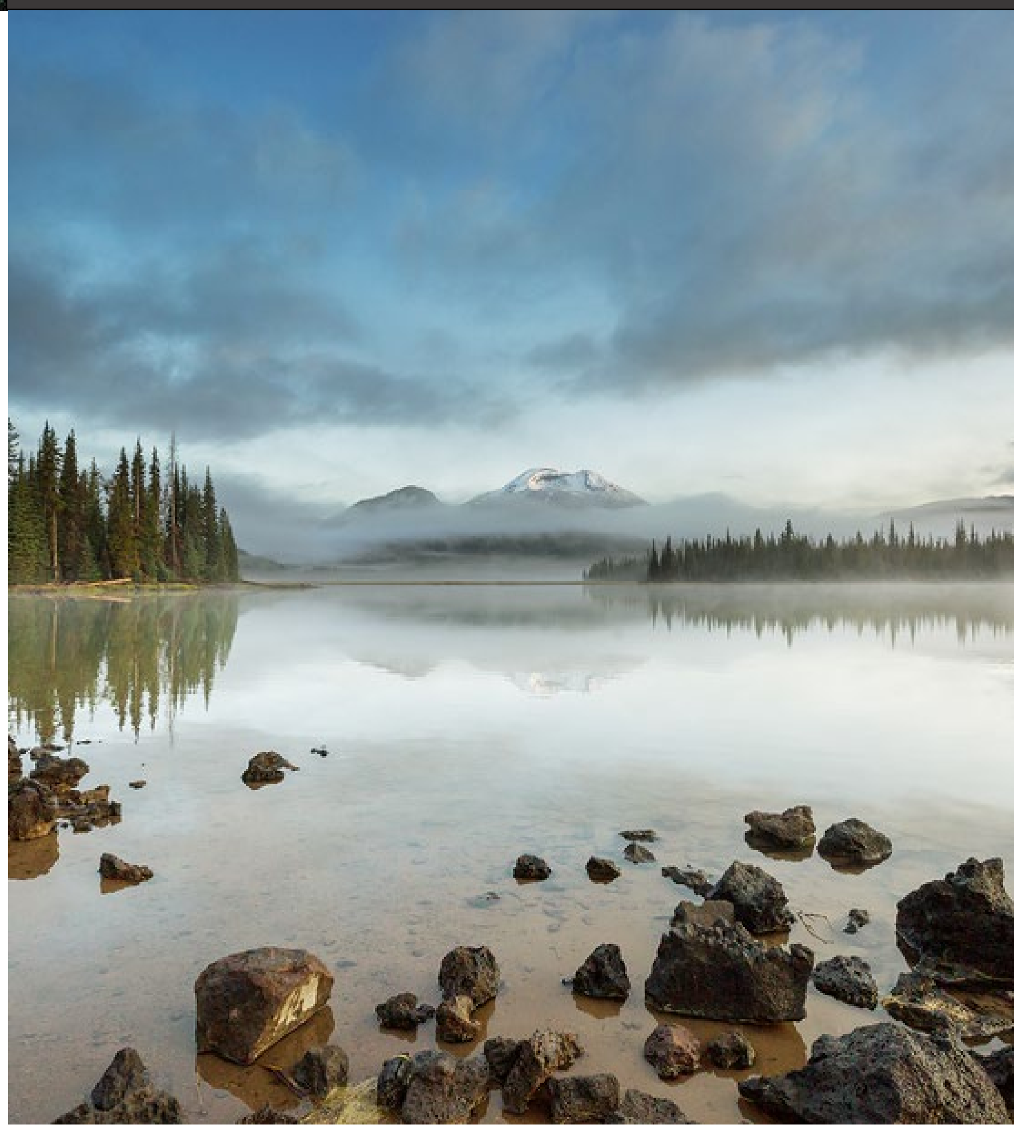
# Section 401 Water Quality Certification

## Post-Construction Stormwater Management Plan Submission Guidelines

**October 2022**



State of Oregon
DEQ Department of Environmental Quality

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# A. Purpose

This document provides submission guidelines for applicants who must provide a post-construction stormwater management plan (SWMP). This document does not relieve applicants from the responsibility of complying with any other local, state, or federal requirements.

# B. Requirements

Applicants for any project requiring a 401 Water Quality Certification that adds or re-constructs any impervious surface must submit a post-construction SWMP to the Oregon Department of Environmental Quality (DEQ) 401 Water Quality Certification (WQC) Program unless the applicant demonstrates to the satisfaction of the DEQ 401 WQC Program that the water quality impacts from post-construction stormwater runoff are minor. Below are examples of projects where the DEQ 401 WQC Program considers the water quality impacts from post-construction stormwater runoff to be minor:

- Utility line installation with no new impervious surface area;
- Small, localized repairs with no new impervious surface area;
- Pavement preservation that does not expose gravels, aggregate, or soil; and
- Exterior remodeling with no new impervious surface area.

The post-construction SWMP must demonstrate post-construction stormwater runoff generated by the water quality storm event will receive all necessary treatment prior to discharge to waters of the state. If infeasible, the applicant must demonstrate that post-construction stormwater runoff from an equivalent offsite area will be treated to offset the water quality impacts from the project's post-construction stormwater runoff.

Within 30 days of project completion, the applicant must submit to the DEQ 401 WQC Program as-builts or red-lined construction drawings of all structural stormwater controls.

If projects occur within the City of Eugene, City of Portland, or within the Clean Water Services boundaries, DEQ may defer post-construction SWMP review, baring any nexus with DEQ's Cleanup program.

Projects receiving a 401 WQC must meet all other agency requirements (e.g. USACE 404 Permit, DSL /Fill Permit) and other applicable permits from DEQ (e.g. NPDES 1200-C or NPDES 1200-Z Stormwater Discharge Permits).

# C. Background

Section 401 of the Clean Water Act (CWA) gives states and tribes the authority to issue state water quality certifications (WQCs) for projects that require a federal license or permit that may result in a discharge to waters of the United States. The certification states that the discharge will comply with applicable provisions of the CWA, including state water quality standards.[1] DEQ has the authority to require modifications to and approve projects with conditions. DEQ also has the authority to deny 401 WQCs for such projects. If a 401 WQC is denied, the federal permit or license cannot be issued for the project.

State water quality standards are established in Oregon Administrative Rules (OARs) Chapter 340 Division 41. DEQ requires the use of all available and reasonable methods necessary for the project to meet state water quality standards. [2] This includes protecting designated beneficial uses (see Appendix F.2), meeting narrative and numeric water quality criteria, and complying with the antidegradation policy.

Stormwater runoff that may cause or tend to cause pollution is a waste.[3] As stated in Oregon Revised Statutes (ORS) *Chapter 468B,* it is the public policy of the state *to provide that no waste be discharged into any waters of this state without first receiving the necessary treatment or other corrective action to protect the legitimate beneficial uses of such waters and to provide for the prevention, abatement and control of new or existing water pollution.*[4] State water quality standards require, in part, that the highest and best practicable treatment and/or control of wastes be provided to maintain overall water quality at the highest possible levels.[5]

The DEQ 401 Program requires applicants submit a post-construction stormwater management plan (SWMP) for projects where post-construction stormwater runoff may cause or tend to cause pollution. To meet 401 WQC requirements, post-construction SWMPs must demonstrate that post-construction stormwater runoff receives the highest and best practicable treatment and/or control.

This document provides guidelines for compiling and evaluating a post-construction SWMP to ensure it demonstrates the use of available and reasonable methods to provide the highest and best practicable treatment and/or control of post-construction stormwater runoff. On a case-by-case basis, additional information may be required to ensure compliance with state water quality standards and other applicable water quality laws.

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[1] Clean Water Act Sections 401(a)(1) and 401(b)(7)
[2] Oregon Revised Statutes (ORS) 468B.020(2)(b)
[3] See the Glossary (Appendix F.1) for the definitions of "pollution" (from ORS 468B.005(5)) and "waste" (from Oregon Administrative Rule (OAR) 340-041-0002)
[4] ORS 468B.015(3),(4)
[5] OAR 340-041-0007

# D. Acronyms

| | |
|---|---|
| BMPs | Best Management Practices |
| CIA | Contributing Impervious Area |
| CWA | Clean Water Act |
| DEQ | Oregon Department of Environmental Quality |
| DSL | Oregon Department of State Lands |
| LA | Load Allocations |
| LID | Low Impact Development |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | Natural Resource Conservation Service |
| OAR | Oregon Administrative Rule |
| ODOT | Oregon Department of Transportation |
| ORS | Oregon Revised Statute |
| PAHs | Polycyclic Aromatic Hydrocarbons |
| SWMP | Post-Construction Stormwater Management Plan |
| TAPE | Technology Assessment Protocol - Ecology |
| TMDL | Total Maximum Daily Load |
| UIC | Underground Injection Control |
| USACE | United States Army Corps of Engineers |
| USDA | United States Department of Agriculture |
| WLA | Waste Load Allocations |
| WQC | Water Quality Certification |

# E. Elements of a Post-Construction Stormwater Management Plan

Refer to Appendix H for a checklist and Stormwater Plan Submission Form of the necessary elements of a SWMP. A SWMP includes the elements listed below, plus any additional information requested by DEQ.

## E.1 Determine the Water Quality Storm Event

DEQ's 401 WQC Program defines the water quality storm event as the greater of

1) the storm event at which 80% of the average annual rainfall comes from storms that are equal to or smaller than that event or
2) the first flush event (assumed to be 0.7 inches of rainfall over 24 hours).

### E.1.1 Determine the Water Quality Storm Event Depth

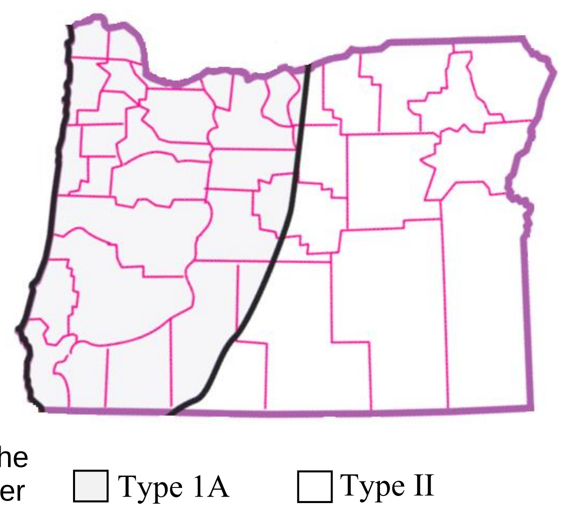
Option 1: Approximate using Statewide Datasets

a) Find the site's 2-year, 24-hour precipitation. The 2-year, 24-hour precipitation can be found using the National Oceanic and Atmospheric Administration (NOAA) Atlas 2 Precipitation Frequency Estimates[6].

b) Multiply the 2-year 24-hour precipitation by the appropriate water quality design storm factor: 0.67 for Zone 9 (Malheur County) and Zone 4 (the Northern Cascades), 0.75 for Zone 5 (the High Plateau) and 0.5 for the rest of the state. See Figure 4 for the zone map

c) If the results are less than 0.7 inch, use 0.7 inch.

**Figure 3: NRCS Storm Distribution from USDA Urban Hydrology fo Small Watersheds, TR-55, 1986**




Option 2: Calculate using Local Data

Calculate the depth of a 24-hour storm event that represents at least 80% of the cumulative rainfall using at least 20 contiguous years of rainfall data, beginning in 1996 or earlier to the most recent verified data. If the results are less than 0.7 inch, use 0.7 inch. If local precipitation data is used to find the 2-year, 24-hour storm precipitation, the calculated water quality storm event depth must be equal to or greater than the depth when using the NOAA Atlas 2 Precipitation Frequency Estimates.

### E.1.2 Consider Rainfall Rates

Option 1: Continuous Simulation

Use a continuous simulation program with at least 20 contiguous years of local rainfall, beginning in 1996 or earlier to the most recent verified data to demonstrate at least 80 percent of the average annual rainfall will be treated.

[6] https://www.weather.gov/owp/hdsc_noaa_atlas2

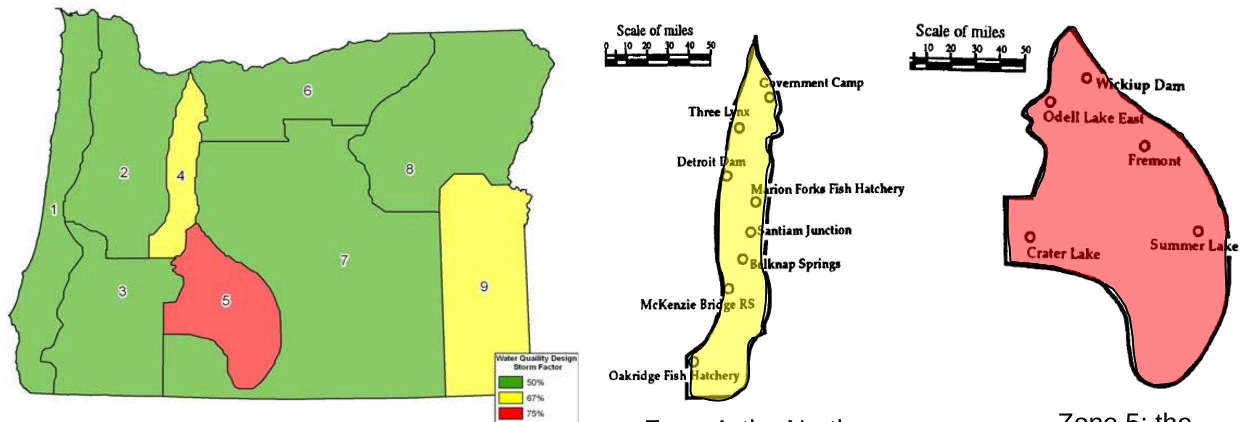
Option 2: Hydrograph Method

Use a single 24-hour storm hydrograph method using an appropriate design storm distribution (such as NRCS Type 1A or Type II) as shown in Figure 3 and multiple these values by the water quality storm event depth found in step E.1.1.

