ☐ Yes ☐ No

If answer to S.1 or S.2 is yes, than lined or partial infiltration facility with an overflow to an approvable discharge point is required.

S.3. Is there a required geotechnical report? ☐ Yes ☐ No

S.4. Required infiltration testing complete? ☐ Yes ☐ No

If using prior test results at same site, provide Land Use case/permit number:_____

SIMPLIFIED INFILTRATION TESTING PROCEDURE

The Simplified Approach provides a method that a nonprofessional can use for design of simple stormwater systems on small projects. A geotechnical report or different infiltration test may be required at the discretion of the assigned BES plan reviewer. See Section 2.3.6 for infiltration testing requirements.

Test instructions:

1. Conduct test in and/or near location of proposed infiltration facility.
2. Excavate a test hole a minimum of 16" in depth, or to the bottom of the proposed infiltration system, whichever is greater. If a hard pan layer is encountered that prevents further excavation, or if noticeable moisture/water is encountered in the soil, stop and measure this depth and note it on the SIM form. If further excavation is not possible, conduct the test at this depth.
3. Fill the hole with water to a depth of at least 6" from the bottom of the hole. Record the amount of time required for the water to draw down to the bottom of the test pit. Check the water level at regular intervals to ensure accurate data collection.
4. Repeat the process two more times for a total of 3 rounds of testing. Conduct the tests in succession to accurately portray the soil's ability to infiltrate at different levels of saturation. The 3rd test provides the best measure of the infiltration rate at saturated conditions.
5. Record infiltration test data in the table at left and certify the results.

Required Infiltration Testing

Date of Test: _____

Depth of Excavation (ft): _____

	TEST 1	TEST 2	TEST 3
A. Time *(of day)*			
B. Duration *(hours)* *(1 hour minimum)*			
C. Initial Water Depth *(inches)*			
D. Final Water Depth *(inches)*			
E. Infiltration Rate* *(inches/hour)*			

*Infiltration Rate = Initial Depth *(in)* – Final Depth *(in)* / Duration of Test *(hours)*

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

Certification of Infiltration Results *(required)*

I acknowledge the accuracy of these infiltration testing results.

_____
Signature of tester *(required)*

_____
Print Name

_____
Date

SIMPLIFIED APPROACH FORM
PROPOSED STORMWATER FACILITIES

Proposed Stormwater Facilities

Please note: Each individual taxlot is required to manage the stormwater runoff it generates from new construction or redevelopment on the same lot to the maximum extent feasible. The following table includes accepted simplified stormwater management facilities as described in Chapter 2 of the 2016 Stormwater Management Manual. Copies of the manual are available online at **www.portlandoregon.gov/bes/swmm**.

	STORMWATER FACILITY TYPE	TOTAL AREA MANAGED BY FACILITY TYPE (SF)	FACILITY SIZING FORMULA	FACILITY SIZE (SF)
IMPERVIOUS AREA REDUCTION TECHNIQUE	Tree Credit		Complete Tree Credit Worksheet and attach	n/a
	Ecoroof		1:1 ratio only	n/a
	Pervious Pavement		1:1 ratio only	n/a
SURFACE INFILTRATION OR FILTRATION	Downspout Extension		Area x 0.10	
	Rain Garden		Area x 0.10	
	Basin		Area x 0.09	
	Swale		Area x 0.09	
	Planter		Area x 0.06	
	Filter Strip (paved areas only)		Area x 0.20	
SUBSURFACE DISPOSAL UIC	Soakage Trench		Westside soakage trench no longer an option under the simplified approach. Only a single soakage trench sizing possible. *See below for sizing information.*	
	Drywell		Enter drywell type and quantity for facility size. *See below for sizing information.*	
TOTAL IMPERVIOUS AREA MANAGED			Total Impervious Area Managed must match Total New or Redeveloped Impervious Area. Site plans must identify stormwater facility location, drainage areas, overflows and escape routes.	

Subsurface facilities can receive overflow from impervious area reduction techniques or surface infiltration/filtration facilities or can be used independently to manage runoff. If stormwater is generated from anything other than roof area, stormwater facilities are subject to UIC requirements (see Chapter 1 for UIC requirements).