Option 3: Local Stormwater Manual's Rate

Use the local jurisdiction's water quality design rainfall intensity for the time of concentration to rate-based structural stormwater controls if this treats at least 80% of the average annual rainfall.

***Figure 4: Oregon Climate Zone Map***[7]




Zone 4: the Northern Cascades

Zone 5: the High Plateau

# E.2 Evaluate Site Constraints

Site conditions and features can influence the siting and design of structural stormwater controls. Evaluate the pre- and post- construction topography and flow patterns and identify any features that impact the siting and design of structural stormwater controls, as described below.

### E.2.1 Identify Areas Not Recommended for Siting Structural Stormwater Controls

Post-construction stormwater runoff from the water quality storm event must be treated prior to discharge from the project site to a water of the state. Structural stormwater controls for treating stormwater runoff located within a water of the state are prohibited. Avoid siting structural stormwater controls in sensitive areas (e.g., wetlands, natural buffers, floodplains). If siting structural stormwater controls in wetlands or natural buffers is unavoidable, authorizations must be obtained for those unavoidable impacts, including demonstrating that Oregon Department of State Lands (DSL) mitigation requirements will be met. If siting structural stormwater controls in floodplains is unavoidable, address how sediment will be stabilized or removed prior to flood events and how the project will conform to federal, state, and local floodplain regulations.

[7] This figure is from ODOT's April 9, 2008 Water Quality Design Storm Evaluation Memorandum; the zones are the Oregon Climate Service zones, and the factors are set to approximate 85% of the cumulative annual rainfall. The close-ups are from Special Reports 916 and 917 of the Oregon State University Agricultural Experiment Station.

### E.2.2 Buffers for Protection of Waterbodies

The applicant shall avoid and protect from harm, all wetlands and provide a 50 foot buffer to waters of the state, unless proposed, necessary, and approved as part of the project. If a local jurisdiction has a more stringent buffer requirement, that requirement will override this certification requirement.

The 401 Program uses buffers to attain the reasonable assurances needed to ensure a project will meet state water quality standards. The buffer concept is a widespread tool used across many agencies and municipalities nationwide to aid in the protection of natural resources, and is one component of the review for a project requiring a 401 WQC. This concept is also incorporated into the conditions of the 401 WQC, and once issued, must be adhered to as indicated in the site plans.

The framework for this buffer is consistent with management goals of partner agencies like ODFW (see OAR 635-430-0375(12))[8], as well as with the DEQ Stormwater Program, which has the same 50' buffer requirement in the 1200-C Construction Stormwater Permit[9]. Similar to the 1200-C Permit, EPA has a set of buffer requirements in Appendix G [10] of their 2017 Construction General Permit. Additionally, Oregon's Department of Land Conservation and Development (DLCD) has developed Statewide Land Use Planning Goals, which include protecting riparian corridors (see OAR 660-015-0000(5))[11]. Collectively, these concepts complement the 401 Program's decision to adopt the 50' buffer as a tool for minimizing degradation, and assuring state water quality standards will be met.

The 401 Program recommends inclusion of all wetland delineations on the construction design plans, so it is clear where impacts are anticipated to occur, and avoidance will be maximized. If there are areas where a 50 foot buffer is to be altered, degraded, or minimized, then compensation is necessary to retain the assurances needed to issue a certification. In these cases, providing enhanced buffers can serve as a substitute, as well as providing buffers greater than 50 feet in other areas of a project, where there are fewer development constrictions

### E.2.3 Identify Areas where Excavation and/or Infiltration may not be Possible

Identify areas where stormwater can be infiltrated, or provide documention if not possible. Lined structural stormwater controls may be advisable where infiltration is not possible. Examples where infiltration may not be possible may include:

- **Areas with Steep Slopes or Landslide Risk**
  Check the topography and Oregon Department of Geology and Mineral Industries' Statewide Landslide Information Database[12]. Consult with an Oregon-registered geotechnical engineer or engineering geologist in areas with steep slopes or landslide risk to see if excavation and/or infiltration should be avoided.

- **Drinking Water Sources Areas**
  Check the DEQ's Drinking Water Protection Interactive Map Viewer[13] and relevant local data. If the project is within a drinking water source area or groundwater 2-year time of

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8 https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=2992
9 https://www.oregon.gov/deq/FilterPermitsDocs/1200Cpermit.pdf
10 https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_g_-_buffer_reqs_508.pdf
11 https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=175375
12 https://www.oregongeology.org/slido/
13 https://oregonexplorer.info/content/oregon-drinking-water-protection-program-interactive-map

travel, check with the local jurisdiction or the Oregon Health Authority to see if infiltration should be avoided or if structural spill control might be required to protect the resource.

- **Areas with Soil or Groundwater Contamination**
  Check historical records and DEQ's Environmental Cleanup Site Information database[14] and Facility Profiler-Lite[15]. If the site has known or suspected contamination, check with DEQ Cleanup to see if excavation and/or infiltration should be avoided to prevent mobilizing contamination.

- **Areas within any Setbacks**
  Check with the local jurisdiction regarding setback requirements (e.g., property lines, domestic wells, utilities, retaining walls, berms, structures, basements). To protect infrastructure, a partially or fully lined structural stormwater control might be required.

### E.2.4 Check Depth to Groundwater

If groundwater is too shallow, it can interfere with the effective functioning of structural stormwater controls. If not considered in the design of a structural stormwater control, shallow groundwater can take up volume that was intended for stormwater retention and/or treatment. Additionally, for infiltration structural stormwater controls, shallow groundwater can reduce the infiltration rate. Any of the above can result in a structural stormwater control that is undersized. Poor design of structural stormwater controls can also impact groundwater by inadvertently draining groundwater through outlets and, if unlined, by discharging insufficiently treated stormwater runoff to groundwater.To reduce the likelihood of adverse water quality impacts, the following elevations should be considered in the design of the structural stormwater control:

- **Outlets**
  The invert elevation of any outlets should be above the highest anticipated seasonal groundwater to prevent draining groundwater.

- **Infiltration Structural Stormwater Control Bottom**
  Avoid siting infiltration structural stormwater controls in areas where shallow groundwater will prevent the structural stormwater control from draining between storm events. Generally the available storage volume within the soil pores should be sufficient to store the volume of post-construction stormwater runoff the structural stormwater control is designed to infiltrate (see step E.7.2.1). The lowest elevation in a infiltration structural stormwater control should be ***at least 5 ft*** above the seasonally high groundwater elevation[16].

The highest anticipated groundwater elevation can be estimated by reviewing data during the wet season from piezometers, wells, or boring logs and/or checking soil properties for conditions associated with saturation. See the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) 2017 *Field Indicators of Hydric Soils in the United States* for field indicators of soil conditions associated with saturation[17].

[14] http://www.oregon.gov/deq/Hazards-and-Cleanup/env-cleanup/Pages/ecsi.aspx
[15] hhttps://hdcgcx1.deq.state.or.us/Html5viewer291/?viewer=FacilityProfilerLite
[16] https://www.portland.gov/bes/stormwater/swmm#toc-the-2020-stormwater-management-manual
[17] https://www.nrcs.usda.gov/resources/guides-and-instructions/field-indicators-of-hydric-soils

See also the Oregon State University (OSU) 2000 *Measuring Well Water Levels* document for a description of well measurements[18].

Unless the project is small, such as a rain garden for a residential house, a qualified professional such as a soil scientist, engineering geologist, or registered geotechnical engineer should estimate the depth to groundwater.

## E.3 Determine the Level of Infiltration

Infiltration of post-construction stormwater runoff generated by the water quality storm event is recommended unless there is

1) both a high likelihood of spills and structural spill control is not feasible or
2) site constraints prevent infiltration.

### E.3.1 Review Soil Data

Review existing soil maps such as USDA NRCS soil maps[19] and any other relevant, available information. USDA NRCS soil maps are for planning purposes and are useful to help assess where to take infiltration tests; these maps may or may not reflect actual soil conditions.

***Table 1: NRCS Soil Group Infiltration***

| NRCS Group | Suitability for Infiltration Structural Stormwater Controls |
|---|---|
| A | Likely to allow infiltration |
| B | Likely to allow infiltration |
| C | May allow some infiltration |
| D | Likely too slow to allow for infiltration |

### E.3.2 Perform Infiltration Testing

At least two business days before digging, call 811 or the One Call Center[20]. Follow Oregon Occupational Safety & Health precautions for excavations and do not leave any open excavation unsecured or unmarked. An Oregon-registered professional engineer, soil scientist, or geologist should perform the infiltration tests, except for small facilities such as rain gardens serving a single-family residence.

Types of infiltration tests include percolation, modified percolation, and double-ring infiltrometer tests. In general each test involves digging a hole at the approximate location and depth of the proposed structural stormwater control, pouring water in an open-bottomed ring or dug hole, and measuring the drop over time. Follow local manuals and refer to the 2011 *Infiltration Testing Fact Sheet*, by Maria Cahill, Green Girl Land Development Solutions; Derek C. Godwin and Marissa Sowles, and the Oregon Sea Grant Extension (ORESU-G-11-008)[21].
Document the method and results of the infiltration tests. If the tested infiltration rate is too rapid (e.g., > 9 inches/hour), pretreatment or soil amendments may be required in the structural stormwater control; if too slow, it may be impractical to infiltrate all of the post-construction stormwater runoff generated by the water quality storm event. If the infiltration rate is less than

[18] https://extension.oregonstate.edu/catalog/pub/ec-1368-measuring-well-water-levels
[19] https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
[20] http://callbeforeyoudig.org/oregon/index.asp
[21] https://digitalcollections.library.oregon.gov/nodes/view/188485

0.5 inch/hour, the infiltration structural stormwater control should be designed by a qualified Oregon-registered professional engineer.[22]

# E.4 Reduce Stormwater Runoff Volume

Consider options listed below to reduce post-construction stormwater runoff. If the site has known or suspected contamination, check with and follow the advice of DEQ Cleanup Program Conduct a search for potential contamination from hazardous substances on the DEQ Environmental Cleanup Site Information Database[23].

1. Avoid adding impervious surfaces over areas that could be used to infiltrate post-construction stormwater runoff.

2. Minimize impervious surface area

    a. Design narrow or curb-tight sidewalks (lacking furnishing zones or street trees) and small building footprints (e.g., build up instead of out).
    b. Only use porous pavement to infiltrate direct precipitation. Avoid use of porous pavement in areas with significant windblown sediment (e.g. Summer Lake area), a high potential for spills (e.g. vehicle wrecking yards, fast food parking lots, and automotive repair places ), or high groundwater.

    c. Remove abandoned pavement.

3. Reuse or infiltrate direct rainfall on roofs (see Appendix).

    a. Disconnect roof drain downspouts to gently sloped or flat vegetated areas.

    b. Harvest rainwater from rooftop surfaces (e.g., using a rain barrel, planters, or cistern), directing the initial fraction of an inch of each rain event to vegetated areas.[24]

4. Retain and plant trees (especially evergreens) and shrubs onsite.

# E.5 Review Stormwater Runoff Water Quality Impacts

### E.5.1 Receiving Water Beneficial Uses and Water Quality Limited Pollutants

1. Identify each receiving water to which post-construction stormwater runoff discharges.
2. List each receiving water's designated beneficial uses (see Appendix F.3).
3. List all water quality limited pollutants per the latest EPA-approved Integrated Report Assessment Database. At the time of this publication, this is the 2018-2020 Integrated

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[22] From the Template for LID Stormwater Manual for Western Oregon, Appendix C Infiltration Testing, Maria Cahill, Green Girl Land Development Solutions.
[23] https://www.oregon.gov/deq/Hazards-and-Cleanup/env-cleanup/Pages/ecsi.aspx
[24] Refer to the Building Codes Division Oregon Smart Guide on Rainwater Harvesting for additional information: https://www.oregon.gov/bcd/Documents/brochures/3660.pdf.

Report Assessment Database[25]. If the receiving water has any total maximum daily loads (TMDLs), describe any applicable restrictions or goals from the water quality management plan and how these will be addressed[26].

### E.5.2 Materials that Could Impact Water Quality

Design the site to minimize water quality impacts to receiving waters from the post-construction stormwater runoff generated by the water quality storm event. Consider the use of cool pavements to reduce thermal impacts to receiving waters. Also consider alternatives to the following materials that could detrimentally impact water quality:

- Galvanized steel (which releases zinc and lead);
- Copper;
- Pavement sealcoats (which release polycyclic aromatic hydrocarbons (PAHs); and
- Treated wood (which releases copper and arsenic if chromated copper arsenate-treated, PAHs if creosote-treated, and pentachlorophenol if pentachlorophenol-treated).