Sizing Charts:

DRYWELL TYPE	AREA MANAGED
2'x2' mini drywell	Up to 500 sf
28"x5'	Up to 1,000 sf
4'x5'	Up to 3,000 sf
4'x10'	Up to 6,000 sf

SOAKAGE TRENCH	LENGTH PER 1,000 SF OF IA	WIDTH	DEPTH	SIZING
Soakage Trench	20'	2.5'	1.5'	AREA x 0.05

2.4.4 Presumptive Approach Submittal Requirements

The Presumptive Approach is required for sites larger than 10,000 square feet, such as medium- to large-scale residential and commercial projects on either private or public property. The Presumptive Approach is required for private streets and for any project in the public right-of-way. (See Section 2.2.2 for more information.) It can also be applied to size facilities on smaller projects where the more detailed hydrologic calculations will allow the design professional to size a facility more accurately by taking measured infiltration rates and other specific design factors into account. This approach requires the assistance of a licensed engineer or qualified design professional.

If a site includes proposed encroachments into the drainage reserve or channel, the Drainage Reserve Encroachment Submittal Requirements will also apply (see Section 2.4.7).

How to prepare a Presumptive Approach submittal

No submittal application will be reviewed unless it is complete. The minimum submittal requirements are as follows:

- Existing conditions and Proposed Site Plan.
- Stormwater Management Report (see Section 2.4.6).
- Tree Credit Worksheet (if applicable).

Site Plans

Scaled site plans for existing conditions and proposed site plans must include at a minimum:

- Minimum scale of 1 inch to 10 feet.
- North arrow.
- Topography and elevations.
- Property lines and lot dimensions.
- Lot area and setbacks.
- Driveways and footprints of structures.
- Wells and septic systems.
- Easements.
- Utility Lines.

- Impervious Areas.
- Type, location, and size of stormwater facilities.
- Type, location, and size of conveyance features (if present or proposed).
- Existing and proposed surface drainage.
- Proposed stormwater discharge location.
- Width of right-of-way and curb height.
- All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection.

Cross-Section and Details of the proposed facility must be included with the plan set. Where sites are topographically varied, it may be imperative to show elevations of inlets, outlets, and discharge locations on the cross-section to show how gravity drainage will be met.

Draft Operations and Maintenance Plans

BES must review and approve O&M Forms and Plan prior to permit issuance. For private stormwater facilities and conveyance features, the O&M Form and Plan must be recorded in the County of the subject property. See Section 3.1.4 for private O&M submittal requirements and Section 3.2.3 for public O&M submittal requirements for future BES facilities.

How to submit the Presumptive Approach Requirements

Applications must be submitted concurrently with the development proposal or public improvement for BES review. Inaccurate or incomplete applications will be returned and will cause a delay in review. For questions regarding the submittal process, call the BES Development Review Hotline at 503-823-7761.

2.4.5 Performance Approach Submittal Requirements

If the proposed stormwater management plan meets the intent of all the Stormwater Management Manual requirements, but not as specified under the Simplified or Presumptive Approach, the applicant may submit the project under the Performance Approach. The application must demonstrate that the proposed management plan meets or exceeds all of the City of Portland's stormwater requirements. Refer to Section 2.2.3 for more information about the Performance Approach.

Some stormwater facilities have specific submittal requirements in addition to the design approach requirements. See the facility specific design requirements in Section 2.3.4.

If a site includes proposed encroachments into the drainage reserve or channel, the Drainage Reserve Encroachment Submittal Requirements will also apply (see Section 2.4.7).

Technical staff under the direction of the Chief Engineer or designee will review Performance Approach submittals. The applicant can initiate a Performance Approach review by submitting a Stormwater Management Report (as specified in Section 2.4.6). The applicant must provide additional materials and supporting information as requested by city staff to demonstrate how the proposal meets the site-specific stormwater requirements.

How to prepare a Performance Approach submittal

No submittal application will be reviewed unless it is complete. The minimum submittal requirements are as follows:

- Existing conditions and Proposed Site Plan.
- Stormwater Management Report (see Section 2.4.6).
- Tree Credit Worksheet (if applicable).