### E.5.3 Shade Preservation

Avoid loss of shading to waters of the state. This is especially critical in areas that are water quality impaired due to high temperature. Shade loss can be avoided through the preservation of buffers around waters of the state. For sites that are in question, DEQ may require applicants to conduct models related to water quality impacts. Please visit DEQ's Analysis Tools and Modeling Review page[27] for more information on Heat Source Modeling.

## E.6 Select Stormwater Treatment Method(s)

Stormwater treatment should mimic natural hydrology as much as feasible. Low impact development (LID), such as preserving buffers and trees and providing smaller structural stormwater controls distributed throughout the site, is encouraged. The focus of LID is to keep the raindrop as close to it's source as possible utilizing techniques such as infiltration, capture, storage, and / or redistribution. DEQ has provided LID guidance designed to help communities address post-construction stormwater runoff[28].

### E.6.1 Provide Structural Stormwater Control(s) for Each Drainage Basin

Divide the site into drainage basins, such that all post-construction stormwater runoff generated by the water quality storm event from each drainage basin will be infiltrated and/or treated by a structural stormwater control, suited to treat the constituents of concern prior to being discharged from the project site. If a structural stormwater control exists onsite, consider retrofitting it, if necessary. Site each structural stormwater control such that it is accessible for maintenance and post-construction stormwater runoff flows to it. Demonstrate the following steps were adhered to in the design:

1. Infiltrate as much of the post-construction stormwater runoff generated by the water quality storm event as feasible, unless not recommended due to site constraints or spill potential.

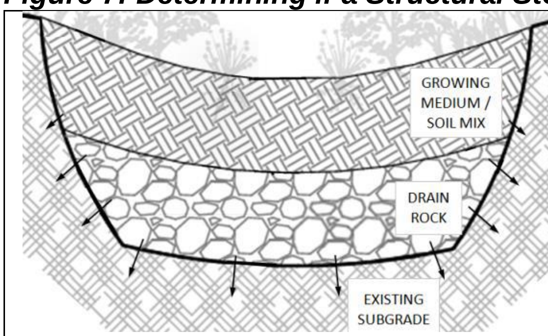
[25] https://www.oregon.gov/deq/wq/Pages/epaApprovedIR.aspx
[26] https://www.oregon.gov/deq/wq/tmdls/Pages/default.aspx
[27] https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Tools.aspx
[28] https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-LID.aspx

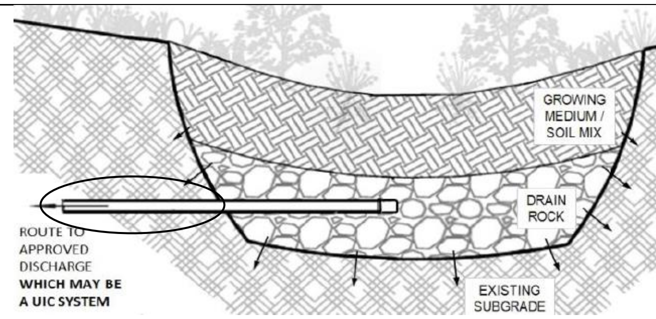
Include treatment (e.g., filtration through filter media) unless stormwater runoff has already been treated or unlikely to have contaminants (e.g., some rooftops, pedestrian-only areas). Examples of infiltration structural stormwater controls include the following:

- With treatment (e.g., bioretention basins, stormwater planters, rain gardens, bioslopes, and sand filters) and
- Without treatment (e.g., soakage trenches, french drains, and drywells).

If the structural stormwater control is deeper than its largest surface dimension, or uses piping that emplaces stormwater in subsurface soils (see Figure 7 below), the requirements of the Underground Injection Control (UIC) Program apply. UICs must be permitted in Oregon. UIC permittees are required to show that UICs are protective of groundwater. To prevent groundwater pollution, stormwater runoff directed to UICs should either 1) be from areas that are not anticipated to cause pollution or 2) be properly treated prior to discharging to the UIC. To apply for a UIC permit, contact the DEQ UIC Program[29].

***Figure 7: Determining if a Structural Stormwater Control is a UIC***




| | |
|---|---|
| This is not a UIC, since it is not deeper than it is wide and does not use piping that emplaces stormwater in subsurface soils. | If the pipe outside of the drain rock (circled above) is perforated, this is a UIC as it uses piping that emplaces stormwater in subsurface soils; otherwise this is not a UIC. |

2. For any portion of a site where post-construction stormwater runoff generated by the water quality storm event will discharge to a receiving water via pipes and/or overland flow, use vegetated structural stormwater controls if practicable (or if the local climate precludes vegetated structural stormwater controls, use unvegetated structural stormwater controls such as sand filters) and identify both the discharge location(s) and the receiving water(s). *Note that detention ponds are not considered to be a sufficient stand-alone treatment method and must be combined in series or parallel with other structural stormwater controls to form a stormwater treatment train.* Examples of structural stormwater controls that perform water quality treatment trains include:

   - Swales and filter strips[30] (e.g., vegetated swales, grassy swales, filter strips);
   - Filters (e.g., bioretention basins, stormwater planters, bioslopes, and sand filters, all with underdrains); and
   - Ponds (e.g., wet ponds, extended wet ponds, and constructed wetlands).

[29] https://www.oregon.gov/deq/wq/wqpermits/Pages/UIC.aspx
[30] Swales and filter strips also can serve as alternatives to conventional curb and gutter.

3. If site constraints prevent the above structural stormwater controls (e.g., a highly urbanized area), use proprietary devices that have a general use level designation by the Department of Washington Ecology's Technology Assessment Protocol (TAPE).[31]

### E.6.2 Water Quantity Considerations Erosion Control

The above steps are for post-construction stormwater runoff generated by the water quality storm event. Post-construction stormwater runoff generated by many different storm events (including those larger than the water quality storm event) may contribute to erosion along or within the receiving waterbody. Local jurisdictions typically require larger storm events be detained onsite and released at or below the pre-construction rate for flood control purposes. DEQ may require the applicant to evaluate, and if necessary reduce or address, the erosion impacts to receiving waters caused by post-construction stormwater runoff generated by different storm events (including those larger than the water quality storm event).

Additional DEQ permitting may be required for construction activities. NPDES permits (such as a 1200-C) are required for storm water discharges to surface waters from construction and industrial activities and municipalities if stormwater from rain or snow melt leaves a site through a "point source" and reaches surface waters either directly or through storm drainage. Please contact the DEQ Stormwater Program[32] to see if additional permits may be required for a project.

## E.7 Design the Structural Stormwater Control(s)

Demonstrate each structural stormwater control is appropriately sized and designed to protect the receiving water's designated beneficial uses and existing water quality. Provide site specific plans, cross-sections, and design details of each proposed structural stormwater control and cite any studies and any stormwater manuals followed. Unless the structural stormwater control is small, such as a rain garden for a residential house, the design should be stamped by a qualified Oregon-registered professional engineer. For small rain gardens, see the 2010 Oregon Rain Garden Guide (Sea Grant, Oregon[33]). See Appendix F.4 for example details of some post-construction stormwater controls.

### E.7.1 Note Any Special Considerations

Design the structural stormwater control(s) for any conditions that merit special water quality considerations, including the conditions listed in Table 2, as applicable.

***Table 2: Special Considerations for Designing Structural Stormwater Controls***

| *Condition* | *Special water quality consideration* |
|---|---|
| Shallow groundwater | — Locate outlets above the highest anticipated seasonal groundwater.<br>— Size structural stormwater controls assuming groundwater is at its highest anticipated seasonal elevation.<br>— Size infiltration structural stormwater controls such that there is sufficient depth to groundwater to facilitate drainage (e.g., soil pore storage volume ≥ volume of stormwater designed to infiltrate). |

[31] http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html
[32] https://www.oregon.gov/deq/wq/wqpermits/Pages/Stormwater.aspx
[33] https://seagrant.oregonstate.edu/sgpubs/oregon-rain-garden-guide

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| Water quality limited for temperature | — Shade areas designed for standing water.<br>— Limit exposure of the discharge to heated surfaces such as rip rap.<br>— Preferably infiltrate, evapotranspirate, or reuse the 2-year, 24-hour summertime storm event.<br>— Utilize shade modeling (e.g. Heat Source) as needed to demonstrate sufficient treatment. |
| Water quality limited for bacteria/ Pathogens | — Avoid ponds and swales as the final step in the treatment train.<br>— Provide best management practices (BMPs) to limit bacteria sources (e.g., discourage waterfowl, encourage pet waste pickup). |
| Water quality limited for algae, nitrogen, phosphorus, or dissolved oxygen | — Avoid underdrains below nutrient-leaching filter media that discharge to surface waters.<br>— Consider including subsurface storage.<br>— Consider providing a longer residence time. |
| Floodplain | — Stabilize or remove accumulated sediment before flood events. |
| Cold climate | — Avoid ponds and swales in areas with frequent ice or snow events. |
| Saline/brackish waters | — Limit direct freshwater discharges. |
| Low hardness[34] | — Provide additional treatment, such as a longer residence time. |
| Avoided wetlands | — Preserve hydrology and functions of wetlands to remain on site. |

### E.7.2 Appropriately Size the Structural Stormwater Control(s)

Design each structural stormwater control to ensure it functions for a specified volume and/or rate.

Additional design considerations should include:

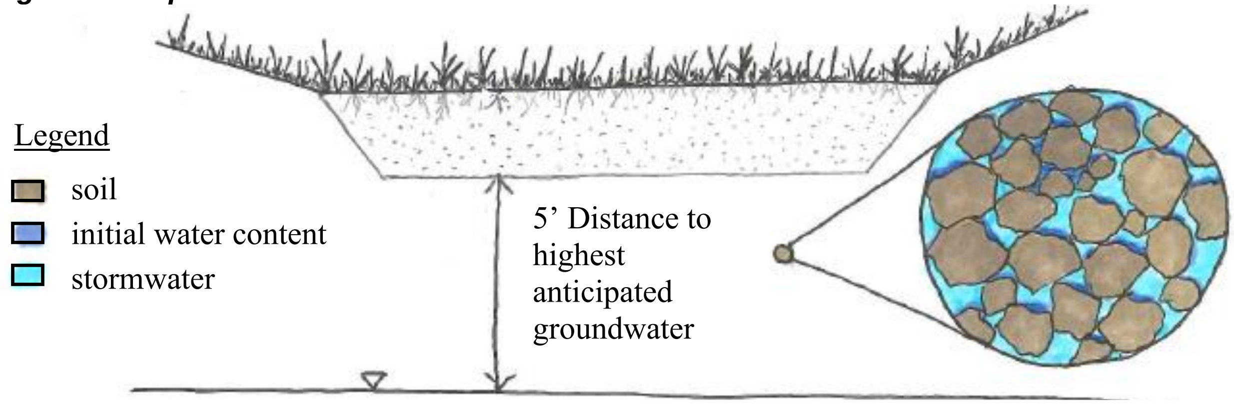
- Protection of public safety (e.g., has adequate freeboard, is fenced or avoids standing water for extended periods and has no retaining walls, has overflow for the 100-year storm event);
- Avoiding creation of mosquito breeding habitat (e.g., fully drains within 72 hours) if feasible or manage to prevent mosquitoes (e.g., stocking with mosquito fish, removing cattails); and
- Treating the water quality design storm event and accommodating the subsequent storm event, when groundwater is at its highest anticipated seasonal level.

#### E.7.2.1 Additional Sizing Requirements for Infiltration Structural Stormwater Controls

The bottom of the structural stormwater control should be sufficiently above the highest anticipated seasonal groundwater to facilitate drainage. Generally, the volume of post-construction stormwater runoff the structural stormwater control is designed to infiltrate should not exceed the storage volume within the soil pores of the subgrade (see Figure 8 below).

[34] Note that freshwaters in coastal basins and the Cascades tend to have especially low hardness.

***Figure 8: Depth to Groundwater for Infiltration Structural Stormwater Controls***




**E.7.3 Design the Components of the Structural Stormwater Control**

Do not use toxic substances in the design of the structural stormwater control (e.g., do not include chemically treated railroad ties and lumber, recycled crushed asphalt, copper, or galvanized metals). Design to local requirements and the plumbing code, where applicable.

E.7.3.1 Route and Possibly Pre-treat Stormwater Runoff into the Structural Stormwater Control

Route post-construction stormwater runoff from the Contributing Impervious Area (CIA) to the structural stormwater control(s):

- Consider swales or filter strips, in lieu of “curb and gutter” systems.
- Consider installing a gross pollutant trap to collect sediment, trash and debris.
- Consider providing a settling basin to remove coarse sediment and debris.
- Consider bypassing large flows to minimize erosion and wash-out of contaminants.
- Design any inlet to ensure stormwater runoff enters the structural stormwater control.
- Either grade to ensure sheet flow to the structural stormwater control (required for filter strips), distribute the inflow[35] or provide energy dissipation[36] for erosion control.

E.7.3.2 Select the Vegetation

Develop a planting plan for the entire structural stormwater control; vegetation should:

- Not be dormant in the wet season.
- Be from a native species palette.
- Be consistent with local jurisdiction height requirements for visibility and safety.
- Preferably target the constituents of concern.
- Be suitable for the post-construction environment, including the wet and dry zones of the structural stormwater control (based on the bottom of any outlets or the top of any check dams) such that minimal maintenance is required and long-term irrigation is not required.

E.7.3.3 Design Filter Media (for structural stormwater controls that include filtration)

Add the appropriate thickness of a filter media (e.g., growing media). Onsite soils may be used if suitable and clean; otherwise import clean soils or amend soils in place (e.g., tilling in compost or sand). This filter media should:

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[35] Examples of flow distribution include a level spreader, filter strip, or grading.
[36] Examples of erosion control include rock, a concrete splash pad, or a riprap stilling basin.

- Be capable of supporting plant growth (for vegetated structural stormwater controls).
- Preferably target the constituents of concern.
- Not be over-fertilized (test prior to applying fertilizer or compost).
- Have sufficient long-term infiltration capacity to accommodate the design capacity.

#### E.7.3.4 Determine the Type and Thickness of Any Drainage Layer

Except for structural stormwater controls and filter strips in well-drained soils, include a drainage layer (e.g. drain rock) for structural stormwater controls that include filtration, to prevent ponding in flow rate-based structural stormwater controls with shallow slopes and/or to provide subsurface storage. If a drainage layer is used, a separation layer (e.g., aggregate) should divide the filter media from the drainage layer.

#### E.7.3.5 Determine Whether Underdrains and Drain Pipe are Needed

Determine if a drain pipe is necessary within the drainage layer and if it needs to serve as an underdrain (i.e., connect to a system that discharges offsite). Underdrains below nutrient-leaching filter media should not discharge to waters with listed nutrient impairments.

- Choose an appropriate diameter pipe to accommodate the flow.
- Include observation well(s)/cleanout(s).
- Consider installing a valve on the drain pipe near the downgradient end so that water may be retained during the dry season for vegetation and drained as needed.

#### E.7.3.6 Determine the Type of Liner, if Needed

Provide a liner only if the groundwater table is less than 5 feet from the surface or if lined structural stormwater controls are required by local jurisdiction.

#### E.7.3.7 Consider Stormwater Runoff Routing and Containment

Consider how post-construction stormwater runoff within the structural stormwater control will be contained and routed. Consider check dams or baffles to slow the flow of stormwater runoff.

- Check dams should be integrated into the grading, installed perpendicular to the flow path and include an orifice for low flows and to minimize long-term ponding.
- Check local manuals to ensure adequate freeboard.
- Slopes should not be greater that 3:1 (except for stormwater planters).

#### E.7.3.8 Outflow

Provide an outlet unless the structural stormwater control is designed to infiltrate all of the post-construction stormwater runoff that can enter through the inlet (including any storms larger than the water quality storm event up to the 10-year, 24-hour storm event, if these can enter through the inlet). Consider the following:

- Provide conveyance for the 100-year storm event, considering public safety.
- Either distribute the outflow or provide energy dissipation.[37]
- Provide a screen (e.g., trash rack) on outfalls.

[37] Examples of energy dissipation include riprap, energy dissipaters, or orienting the discharge pipe to prevent erosion on the opposite bank (when discharging to a channel).

- Set the invert elevation of the outlet such that the post-construction stormwater runoff generated by the water quality storm event in the drainage basin either does not discharge through it or discharges only after receiving adequate treatment.
- Size the outflow pipe to ensure an adequate residence time, if applicable.

#### E.7.3.9 Access

Maintenance access shall be provided to the structural stormwater control.

For underground detention, provide access to the upstream side of any outlets from underground detention.

To prevent public access and protect public safety, fencing may be needed (e.g., if there are retaining walls, steep slopes, and/or standing water for more than 24 hours).
Any fencing near a wildlife corridor should be wildlife-friendly.

## E.8 Post-Construction Structural Stormwater Control Protection

Construction methods can impact the longevity of structural stormwater controls. Clearly explain how each structural stormwater control will be constructed. Within 30-days following completion of construction, submit as-built design plans to DEQ.

### E.8.1 Delineate Structural Stormwater Controls

Describe how areas proposed to be structural stormwater controls will be clearly marked off (e.g., with orange constructing fencing or a covering) before site work begins to prevent compaction. Do not allow staging areas or vehicles (except those specifically authorized to construct the structural stormwater control) within 10 feet of areas proposed to be infiltration structural stormwater controls.

### E.8.2 Prevent Sediment Inundation

Prevent structural stormwater controls from being inundated with sediment from construction. Remove any construction-related sediment from all structural stormwater controls.

### E.8.3 Prevent Sedimentation in Facilities

Protect any exposed areas of structural stormwater controls (e.g., with jute matting, tackified mulches (in low velocity areas), biodegradable blankets or nets, or turf reinforcement mats) until plants have become fully established. Plants must be established prior to routing concentrated flows to the structural stormwater control.

### E.8.4 Provide Post-Construction Quality Assurance

After construction, check structural stormwater control elevations (including the inlets and outlets and the bottom of the structural stormwater controls), and the dimensions and slopes. For infiltration structural stormwater controls, also check the infiltration rate after construction. If the facilities have been impacted during construction, they must be ameneded and fully functional prior to construction barricade removal.

### E.8.5 Establish Plants for Long-Term Success

Salvage onsite plants for later planting, as appropriate, and prepare the site prior to planting. Schedule planting during the growth season and time seeding to avoid rain wash-off. Install an irrigation system only if necessary to establish plants and remove any irrigation system after plants are established.

# E.9 Provide an Operations and Maintenance Plan

Provide an operations and maintenance plan that identifies the location of all structural stormwater facilities and includes the items described below:

### E.9.1 Best Management Practices (BMPs) at the Site

Describe BMPs used to reduce pollution at the source (e.g., pet waste pickup, roof-covered community garbage cans, a street sweeping schedule).

### E.9.2 Structural Stormwater Control Upkeep

Provide an inspection schedule that includes an annual inspection in the spring, fall and after large storm events. The plan should describe the following items, as appropriate.

#### E.9.2.1 Debris and Sediment Removal

Remove sediment build-up (e.g., clogged inlets/outlets, pretreatment areas, splash pads) and remove trash, leaf litter, and other debris. Consider sending clippings to a composting facility.

#### E.9.2.2 Vegetation Maintenance (for vegetated structural stormwater controls)

Remove invasive plants (e.g., Himalayan blackberry). Weed the structural stormwater control, minimizing pesticides and herbicides. Reseed bare areas and replace dead plants semi-annually.

#### E.9.2.3 Replace Filter Media (if used)

Periodically check for standing water after storms to determine if the filter media is clogged. Conduct infiltration tests and replace the filter media, as needed.

#### E.9.2.4 Check for Operational Problems and Damages

Repair damaged surfaces (e.g. damaged by erosion, rodents, tree roots), correct operational problems (e.g., rill formation), and, if there are embankments, check for embankment stability issues (e.g., cracking, leaking).

#### E.9.2.5 Other

Clean and flush risers, as needed. Provide mosquito control as needed if the structural stormwater control has standing water for four or more days.

### E.9.3 Identify Prohibited Activities

Prohibit heavy equipment and stockpiling materials in infiltration structural stormwater controls. Prohibit applying sealcoats to, stockpiling materials in, and routing stormwater runoff to porous pavement.

### E.9.4 Identify Maintenance Responsibility

Operation and maintenance responsibility must be assigned to an existing person or entity. Provide the name and contact information and the process for transferring maintenance responsibility in the future (e.g., delegated to homeowners associations, or contracted out to management entities). The applicant is responsible for maintenance unless documentation is provided to DEQ that demonstrates another entity has agreed to be the responsible party.

# F. Appendices

# F.1 Glossary

**2-year, 24-hour precipitation:** The amount of rainfall over a 24-hour period that has a 50% probability of occurring in a given year. The 2-year, 24 hour precipitation can be found using the NOAA Atlas 2 Precipitation Frequency Estimates[38] or the ODOT Precipitation Data Viewer[39].

**10-year, 24-hour storm event:** The amount of rainfall over a 24-hour period that has a 10% probability of occurring in a given year.

**401 Water Quality Certification (WQC):** A determination made by DEQ that a dredge and fill activity, private hydropower facility, or other federally licensed or permitted activity that may result in a discharge to waters of the state has adequate terms and conditions to meet state water quality standards and other applicable water quality laws. The federal permit in question may not be issued without this state determination in accordance with the Federal Clean Water Act, section 401 (33 USC 1341).[40]

**Amend:** The process of adding material to the soil or growing media to improve its characteristics for plant growth, water quality treatment, or infiltration purposes.

**Amendment:** The material added to the soil or growing media to improve its characteristics for plant growth, water quality treatment, or infiltration purposes.

**Baffle:** A structure designed to slow and/or redirect flow within a structural stormwater control.

**Best Management Practices (BMPs):** Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of "waters of the United States." BMPs also include treatment requirements, operating procedures, and practices to control [project] site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.[41]

**Bioretention Basin:** A structural stormwater control that is comprised of a shallow, landscaped depression with growing media and vegetation that allows stormwater runoff to pond in a designated area, then filter through the filter media (e.g., growing media) and vegetation and possibly infiltrate to groundwater. Small-scale bioretention basins are also known as rain gardens.[42] See Appendix F.4 for example details of bioretention basins.

**Bioslope:** A structural stormwater control that is comprised of a trench filled with aggregate at the top, filter media in the middle, and a drain layer at the bottom. Bioslopes are typically preceded by filter strips that provide pretreatment. See Appendix F.4 for a design detail of a bioslope.

**Check Dam:** A small dam or weir located across an open channel within a structural stormwater control to slow down the flow.

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[38] http://www.nws.noaa.gov/ohd/hdsc/noaaatlas2
[39] https://gis.odot.state.or.us/transgis/
[40] From the Clean Water Act Section 401 and OAR 340-041-0002(1)
[41] 40 Code of Federal Regulations 122.2.
[42] From EPA's website https://www.epa.gov/greeningepa/stormwater-management-practices-epa-facilities

**Cistern:** A container to which stormwater runoff is directed and stored for later use. Cisterns are generally for larger applications than rain barrels. See also the definition for "Rain Barrel".

**Cleanout:** A pipe fitting that allows access to a pipe for maintenance purposes (e.g., inspecting and clearing clogs).

**Combination rate/volume-based structural stormwater control:** A structural stormwater control where there is a combination of ponding and flow-through (e.g., filtering through media). Examples include stormwater planters, bioretention basins, rain gardens, and sand filters.

**Compost:** A substance derived primarily or entirely from the decomposition of vegetative or animal organic material that is distributed for the purpose of promoting or stimulating plant growth and to which no fertilizer, agricultural amendment, agricultural mineral or lime product is added other than to promote decomposition.[43]

**Concentrated Flow:** Stormwater runoff that has converged and accumulated.

**Constructed Wetlands:** A structural stormwater control designed to mimic natural wetlands, with growing media and vegetation that provides for standing water or saturated conditions within a foot of the ground surface.

**Contained Planter:** A vegetated container placed over impervious surface.

**Contributing Impervious Area (CIA):** All impervious surface areas within the project boundaries plus impervious surface areas owned or managed by the same entity from which stormwater runs overland or via discrete conveyance (e.g., piped) to an area within the project boundaries. The area outside of the project boundaries that is considered to be part of the CIA may be negotiated for public works projects if necessary to make the project economically feasible.

**Designated Beneficial Use:** The purpose or benefit to be derived from a water body as designated by the Water Resources Department or the Water Resources Commission.[44] See Appendix F.3 for a list of designated beneficial uses.

**Detention Pond:** A structural stormwater control that is comprised of a depression that stores and slowly releases stormwater runoff.

**Drainage Basin:** All of the area that contributes post-construction stormwater runoff to the structural stormwater control.

**Drywell:** A structural stormwater control that is comprised of a deep, vertical underground structure with perforations that stores stormwater runoff until it can infiltrate out the sides.[45]

**Ecoroof:** A type of rooftop that includes vegetated growing media over a drainage layer all overlying a waterproof membrane to protect the roof.

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[43] ORS 633.311(5)
[44] OAR 340-041-0002(17)
[45] DEQ 2015 Fact Sheet Identifying an Underground Injection Control http://www.oregon.gov/deq/FilterDocs/IDswInjSysFS.pdf

**Energy Dissipation:** A design feature to prevent erosion from stormwater runoff.

**Erosion:** The movement of soil particles or rock fragments by water or wind.

**Evapotranspirate:** Evaporation from surfaces (e.g., soils, water surfaces, and vegetative surfaces) plus transpiration through vegetative surfaces (e.g., leaves).

**Extended Wet Pond:** A structural stormwater control that is comprised of a depression that provides a permanent pool of water with growing media and vegetation and an outlet. Extended wet ponds are wet ponds that have additional storage above the permanent pool of water to meet flow control requirements for storm events larger than the water quality storm event.

**Feasible:** Technologically possible and economically practicable and achievable in light of best industry practices.

**Filter Strip:** A structural stormwater control that is comprised of gently sloping dense vegetation that receives sheet flow from impervious surfaces. See Appendix F.4 for an example detail of a filter strip.

**Filtration:** The physical straining of suspended particles (and pollutants that adhere to these particles) in stormwater runoff through filter media (e.g., growing media). The size of the voids in the filter media and the rate of flow impact the size and shape of the particles that will be filtered. Filtration can also provide opportunities for sorption processes to occur, reducing dissolved and fine suspended constituents. Filtration can often be an effective preliminary treatment for stormwater, by increasing the longevity of downstream BMPs and reducing maintenance frequency. Filtration removes particulate matter either on the surface of the filter or within the pore space of the filter. Filtration such as a sand filter can provide the added benefit of removing stormwater constituents that may be attached to solids such as metals and bacteria.