Site Plans

Scaled site plans for existing conditions and proposed site plans must include at a minimum:

- Minimum scale of 1 inch to 10 feet.
- North arrow.
- Topography and elevations.
- Property lines and lot dimensions.
- Lot area and setbacks.
- Driveways and footprints of structures.
- Wells and septic systems.
- Easements.
- Utility Lines.
- Impervious Areas.

- Type, location, and size of stormwater facilities.
- Type, location, and size of conveyance features (if present or proposed).
- Existing and proposed surface drainage.
- Proposed stormwater discharge location.
- Width of right-of-way and curb height.
- All stormwater piping associated with the facility, including pipe materials, sizes, slopes, and invert elevations at every bend or connection.

Cross-Section and Details of the proposed facility must be included with the plan set. Where sites are topographically varied, it may be imperative to show elevations of inlets, outlets, and discharge locations on the cross-section to show how gravity drainage will be met.

Draft Operations and Maintenance Plans

BES must review and approve O&M Forms and Plan prior to permit issuance. For private stormwater facilities and conveyance features, the O&M Form and Plan must be recorded in the County of the subject property. See Section 3.1.4 for private O&M submittal requirements and Section 3.2.3 for public O&M submittal requirements for future BES facilities.

How to submit the Performance Approach Requirements

Applications must be submitted concurrently with the development proposal or public improvement for BES review. Inaccurate or incomplete applications will be returned and will cause a delay in review. For questions regarding the submittal process, call the BES Development Review Hotline at 503-823-7761.

2.4.6 Stormwater Report Submittal Requirements

A Stormwater Management Report is required for every development proposal or public improvement where the Presumptive Approach or Performance Approach is used. If submitted in hardcopy form, reports should be paginated and securely fastened (including maps and exhibits). If submitted digitally, submit as a single PDF. A Stormwater Management Report must include all of the following items. The Stormwater Management Report must concisely convey the stormwater management plan, including design assumptions.

Cover Sheet

The cover sheet must include the project name, property owner, site address, associated permit numbers, submittal date, and the engineer of record and their full contact information.

Designer's Certification and Statement

The Stormwater Management Report should be certified with the following statement:

"I hereby certify that this Stormwater Management Report for (name of project) has been prepared by me or under my supervision and meets minimum standards of the City of Portland and normal standards of engineering practice. I hereby acknowledge and agree that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me."

The design professional should stamp and sign the statement with their Oregon registration stamp.

Table of Contents

Provide a table of contents that identifies elements, exhibits, maps, and other information within the Stormwater Management Report.

Project Overview and Description

The project overview must include the size and location of project site (vicinity map), property zoning, type of development or proposed improvements, watershed, permits required (local, state, federal), and existing versus post construction conditions.

Methodology

The Stormwater Management Report must include site specific information and methodologies used to develop the proposed design, including:

- Drainage and conveyance given existing site conditions, including any existing drainageways, description of potential impacts from proposal to existing drainage, and description of techniques for mitigating impacts.
- Infiltration testing results (see Section 2.3.6).
- Stormwater hierarchy category justification.

- Narrative that describes the proposed stormwater management techniques, including how to meet the site-specific stormwater requirements for infiltration or offsite discharge.

Analysis

The Stormwater Management Report must include:

- Design assumptions used to size stormwater management facilities and conveyance features, such as design storms, computation methods, software used, safety factors, curve numbers, and design coefficients, and clarifying variations from the norm.
- Approved results from the Presumptive Approach Calculator as provided in the PAC Report (see Appendix A.4).
- Conveyance requirements and design.
- Table of impervious area treated, differentiating between public right-of-way and private stormwater facilities and types of impervious area treated, such as roof or parking lot. See Figure 2-35 as an example. Include areas managed with impervious area reduction techniques, including ecoroofs, pervious paving, and trees.

Figure 2-35. Catchment and Facility Summary

Catchment or Facility ID	IA Type (roof, road)	Impervious Area (sf or ac)	Ownership (private/ public)	Facility Type	Facility Size (sf or ac)	CN

- Demonstrate that the project meets any applicable flow control requirements set forth in Section 1.3.4 or 1.3.5 if stormwater is being discharged offsite to Stormwater Hierarchy Categories 3 or 4. The Presumptive Approach Calculator (PAC) Report will provide a summary or see Figure 2-36.

Figure 2-36. Pre vs. Post Construction Flow Rates

Catchment ID	Peak Flow Rate (CFS)								Time of Concentration	
	2 yr		5 yr		10 yr		25 yr			
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post

- Determination of the escape route or inundation level for the 24-hour 100-year event.

Engineering Conclusions

Based on compliance with the Stormwater Management Manual, determine how the site-specific stormwater requirements are met, including any flow control or water quality requirements.

Stormwater Facility Details/Exhibits

Include grading plans of pre and post-development, impervious area identification, watershed, existing and new drainageways, and any offsite discharge locations. Delineate each catchment (area treated by a single stormwater facility) and identify any stormwater conveyance features. A Landscape Plan is required for all projects that include at least one vegetated stormwater facility (see Section 2.4.1; for facility-specific planting requirements, see Section 2.3.4).

2.4.7 Drainage Reserve and Channel Encroachment Submittal Requirements

Drainage reserves are typically 30 feet in width (15 feet from the centerline of the channel on both sides). On sites with drainage reserves, encroachments into either the drainage reserve (within 5 feet of the outer reserve edge) or the drainageway channel (within 10 feet of the centerline of the channel itself) may be allowed if approved by BES. Design criteria for drainage reserves are in Section 2.3.4.20; design criteria for reserve encroachments are in Section 2.3.4.21; and design criteria for channel encroachments are in Section 2.3.4.22.

How to prepare a drainage reserve encroachment or a channel encroachment submittal

No submittal will be reviewed unless it is complete. It is critical that information provided be clear, concise, accurate, and complete. A complete submittal consists of the following elements:

- Site plans including topography and grading for both existing conditions and proposed conditions.
- Compliance with drainage reserve conveyance requirements.
- Construction Management Plan (including erosion control plan).
- Landscape Plan.
- Operations and Maintenance Form and Plan.

A number of these elements can be combined with submittal requirements for the required design-specific approach (See Section 2.4 and Chapter 3).

Site Plans

In addition to the site plan requirements for the design-specific approach, the following information must be included for existing and proposed site conditions.

For development sites that are less than 10,000 sf a survey of the existing conditions is required to delineate the drainage reserve.

Existing Conditions Site Plan

- Indicate location of the surveyed centerline of the drainageway, both natural and man-made. The limits of the identified drainageway must be clearly delineated.
- Provide 1' contours within the area of disturbance.
- Indicate the location of all surveyed cross sections.
    - A minimum of three surveyed cross-sections of the drainage reserve are required: where the drainage reserve enters and exits the property, and at the location(s) of the encroachment(s). Additional surveyed cross-sections are required at points of significant change and configuration (e.g. grade or size of channel).
    - Development sites that are greater than 10,000 sf will require the delineation of all drainageways within the disturbance area. If a drainageway is not within the disturbance area, drainage reserves will be placed but not delineated and the estimated location will be noted on the Operations and Maintenance site plan.
- Indicate the location of 30-foot wide drainage reserve. The standard drainage reserve is 15 feet from the drainageway centerline.

- Indicate existing structures and/or impervious area within the disturbance area or drainage reserve.
- Indicate existing trees greater than six inches in diameter at breast height (DBH) by size and species within the disturbance area or drainageway including within the drainage reserve.

Proposed Site Plan

- Indicate the type of proposed encroachment (reserve encroachment or channel encroachment).
- Indicate the proposed cross-section of the drainage reserve at the encroachment or proposed channel.
- Indicate the location of the proposed centerline of the drainageway. If a pipe/culvert is proposed, show a cross-section and profile including diameter, depth, slope, type and invert elevation of the pipe/culvert. The profile should extend as far as necessary to go beyond hydraulic effects caused by the crossing.
- Indicate a long-profile of the drainageway including the calculated average channel slope.
- Indicate the proposed changes to the drainage reserve.
- Indicate the location of proposed development activity, disturbance area (temporary and permanent), and staging area (including utilities).
- Indicate the location of existing trees and trees proposed to be removed greater than six inches diameter at breast height by size and species within the disturbance area or within the drainage reserve.
- Indicate the type, location, and size of the stormwater facility(s) discharging to the drainage reserve and the location of the proposed stormwater discharge location.
- Indicate the cross-section and plan view of the discharge location.