**First Flush Event:** The initial stormwater runoff with a higher pollutant concentration than stormwater runoff later in the storm event. For purposes of determining the water quality event, the "first flush" event is assumed to be 0.7 inches over a 24-hour period.

**Floodplain:** An area along a waterway subject to flooding when the stream overflows its banks.

**Foundation Planter:** See the definition for "Stormwater Planter".

**Freeboard:** The vertical distance between the highest point of the structural stormwater control that is capable of fully storing water and the highest design water elevation.

**French Drain:** A structural stormwater control that is comprised of a trench filled with aggregate and a perforated pipe.

**Green Roof/Green Rooftop:** See the definition for "Ecoroof".

**Gross Pollutant Trap:** A structure that physically separates out of stormwater runoff, large pollutants (e.g., litter, debris, coarse sediment) and/or pollutants less dense than water (e.g., oils, floatables). Examples include water quality manholes (with a sump) and catch basin inserts.

**Groundwater:** Water beneath the land surface where the soil is fully saturated.

**Growing Media:** A soil or other base that supports vegetation.

**Highest Anticipated Seasonal Groundwater:** The highest elevation that groundwater is anticipated to typically reach annually.

**Hydrologic Attenuation**: Achieves pollutant reduction through runoff volume reduction. Infiltration is the primary means of hydrologic attenuation for the purposes of the types of BMPs used in stormwater management. Attenuation reduces the pollutant load discharged to surface waters, but does not necessarily reduce pollutant concentrations. Infiltration includes several different treatment mechanisms. Processes such as sorption, filtration, and microbial degradation occur as runoff infiltrates through the soil matrix.

**Impervious Surface:** Any surface resulting from development activities that prevents the infiltration of water or results in more stormwater runoff than in the undeveloped condition. Common impervious surfaces include building roofs; traditional concrete or asphalt paving on walkways, driveways, and parking lots; gravel lots and roads; and packed earthen materials.

**Infiltration:** Flow of rainfall or stormwater runoff into the soil through soil pores.

**Infiltration Rate:** The velocity at which stormwater runoff flows into the soil through soil pores.

**Infiltration Structural Stormwater Control:** A structural stormwater control designed to infiltrate stormwater into the soil beneath the structural stormwater control.

**Level Spreader:** A design feature to evenly distribute stormwater runoff.

**Low Impact Development (LID):** A land development approach that mimics natural hydrology by preserving natural resources and infiltrating stormwater runoff close to where it falls.

**Microbially Mediated Transformation**: Microbial activity promotes or catalyzes redox reactions and transformations including degradation of organic and inorganic pollutants and immobilization of metals. Bacteria, algae, and fungi present in the soil or water column are primarily responsible for the transformations. Stormwater treatment that incorporates vegetation or permanent water pools usually has a diverse microbial population. These transformations can remove dissolved nitrogen species, metals, and simple and complex organic compounds. Soils may be inoculated with desirable microbes to promote specific reactions.

**Minimize:** Reduce and/or eliminate, or both, to the extent achievable using control measures (including best management practices) that are technologically available and economically practicable and achievable in light of best industry practice.

**Natural Buffer:** An area of undisturbed natural cover surrounding surface waters within which construction activities are restricted. Natural cover includes the natural vegetation, exposed rock, and barren ground that existed prior to commencement of earth-disturbing activities.

**Nutrients:** Substances necessary for the growth and maintenance of life; notably nitrogen and phosphorus.

**Observation Well:** A well (e.g. pipe) that allows subsurface drainage to be monitored.

**Pollution:** Such alteration of the physical, chemical or biological properties of any waters of the state, including change in temperature, taste, color, turbidity, silt or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive or other substance into any waters of the state, which will or tends to, either by itself or in connection with any other substance, create a public nuisance or which will or tends to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational or other legitimate beneficial uses or to livestock, wildlife, fish or other aquatic life or the habitat thereof.[46]

**Porous Pavement:** Also known as permeable pavement. This is a special type of pavement that allows rainwater and snowmelt to pass through it, thereby reducing the stormwater runoff from a site. In addition, porous pavement filters some pollutants from the infiltrated rainwater and snowmelt. Porous pavement includes porous asphalt and pervious concrete.[47]

**Pretreatment:** Initial stormwater treatment prior to entering the main part of the structural stormwater control; this typically involves settling or screening stormwater runoff to remove coarse sediment, debris, and/or trash, thereby minimizing maintenance requirements and extending the life of the structural stormwater control.

**Rain Barrel:** A barrel to which stormwater runoff is directed and stored for later use. Rain barrels are typically for smaller applications than cisterns. See also the definition for “Cistern”.

**Rain Garden:** A “sunken garden bed” with gentle side slopes and vegetation that collects and ponds stormwater runoff and passes it through filter media (e.g., growing media). Rain gardens are small-scale bioretention areas. See Appendix F.4 for an example detail of a rain garden.

**Rainfall Intensity:** The rate at which rain falls over a given period of time. In a given storm event, the rainfall intensity will vary, as there may be short bursts of heavy rainfall.

**Rainwater Harvesting:** Collecting, storing, and using rainwater or stormwater runoff.

**Rate-Based Structural Stormwater Control:** A structural stormwater control where stormwater runoff is not ponded, but instead flows through the control. Examples include filter strips, bioslopes, and some swales (swales can also be designed as combination rate/volume based structural stormwater controls, with check dams ponding stormwater runoff).

**Receiving Water:** The waterbody into which stormwater runoff discharges.

**Redeveloped Impervious Surfaces:** The alteration of existing improved impervious surfaces that reach or expose gravels, aggregates, or soil. Redevelopment includes but is not limited to: the expansion or change of a structure footprint, reconfiguration of existing roadways, and the addition or modification of an over-water structure.

**Residence Time:** The average time it takes for stormwater runoff to travel though the structural stormwater control.

**Rill:** A shallow channel formed by concentrated flow.

[46] ORS 468B.005(5)
[47] EPA Stormwater Technology Fact Sheet- Porous Pavement, EPA 832-F-99-023

**Riser:** A vertical structure within a structural stormwater control with one or more openings that allow treated stormwater runoff to flow to the outlet pipe for discharge.

**Sand Filter:** A structural stormwater control that is comprised of a depression that temporarily stores water with sand or sand and gravel as the filter media. Vegetation is optional in a sand filter. See Appendix F.4 for an example detail of a sand filter.

**Scarify:** Loosen and make less dense near the surface.

**Sedimentation / density separation**: Density separation refers to the unit processes of sedimentation and flotation that are dependent on the density differences between the pollutant and the water to effect removal. Sedimentation is the gravitational settling of particles having a density greater than water. Flotation is similar to gravitational sedimentation except in the opposite direction. Typically, floatable materials such as trash, debris, and hydrocarbons are removed through treatment processes that utilize the location of these pollutants on the water surface for removal. Stormwater treatment that incorporates vegetation and or permanent water bodies usually has a diverse microbial population, and it is not possible to optimize conditions for all beneficial species.

**Settling Basin:** A structural stormwater control that is comprised of a depression to collect stormwater runoff and slow it down sufficiently to provide the time for suspended particles in the stormwater runoff to fall through the water column by gravity and accumulate at the bottom.

**Sheet Flow:** Stormwater runoff over the surface as a uniform film of water, before it has converged into concentrated flow.

**Soakage Trench:** An excavated trench filled with aggregate that receives stormwater runoff and stores it until it infiltrates.

**Soil Pore:** Open space (i.e., voids) between soil particles.

**Soil Porosity:** The ratio of the volume of the voids in the soil (i.e., soil pore volume) to the total volume of the soil.

**Sorption**: The individual unit processes of both absorption and adsorption. Absorption is a physical process whereby a substance of one state is incorporated into another substance of a different state (e.g., liquids being absorbed by a solid or gases being absorbed by water). Adsorption is the physiochemical adherence or bonding of ions and molecules (ion exchange) onto the surface of another molecule. In stormwater treatment application, particularly for highway runoff, the primary pollutant types targeted with absorption unit processes are petroleum hydrocarbons, while adsorption processes typically target dissolved metals, nutrients, and organic toxicants such as pesticides and PAHs. Different types of filter media may provide either or both of these unit processes.

**Stormwater:** Water from precipitation or snowmelt that collects on or runs off outdoor surfaces such as buildings, roads, paved surfaces and unpaved land surfaces.[48]

**Stormwater Planter:** A structural stormwater control with vertical side slopes and a flat bottom that includes growing media and vegetation. Stormwater planters pond stormwater runoff and

[48] OAR 340-044-0005(41)

provide filtration through the filter media (e.g., growing media). See Appendix F.4 for example details of stormwater planters.

**Structural Spill Control:** A structure that contains spills so that they can be effectively cleaned up. Examples include spill control manholes and secondary containment.

**Structural Stormwater Control:** A physical feature to which stormwater runoff is directed and that is designed to infiltrate or slow down stormwater runoff. Unless all of the stormwater runoff directed to the structural stormwater control is from an area unlikely to introduce contaminants (e.g., some rooftops) the structural stormwater control should provide treatment through a combination of settling, flotation, screening, filtration, adsorption, photodegradation, microbial degradation and/or biological uptake.

**Swale:** A structural stormwater control that is comprised of a vegetated channel with a shallow slope or check dams to provide a low velocity through the channel. Grassy swales are planted with grasses; vegetated swales are planted with other vegetation. See Appendix F.4 for example details of vegetated swales.

**Time of Concentration:** The travel time from the hydraulically most distant point in the drainage basin (or the CIA) to the point of interest (i.e., the time it takes for stormwater runoff from all parts of the drainage area to contribute to flow at the point of interest). In designing structural stormwater controls, the point of interest is the inlet to the structural stormwater control.

**Total Maximum Daily Load (TMDL):** The sum of the individual WLAs for point sources and LAs for nonpoint sources and background. If [the] receiving water has only one point source discharger, the TMDL is the sum of that point source WLA plus the LAs for any nonpoint sources of pollution and natural background sources, tributaries, or adjacent segments. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure. If BMPs or other nonpoint source pollution controls make more stringent load allocations practicable, then wasteload allocations can be made less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs.[49]

**Toxic Substance:** Those pollutants or combinations of pollutants, including disease-causing agents, that after introduction to waters of the state and upon exposure, ingestion, inhalation or assimilation either directly from the environment or indirectly by ingestion through food chains will cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations in any organism or its offspring.[50]

**Underdrain:** A portion of a structural stormwater control filled with aggregate and a perforated pipe that discharges stormwater runoff to a point outside of the footprint of the structural stormwater control. Underdrains are located beneath any vegetation and growing media.

**Underground Injection Control (UIC):** A structural stormwater control that is deeper than its largest surface dimension or uses piping that emplaces stormwater in subsurface soils.

[49] OAR 340-041-0002(65)
[50] OAR 340-041-0002 (66)

**Unvegetated Structural Stormwater Control:** A structural stormwater control that does not rely on vegetation as part of the treatment process.

**Uptake / Storage**: refer to the removal of organic and inorganic constituents by plants and microbes through nutrient uptake and bioaccumulation. Nutrient uptake converts required micro- and macro-nutrients into living tissue. In addition to nutrients, various algae and wetland and terrestrial plants accumulate organic and inorganic constituents in excess of their immediate needs (bioaccumulation). The ability of plants to accumulate and store metals varies greatly. Significant metal uptake by plants will not occur unless the appropriate species are selected.

**Vegetated Structural Stormwater Control:** A structural stormwater control that relies on vegetation as part of the treatment process.

**Volume-Based Structural Stormwater Control:** A structural stormwater control that is sized to store and treat a specific volume of stormwater runoff. Examples include wet ponds, extended wet ponds, and constructed wetlands.

**Waste:** Sewage, industrial wastes, and all other liquid, gaseous, solid, radioactive, or other substances that may cause or tend to cause pollution of any water of the state.[51]

**Water Content (by Volume):** The ratio of the volume of the water in the soil to the total volume of the soil.

**Water Quality Storm Event:** The design storm event used to size structural stormwater controls. The DEQ 401 WQC Program defines this as the rainfall depth or flow rate that corresponds to eighty percent of the annual average rainfall (50% of the 2 year/24 hour storm event), or the "first flush" event, whichever is greater. See step E.1 for instructions regarding how to determine the water quality storm event.

**Waters of the State:** Lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon, and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters that do not combine or effect a junction with natural surface or underground waters) that are located wholly or partially within or bordering the state or within its jurisdiction.[52] Structural stormwater controls are not waters of the state provided they neither were originally created in waters of the state nor resulted from the impoundment of waters of the state.[53]

**Well:** A bored, drilled, driven or dug hole whose depth is greater than its largest surface dimension, an improved sinkhole, a sewage drain hole, or a subsurface fluid distribution system.[54]

**Wetlands:** Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of

[51] OAR 340-041-0002 (69)
[52] OAR 340-041-0002(72)
[53] Adapted from 40 Code of Federal Regulations 122.2
[54] OAR 340-044-0005(51)

vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.[55]

**Wet Pond:** A structural stormwater control that is comprised of a depression that provides a permanent pool of water with growing media and vegetation and an outlet. Wet ponds with extra storage above the permanent pool of water to provide flow control for storm events larger than the water quality storm event are called 'extended wet ponds'.