Compliance with drainage reserve conveyance requirements

For drainage reserve encroachments, a mitigation plan must be submitted that includes:

- A narrative discussing how the encroachment has been minimized to the maximum extent possible.

- An estimation of the flow impacts to the drainageway, including decreases in flow conveyance volume, flow path alteration, or any structure that could cause flow ponding
- Calculation and channel cross-sections to demonstrate proposed conveyance capacity.
- Documentation of restoration of the temporary disturbance area and any mitigation proposed using vegetation that must meet or exceed vegetation requirements indicated in Section 2.3.4.21.

For channel encroachments, a Stormwater Management Report must be used to demonstrate how conveyance capacity requirements will be met. The Stormwater Management Report (see Section 2.4.6) must include a map of the delineated basin area along with the following:

Engineering Analysis for Open Channel Drainageway

For a proposed open channel drainageway, the applicant must provide an engineering analysis documenting that the drainageway is adequately designed, including:

- Hydrology calculations estimating flow volumes for the 2-year, 25-year and 100-year events.
- A downstream hydraulic analysis in order to demonstrate adequate capacity for the proposed development and the existing basin.
- Demonstrate adequate conveyance. Open channel systems are required to convey the 25-year storm within the drainage reserve and cannot cause increased flooding to buildings or other infrastructure during the 100-year design storm. Floodplain and overbank areas should be included in conveyance capacity calculations.
- Cross sections and elevations of the drainageway and delineation of the drainage basin. Cross sections should include existing and proposed sections as appropriate.
- Upgrades and improvements to the downstream system may be necessary to accommodate flow from the proposed development.
- Drainage Reserve review would be required for any future encroachments or enhancements to the drainageway.
- Licensed engineer stamped calculations and plans.

Engineering analysis for proposed pipes or culverts (if applicable)

For a proposed pipe or culvert, the applicant must provide an engineering analysis documenting the pipe is sufficiently sized, including:

- The applicant must submit stamped and/or signed engineering calculations that substantiate the proposed pipe will provide the needed capacity for the drainage basin area. Calculations must account for existing drainage and address downstream impacts.
- Culvert sizing should account for sediment transport and fish passage (where required).

Construction Management Plan

A construction management plan (including an erosion control plan) must include the following elements:

- Provide a narrative indicating a construction management plan for existing drainageways and during proposed modifications of the drainageways.
- Provide a construction staging and access plan showing staging areas and access paths. Provide construction exclusion fencing to preserve undisturbed areas.
- Indicate how the drainage reserve area will be protected during development of the site.
- Submit a development schedule that notes any seasonal development limitations for drainageway protection.
- State and federal agencies may impose an in-water work window.
- Identify how drainageways on the site will be protected during construction (including exclusionary fencing to prevent encroachment and protect drainageways from soil stockpiles, backfill, construction debris, construction equipment, etc.) and how disturbed soil will be permanently stabilized.
- Provide a temporary diversion plan if the channel will be blocked.

Erosion Control Plan

- Provide a narrative indicating erosion control measures for protecting drainageways and the area downstream.
- Erosion control measures during work within the drainage reserve area.
- Erosion control measures after work within the drainage reserve is complete and work on proposed structures is ready to begin.

- Identify temporary and permanent erosion control measures, including details as necessary, in the Erosion Control Plan.

Landscape Plan

Any plan for permanent landscape within the drainage reserve area must have a landscaping plan. Native plants are required in drainage reserves when mitigating for any proposed encroachments. For planting recommendations see the Portland Plant List.

Specific requirements for plant density and size requirements can be found in Section 2.3.4.21. Information the Landscape Plan is located in Section 2.4.1.

Operations and Maintenance Plan

An Operations and Maintenance Plan (O&M) is required for a permitted improvement or encroachment to a drainage reserve. Operations and Maintenance Plans must be recorded with an O&M Form in the County of the subject property. An O&M plan for drainage reserve encroachments is located in Section 3.1.3. Information on how to submit an O&M Form is located in Section 3.1.4.

How to submit a Drainage Reserve Encroachment or a Channel Encroachment for review

The request for a drainage reserve encroachment must be submitted concurrently with the development proposal for BES review. Inaccurate or incomplete applications will be returned and will cause a delay in review.

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

2.4.8 Manufactured Stormwater Treatment Technology Submittal Requirements

This section outlines the submittal requirements and review process for vendors/manufacturers of proprietary treatment systems who seek to be on the City of Portland's list of approved devices.

The current list of approved manufactured stormwater treatment technologies is online at www.portlandoregon.gov/bes/swmm.

Introduction

The City of Portland maintains a list of approved manufactured stormwater treatment technologies that can be used under the Stormwater Management Manual Performance Approach. Manufacturers of stormwater treatment technologies who seek to be on the approved list must apply and follow these

submittal requirements. The approval process evaluates the manufactured stormwater treatment technology for its effectiveness in meeting the pollution reduction requirements of the *Stormwater Management Manual* and Portland City Code 17.38.

Engineers or qualified design professionals who wish to use manufactured stormwater treatment technologies not on the approved list must use the Performance Approach for a specific site development or improvement proposal. Approvals under the Performance Approach are site specific and do not imply any wider approval or precedent.

The Washington State Department of Ecology (DOE) Technology Assessment Protocol (TAPE) is a standard method by which many Northwest municipalities evaluate and approve manufactured stormwater treatment technologies for use in their communities. The City of Portland requires that manufactured stormwater treatment technologies must have a current general use level designation (GULD) by Washington State DOE under TAPE prior to application and review to the City of Portland. The Bureau of Environmental Services (BES) has decision-making authority to approve, deny, or revoke the use of manufactured stormwater treatment technologies within the City of Portland at any time, regardless of previous certification by DOE or prior approval by BES.

TAPE (Technology Assessment Protocol – Ecology)

Washington State Department of Ecology evaluates treatment technologies through TAPE. An overview of the process, submittal requirements, and a list of DOE approved technologies are online at:
http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Performance Criteria

Applicants (including, but not limited to, manufacturers, product vendors, consultants or any other person promoting the manufactured stormwater treatment technology) should ensure that the manufactured stormwater treatment technology meets Portland's pollution reduction requirements. The Stormwater Management Manual includes the following pollution reduction requirements:

Total Suspended Solids

The pollution reduction performance goal for the City is 70 percent removal of total suspended solids (TSS) from 90 percent of the average annual runoff (see Section 1.3.4).

Total Maximum Daily Load and 303(d) Listed Parameters

Certain watersheds within the City of Portland have established Total Maximum Daily Loads (TMDLs). The TMDLs apply specific pollution control requirements to designated pollutants of concern. To ensure that new development does not contribute pollutants of concern to a TMDL watershed, pollution reduction facilities are required to demonstrate specific removal rates for those specific pollutants. See Exhibit 1-5 in Section 1.3.4 of the Stormwater Management Manual for a current list of TMDL watersheds with corresponding pollutant parameters. TSS may be used as a surrogate for aldrin, chlordane, DDE, DDT, dieldrin, dioxin, and PCBs.

Application Process

Applicants seeking BES approval of manufactured stormwater treatment technologies must submit an application form, a cover letter, all required documentation, and an application fee. The review process consists of a public presentation about the manufactured stormwater treatment technology, a technical interview, and third-party review of the documentation.

The application form, application fee, and cover letter should be submitted to:

City of Portland, Environmental Services
ATTN: Engineering Services Support Program Manager
1120 SW 5th Ave., Suite 1000
Portland, OR 97204

All other required documents should be submitted digitally: one set of PDF file(s), and one set of native files if available in standard format. For example, if analysis or data tracking was done using Excel, submit the original Excel files. All data and documentation necessary to verify performance must be included in the application. BES may request additional documentation or data during the review process.

BES will provide a single point of contact for applicants that will facilitate and track the application process. All correspondence and communication with the City of Portland regarding the application must be through the single point of contact. BES will review one complete application at a time in the order received. BES will convene a Review Committee that will attend the public presentation and the technical interview, review the application and the third-party review evaluation, determine any conditions of use, and maintain the list of approved manufactured stormwater treatment technologies. Following submission of a complete application, BES will provide the Applicant with a list of Review Committee members and single point of contact for any questions or coordination needs.