[55] From USACE and EPA definitions

## F.2 Designated Beneficial Uses

| Basins | Waters | Beneficial Uses | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Public Domestic Water Supply[1] | Private Domestic Water Supply[1] | Industrial Water Supply | Irrigation | Livestock Watering | Fish & Aquatic Life[2] | Wildlife & Hunting | Fishing[3] | Boating | Water Contact Recreation[3] | Aesthetic Quality | Hydro Power | Commercial Navigation & Transportation |
| Columbia River | Columbia River Mouth to RM 86 | x | x | x | x | x | x | x | x | x | x | x | | x |
| | Columbia River RM 86 to 309 | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Deschutes | Deschutes River Main Stem from Pelton | x | x | x | x | x | x | x | x | x | x | x | x | |
| | Crooked River Main Stem | x | x | x | x | x | x | x | x | x | x | x | x | |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Goose and Summer Lakes | Goose Lake | | | | | x | x | x | x | x | x | x | | |
| | Highly Alkaline & Saline Lakes | | | x | | | x | x | x | x | x | x | | |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Grand Ronde | All Basin Waters | x | x | x | x | x | x | x | x | x | x | x | x | |
| Hood | All Basin Waters | x | x | x | x | x | x | x | x | x | x | x | x | |
| John Day | All Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Klamath | Klamath River from Klamath Lake to Keno Dam | x | x | x | x | x | x | x | x | x | x | x | x | x |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Malheur Lake | Natural Lakes | | | | x | x | x | x | x | x | x | x | | |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Malheur | All Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Mid-coast | Estuaries & Adjacent Marine Waters | | | x | | | x | x | x | x | x | x | | x |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | x | |
| North-coast | Estuaries & Adjacent Marine Waters | | | x | | | x | x | x | x | x | x | | x |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Owyhee | Designated Scenic Waterway[4] | x | x | | | x | x | x | x | x | x | x | | |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Powder | All Basin Waters | x | x | x | x | x | x | x | x | x | x | x | | |
| Rogue | Rogue River Estuary & Adjacent Marine Waters | | | x | | | x | x | x | x | x | x | | x |
| | Rogue River Main Stem from Estuary to Lost | x | x | x | x | x | x | x | x | x | x | x | | x |
| | Bear Creek Main Stem | | | x | x | x | x | x | x | x | x | x | | |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | x | |
| Sandy | Streams Forming Waterfalls Near Columbia | | | | | | x | x | x | | x | x | | |
| | Bull Run River and all Tributaries | x | | | | | x | | | | | x | x | |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | x | |
| Snake River | Snake River RM 176 to 409 | x | x | x | x | x | x | x | x | x | x | x | x | x |
| South Coast | Estuaries & Adjacent Marine Waters | | | x | | | x | x | x | x | x | x | | x |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | x | |
| Umatilla | Walla Walla River Main Stem from confluence | x | x | x | x | x | x | x | x | x | x | x | | |
| | All Other Walla Walla Subbasin Waters | x | x | | x | x | x | x | x | x | x | x | x | |
| | All Other Basin Waters[5] | x | x | x | x | x | x | x | x | x | x | x | x | |
| Umpqua | Umpqua R. Estuary to Head of Tidewater & | | | x | | | x | x | x | x | x | x | | x |
| | Umpqua R. Main from head of tidewater to | x | x | x | x | x | x | x | x | x | x | x | | |
| | All Other Basin Waters | x | x | x | x | x | x | x | x | x | x | x | x | |
| Willamette | Willamette River Tributaries | x | x | x | x | x | x | x | x | x | x | x | x | |
| | Main Stem Willamette River Mouth to | x | x | x | x | x | x | x | x | x | x | x | x | x |
| | Main Stem Willamette River Willamette Falls to | x | x | x | x | x | x | x | x | x | x | x | x | x |
| | Main Stem Willamette River Newberg to Salem | x | x | x | x | x | x | x | x | x | x | x | | x |
| | Main Stem Willamette River Salem to Coast | x | x | x | x | x | x | x | x | x | x | x | | |

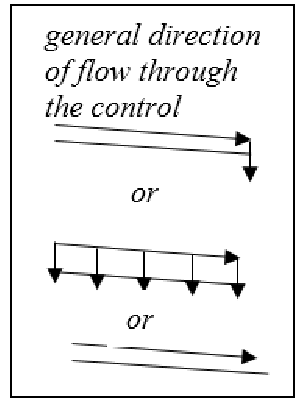
[1] With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards.
[2] See also fish use designations (http://www.oregon.gov/deq/Regulations/Pages/OARDiv41.aspx).
[3] For coastal water contact recreation and shellfish harvesting, see also Figures 220C-H, 230C-H, 300C, D and 320C from 340

[4] The mainstem of the S. F. of the Owyhee River from the Oregon-Idaho river border to Three Forks (the confluence of the N., M. and S. Forks Owyhee River) and the mainstem Owyhee River form Crooked Creek (RM 22) to the mouth of Birch Creek (RM 76).
[5] For the Willow Creek Subbasin, boating applies at the mouth of Willow Creek.
[6] In the Main Stem Willamette River Mouth to Willamette Falls, this is not to conflict with commercial activities in Portland Harbor.

# F.3 Structural Stormwater Control Examples

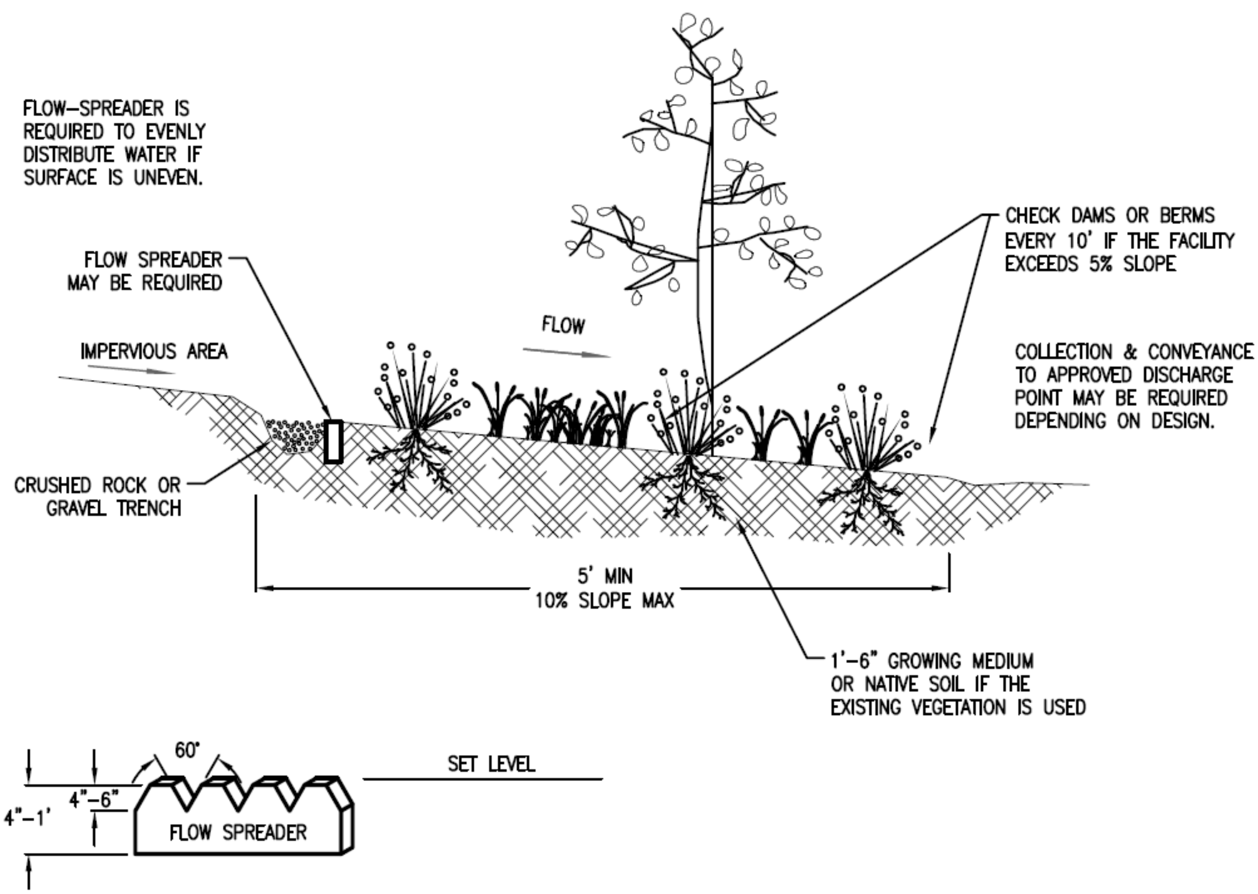
The following examples of post-construction stormwater details are a sample of types of controls found in various design manuals, but are for illustration purposes only . Provide site specific details to DEQ, not these illustraions.

## F.4.1 FLOW-RATE BASED CONTROLS



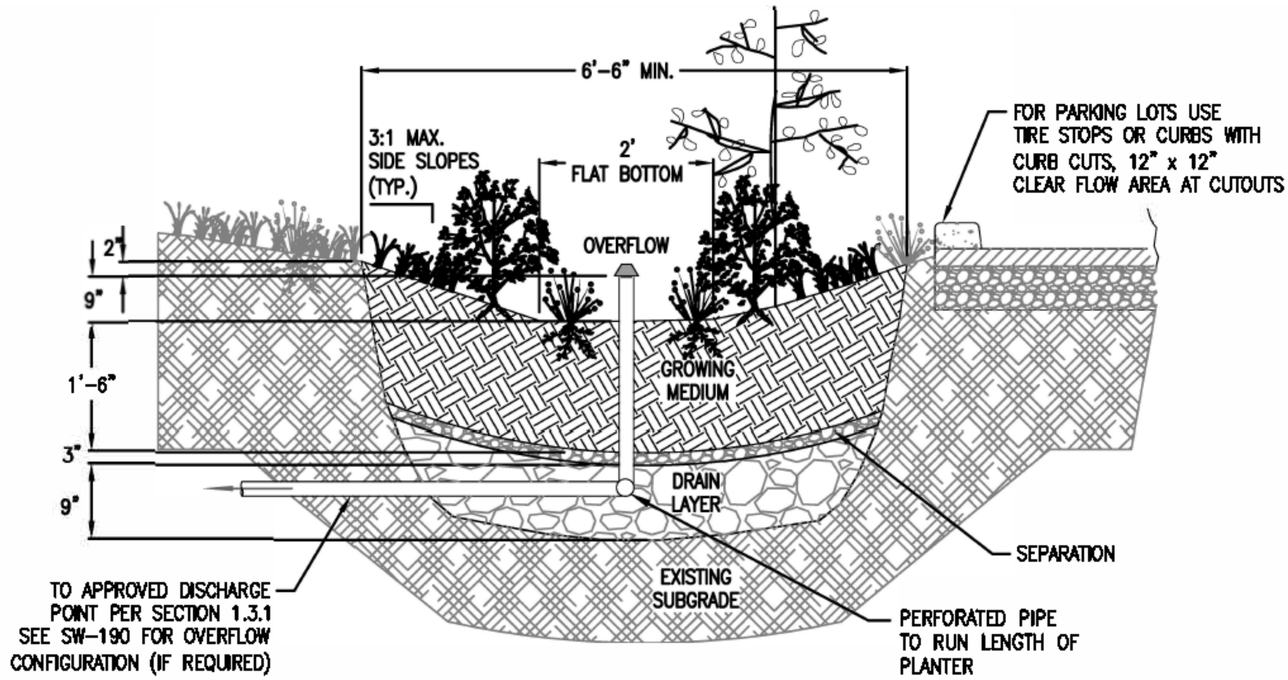

Swales, filter strips, and bioslopes are designed for stormwater runoff to flow over a sloped surface. Swales and filter strips are both fully vegetated; swales have a limited width with a long flow path within a depression while filter strips have an unlimited width, with a (usually much shorter) flow path that is not within a depression. Bioslopes are designed to have stormwater runoff flow over a filter strip and then over aggregate, which allows the water quality storm event to filter through filter media.