Required Submittals

Applicants must submit all of the following documents. Submitting an application does not guarantee that BES will approve a manufactured stormwater treatment technology. BES will review only manufactured stormwater treatment technologies that have achieved TAPE GULD certification.

All information provided to the City must be public record and subject to public disclosure pursuant to Oregon public record laws (ORS 192.410 to 192.505). Any portion of an application that the applicant claims as exempt from disclosure must meet the requirements of ORS 192.501(2) and ORS 192.502(4) and/or ORS 646.461 et seq. In order for such information to be considered exempt from public disclosure, the applicant must certify that the information is unique to the design and construction of the technology, or release to the public or to a competitor would adversely affect the competitive position of the proponent. All monitoring data including, but not limited to, laboratory results and field measurements, QA/QC data, data qualifiers, and monitoring site information cannot be considered confidential.

The applicant must mark only those pages that contain information exempt from public disclosure with the word "confidential" and provide a letter of explanation as to why these pages are exempt from public disclosure. The fact that an applicant marks information as exempt from disclosure does not mean that the information is necessarily exempt. Review of information exempt from public disclosure will be limited to the Review Committee and the Third Party Review.

Application Form

Applicants must submit a Manufactured Stormwater Treatment Technology Application Form. Applicants must complete the form in full.

Application Fee

Applicant must pay the application fee at the time of application submission. Checks must be made out to the City of Portland. The fee will cover costs of the third-party evaluation as well as City staff time to process, coordinate, and review the application. The current fiscal year's application fee is shown on the application form.

Cover Letter

The cover letter must be a single page and include the following:

- The name of the device with a short description of its intended application within the City of Portland.
- A summary of the TAPE history for the device, including the date of achieving GULD certification.
- A summary of the treatment performance goals, specific land uses, and targeted pollutants for which the device received TAPE certification.
- The signature of a company representative authorized to submit the application.

TAPE Documentation

All final documentation used to achieve TAPE GULD certification from Washington State DOE. This includes:

- Technology Evaluation Report (TER), including appendices and any third party review memorandum.
- Quality Assurance Project Plan (QUAPP), including any appendices.
- The most recent General Use Level Designation provided by DOE.

Submit TAPE documentation to BES as it was submitted to Washington State DOE. Do not re-order or otherwise modify the TER or QUAPP. If the TAPE documentation does not clearly demonstrate compliance with Portland's required pollution reduction standards, provide additional testing plus analysis. If the TAPE GUILD approval was dependent on increased sizing or reduced treatment flow rates, provide that justification and analysis. If TAPE GULD certification required post-installation maintenance analysis, provide that as supplemental information.

Design Information

Submit standard details for all configurations, orientations, and bypass options under consideration. If there are unit components that have different sizing criteria, provide criteria and sizing for all unit components. Provide flow-based sizing to meet Portland's pollution reduction requirements (including any sizing assumptions or requirements as per the TAPE GULD certification) for a units' receiving drainage area (square feet or acre). If unit is inclusively designed for volume-based sizing,

provide that as well, as measured in a unit's receiving drainage area (square feet or acre).

References

Provide references for at least two public agencies who have had installations in the public right-of-way installed for at least two years. The references should be from public works departments or other stormwater operations and maintenance departments who have knowledge and experience with maintenance activities and inspection frequencies.

Additional Product Information

If installation guides, maintenance guides, or recommended plant lists have been updated since GULD designation, provide the most recent information. Provide current marketing material for only the MSTT under consideration.

BES Evaluation Process

Following application submittal to BES, BES will review and determine if the application is complete. After BES deems an application complete, the presentation and interview should be scheduled within 30 business days.

Public Presentation and Technical Interview

BES will work with the applicant, the Review Committee, and third-party reviewers to arrange a public presentation of the proposed manufactured stormwater treatment technology. At the conclusion of the presentation, there will be a technical interview of the applicant about the proposed manufactured stormwater treatment technology. The interview will not be open to the public and will consist only of the Review Committee, third-party reviewers, and the applicant.

BES staff will make reasoned decisions about manufactured stormwater treatment technologies and their application in the Portland metro area based on "best professional judgment" of the evidence provided. The TER, submitted as part of the TAPE process, will be critical to understanding the applications and characteristics of the technology and how it will be used in Portland, Oregon. The applicant should be prepared to respond to each of the key sections of the TER as they are applicable to the Portland area. Applicants should also be prepared to discuss or provide local or regional examples of operation and maintenance of systems by public agencies and/or private entities.

Third-Party Review

Following the public presentation and technical interview, the third-party review should be complete within 90 business days. BES will engage a consultant or academic institution to evaluate the manufactured stormwater treatment technology for use within the City of Portland. The third-party review will compare the data used to achieve GULD certification against the pollution reduction requirements for the City of Portland as identified in City Code 17.38 and the Stormwater Management Manual. The third-party review will evaluate whether the manufactured stormwater treatment technology meets Portland's pollution reduction requirements. The third-party review will evaluate water quality data and storm event intensity.

BES Review Determination

BES will make a final decision of approval or denial within 30 business days following completion of a third-party review. BES has decision-making authority for approval of manufactured stormwater treatment technologies for use within the City of Portland and may place conditions of approval to provide consistency with local zoning or land use requirements, or to meet watershed-specific water quality requirements. Conditions may include, but are not limited to, maximum flow rates, limitations on drainage basin size, or installation locations.

BES may at any time suspend or revoke approval of a manufactured stormwater treatment technology if the performance of the technology does not meet the approval performance criteria, or if the performance criteria changes due to local, state, or federal pollution reduction requirements.

Appeals

If the applicant does not agree with the outcome or conditions of the evaluation process, the applicant may request an Administrative Review, as per Section 1.6.

Renewal Process

Manufactured stormwater treatment technologies will be approved for 36 months from the date of approval. If no changes to the manufactured stormwater treatment technology occur (such as, but not limited to, dimensional changes to the physical device, changes to the filtration media, changes to maintenance requirements, or changes in expected performance or device design criteria), the approval can be renewed. At the end of the approval period, the applicant may notify BES of their intent to renew their approval for a subsequent 36 months. If any changes, updates or revisions, have occurred to the manufactured stormwater treatment technology, the applicant must obtain TAPE GULD certification and re-

apply following the submission guidelines in effect at the time of application, including fee payment.

To renew approval of a manufactured stormwater treatment technology, the applicant must submit an application form noting the intent to renew an existing approved manufactured stormwater treatment technology. There is no cost to renew an existing approval. The renewal will begin on the date that BES determines the renewal form is complete.

If an applicant submits a renewal request and the pollution reduction requirements or the evaluation criteria have changed since the original approval, BES may require the applicant to re-apply.

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 2.4.8 of the *Stormwater Management Manual*. The Bureau of Environmental Services (BES) requires that a manufactured stormwater treatment technology has a general use level designation through the Washington State Department of Ecology Technology Assessment Program.

Applicants requesting review of a **new application** must submit all of the required application materials in order for their application to be considered complete. Applicants must submit one set of digital files of all required items and data.

Applicants requesting **renewal of an existing approval** should complete this form and submit to BES, but do not need to re-submit materials or the application fee.

(for Environmental Services use only)

Evaluation milestones

Date Received: _____

Date of Presentation: _____

Date Delivered to TPR: _____

Date Due to BES: _____

Tracking Number: _____

Date of Request: _____

APPLICANT INFORMATION

Contact Name: _____

Company Name: _____

Address: _____

Phone: _____

Email: _____

Website: _____

TECHNOLOGY INFORMATION

Name of Technology: _____

Manufacturer: _____

Brief Description:

_____

_____

_____

_____

_____

_____

THIS APPLICATION IS A:

- ☐ New application
- ☐ Renewal of an existing approval

REQUIRED APPLICATION MATERIALS

- ☐ Application Fee
- ☐ Cover Letter
- ☐ TAPE Documentation
- ☐ Design Information
- ☐ References
- ☐ Additional Product Information

All applications and payments should be submitted to:

ATTN: Engineering Services Support Manager
Bureau of Environmental Services
City of Portland
1120 SW 5th Ave., Room 1000
Portland, OR 97204-1972