### 4.1.1 FILTER STRIP PROFILE[56]

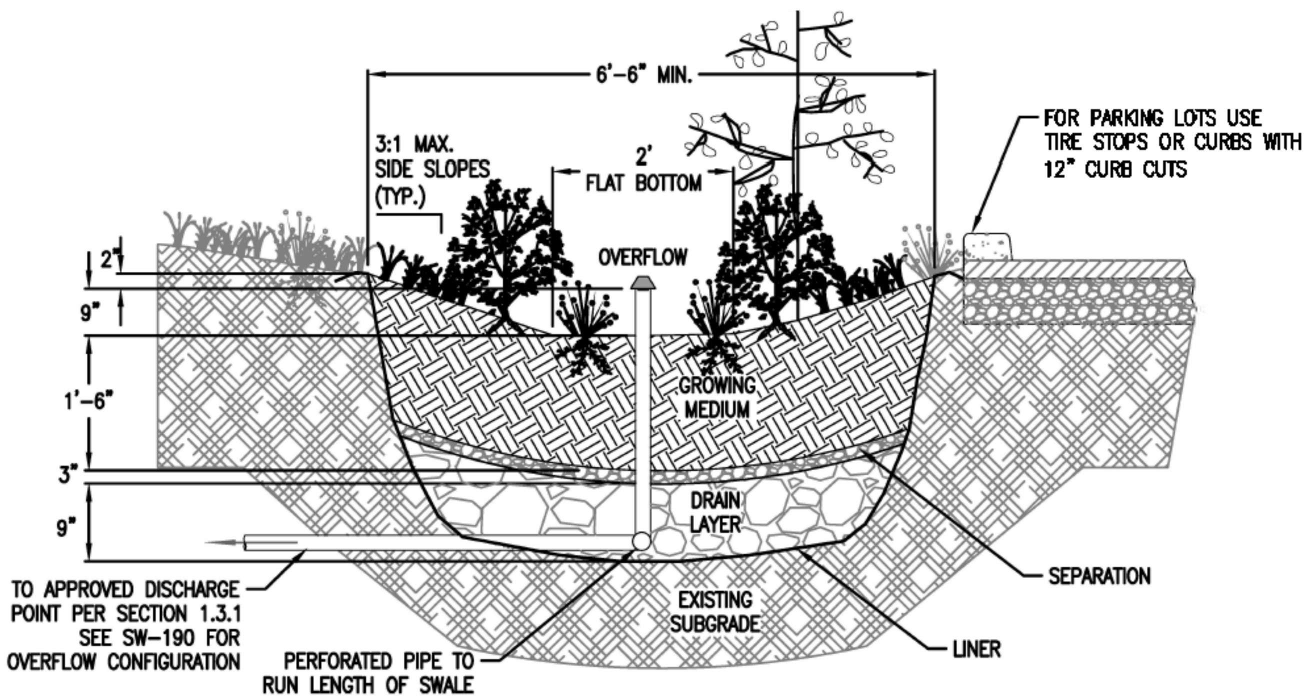



[56] City of Portland Stormwater Management Manual, 2020
https://www.portlandoregon.gov/bes/80834

## 4.1.2 UNLINED VEGETATED SWALE CROSS SECTION[57]

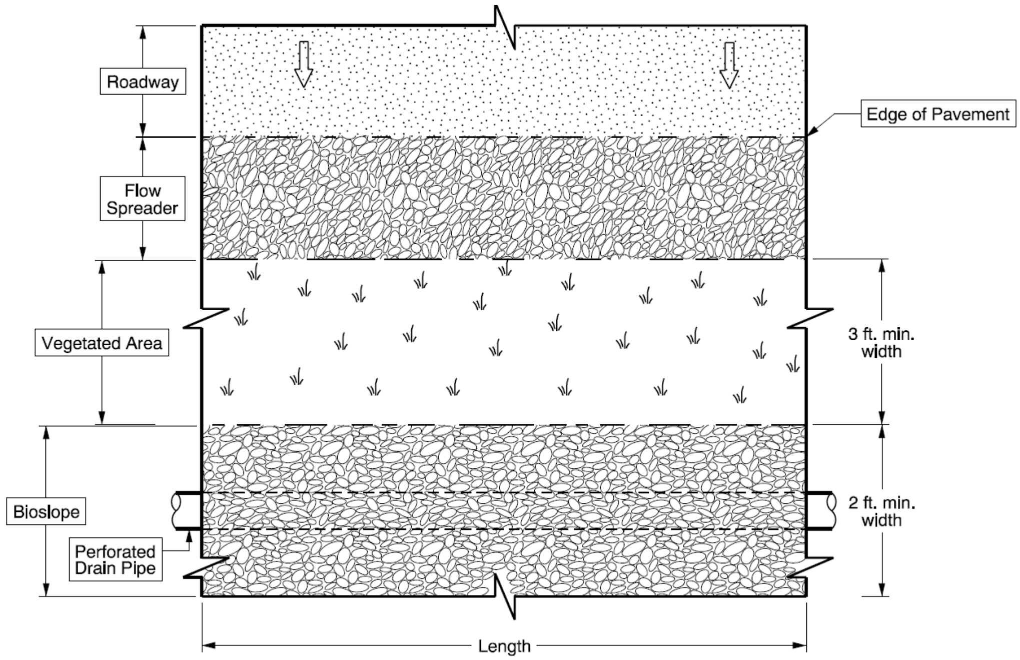



## 4.1.3 LINED VEGETATED SWALE CROSS SECTION[58]

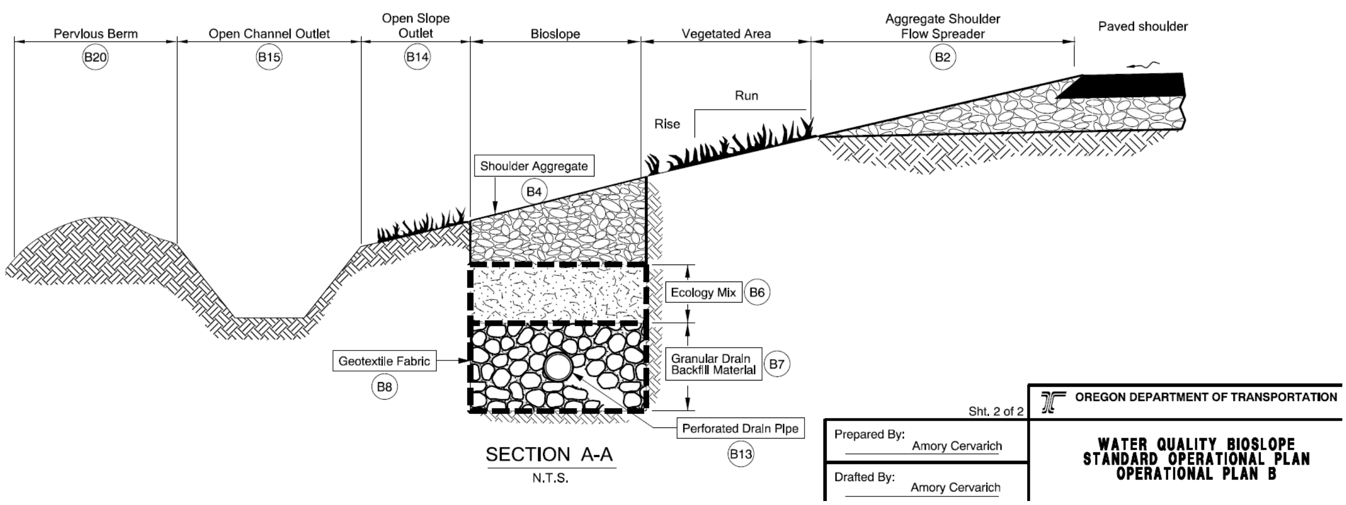



[57] [59] City of Portland Stormwater Management Manual, 2020
https://www.portlandoregon.gov/bes/80834

## 4.1.4 BIOSLOPE[59]



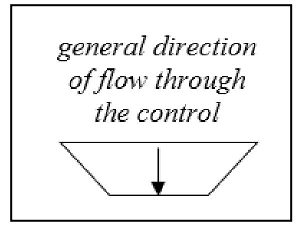

PLAN VIEW DETAIL



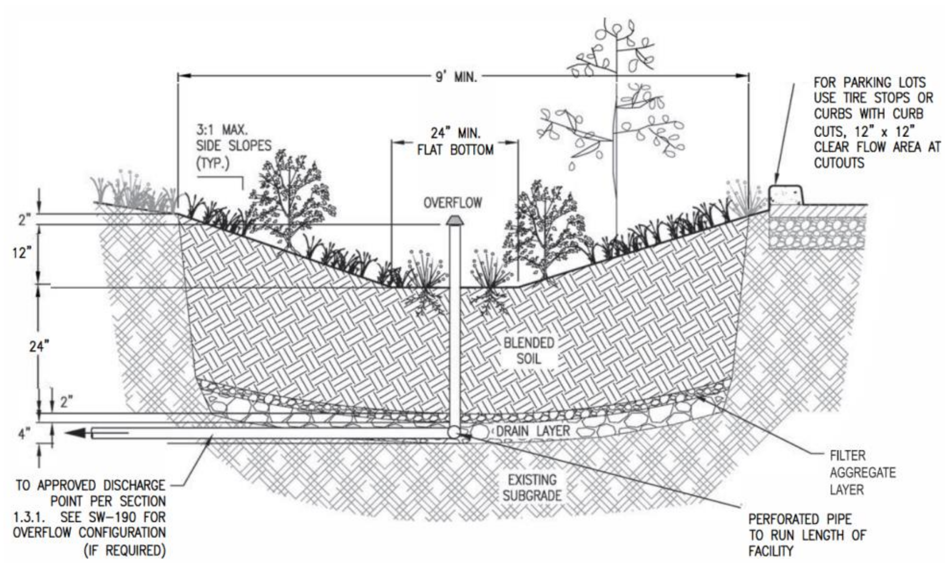

59 Oregon Department of Transportation, 2018
https://www.oregon.gov/ODOT/hydraulics/drainagefacility/DFI_D00873.pdf

## F.4.2 COMBINATION VOLUME and RATE BASED CONTROLS

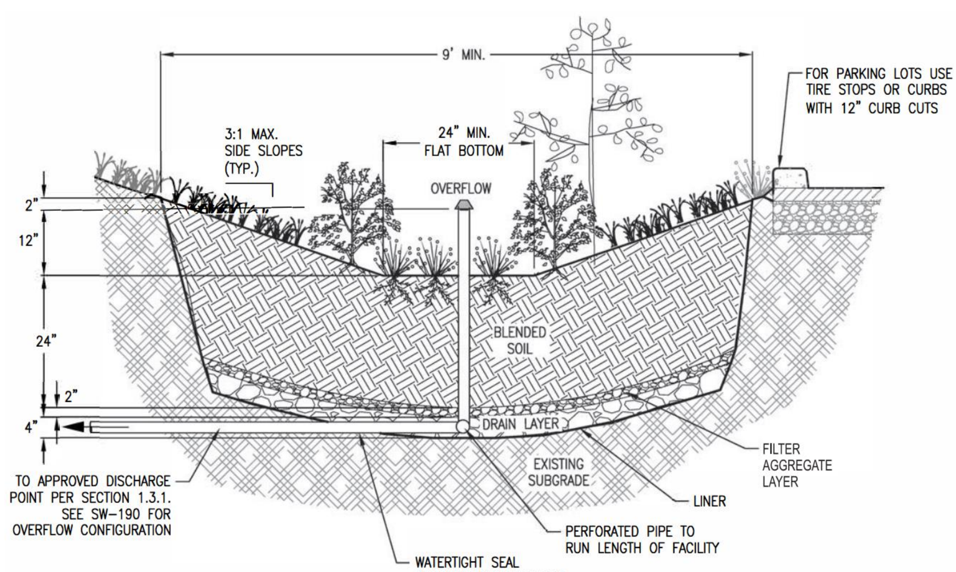
Filters are designed for stormwater runoff to pond and then filter through filter media such as a growing media or sand. Some filters allow full infiltration, some partial, and some are lined to prevent infiltration. Bioswales proposed within a bioretention basin must never be designed to overbank. If the swales cannot treat the entire storm event, then they are not considered an effective BMP.




### 4.2.1 UNLINED BIORETENTION BASIN CROSS SECTION[60]

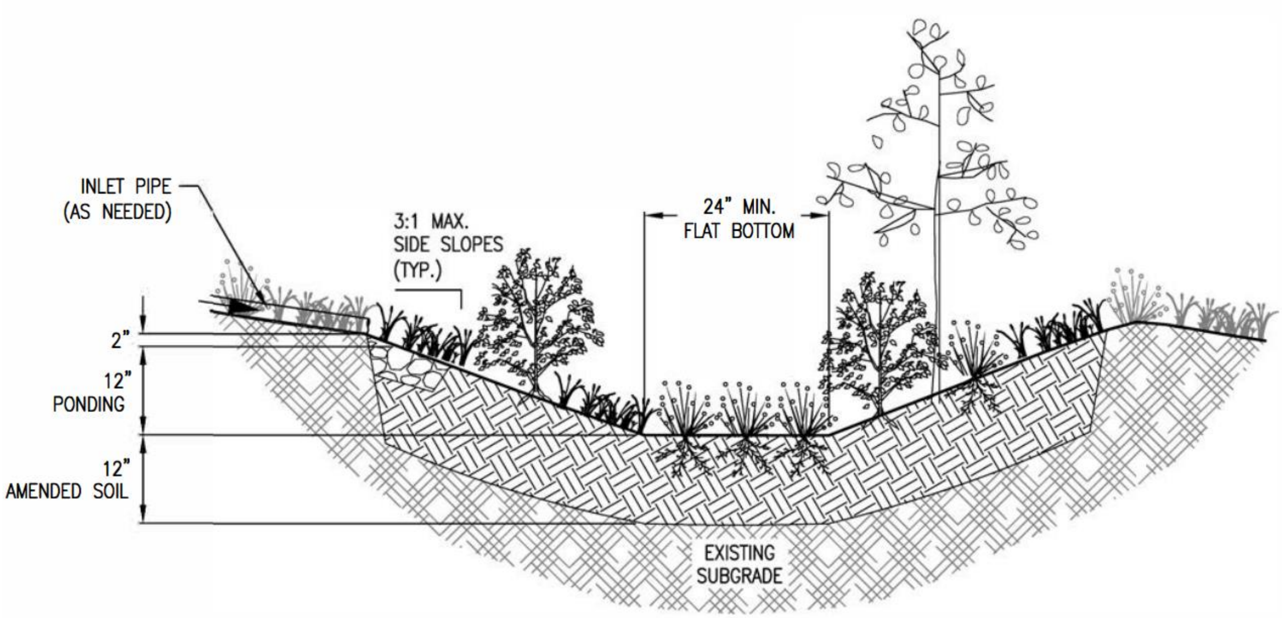



### 4.2.2. LINED BIORETENTION BASIN CROSS SECTION[61]

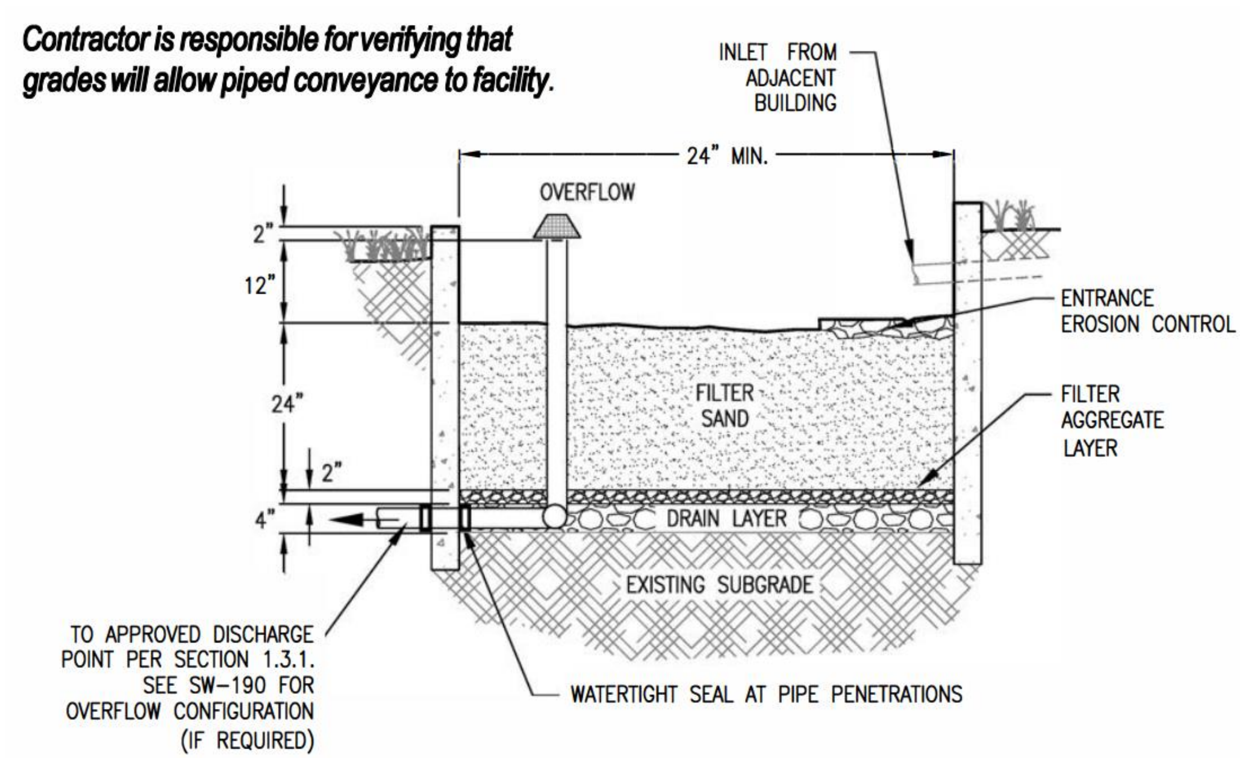



[60] [62] City of Portland Stormwater Management Manual, 2020
https://www.portlandoregon.gov/bes/80834

### 4.2.3 RAIN GARDEN CROSS SECTION[62]

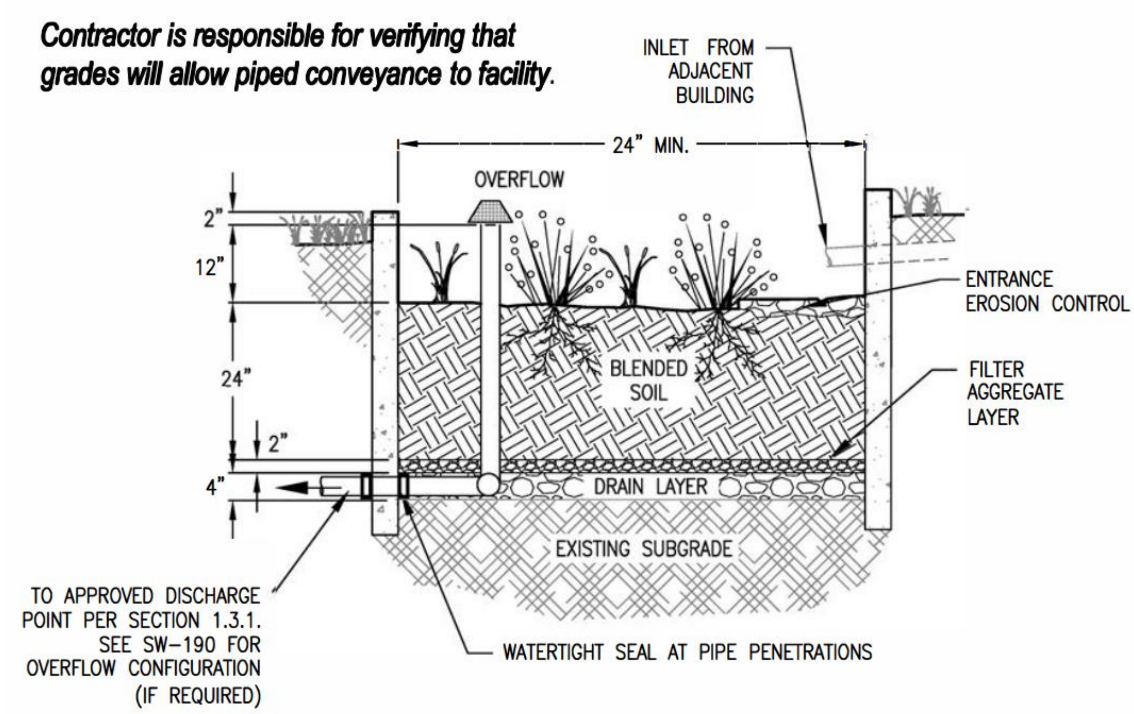



### 4.2.4 SAND FILTER CROSS SECTION[63]

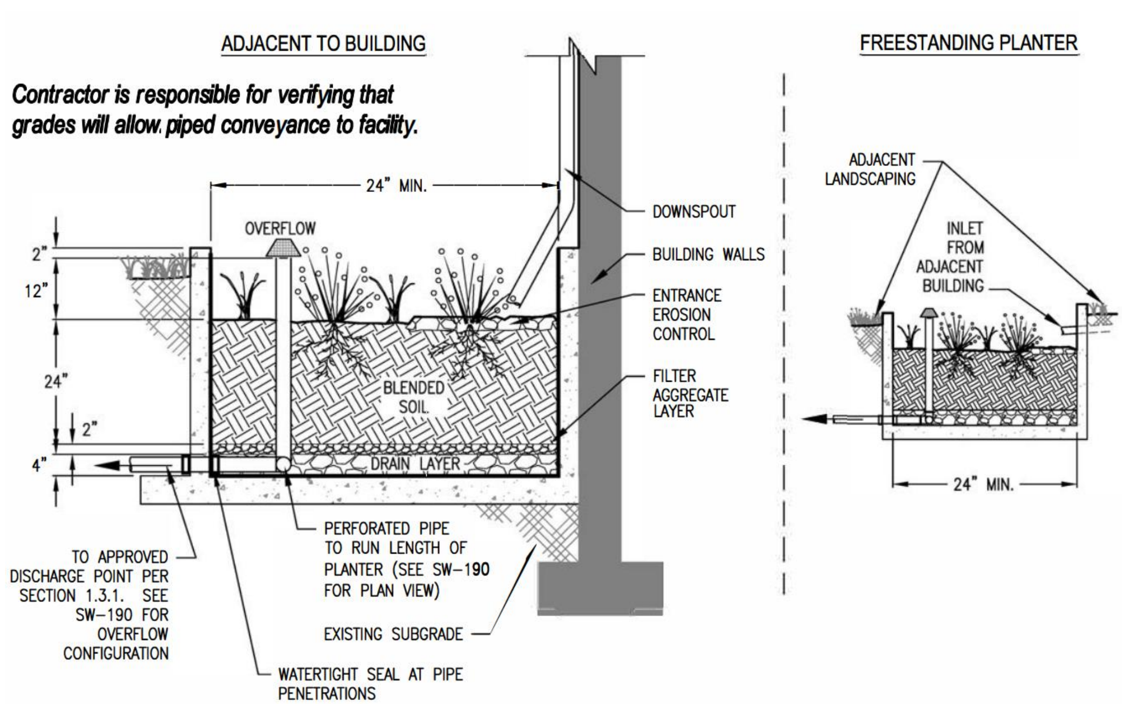



[62] [64] City of Portland Stormwater Management Manual, 2020
https://www.portlandoregon.gov/bes/80834

### 4.2.5 UNLINED STORMWATER PLANTER CROSS SECTION[64]



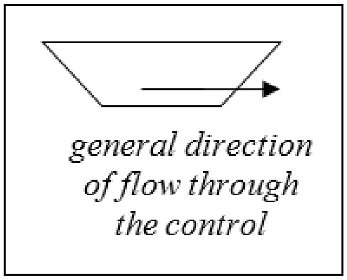

### 4.2.6 LINED STORMWATER PLANTER CROSS SECTION[65]



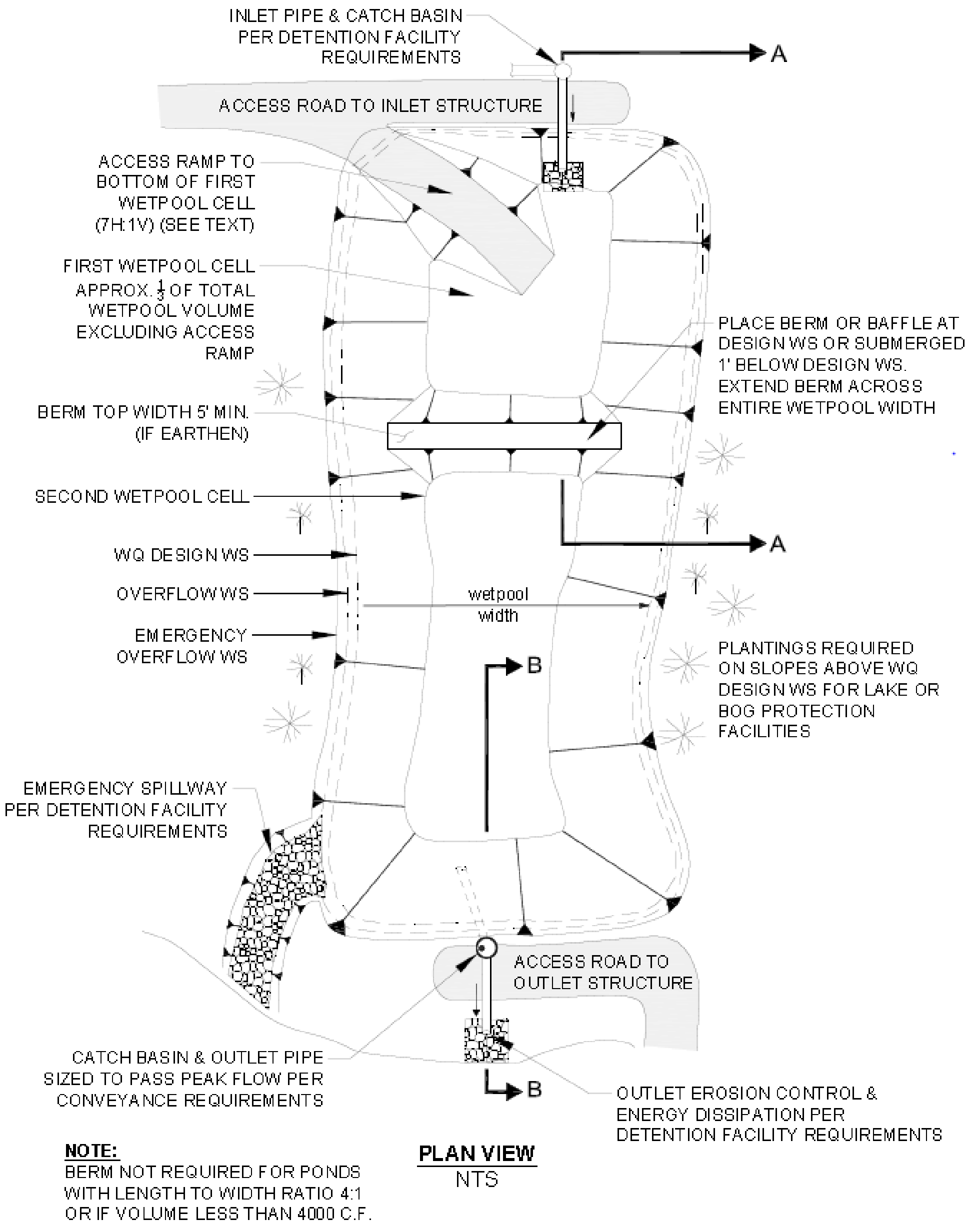

[64] [66] City of Portland Stormwater Management Manual, 2020
https://www.portlandoregon.gov/bes/80834

## F.4.3 VOLUME-BASED CONTROLS

Wetponds, extended wetponds, and wetlands are designed to store a pool of water (the water quality design storm volume) that gets displaced during storm events.




### 4.3.1 WETPOND PLAN VIEW[66]

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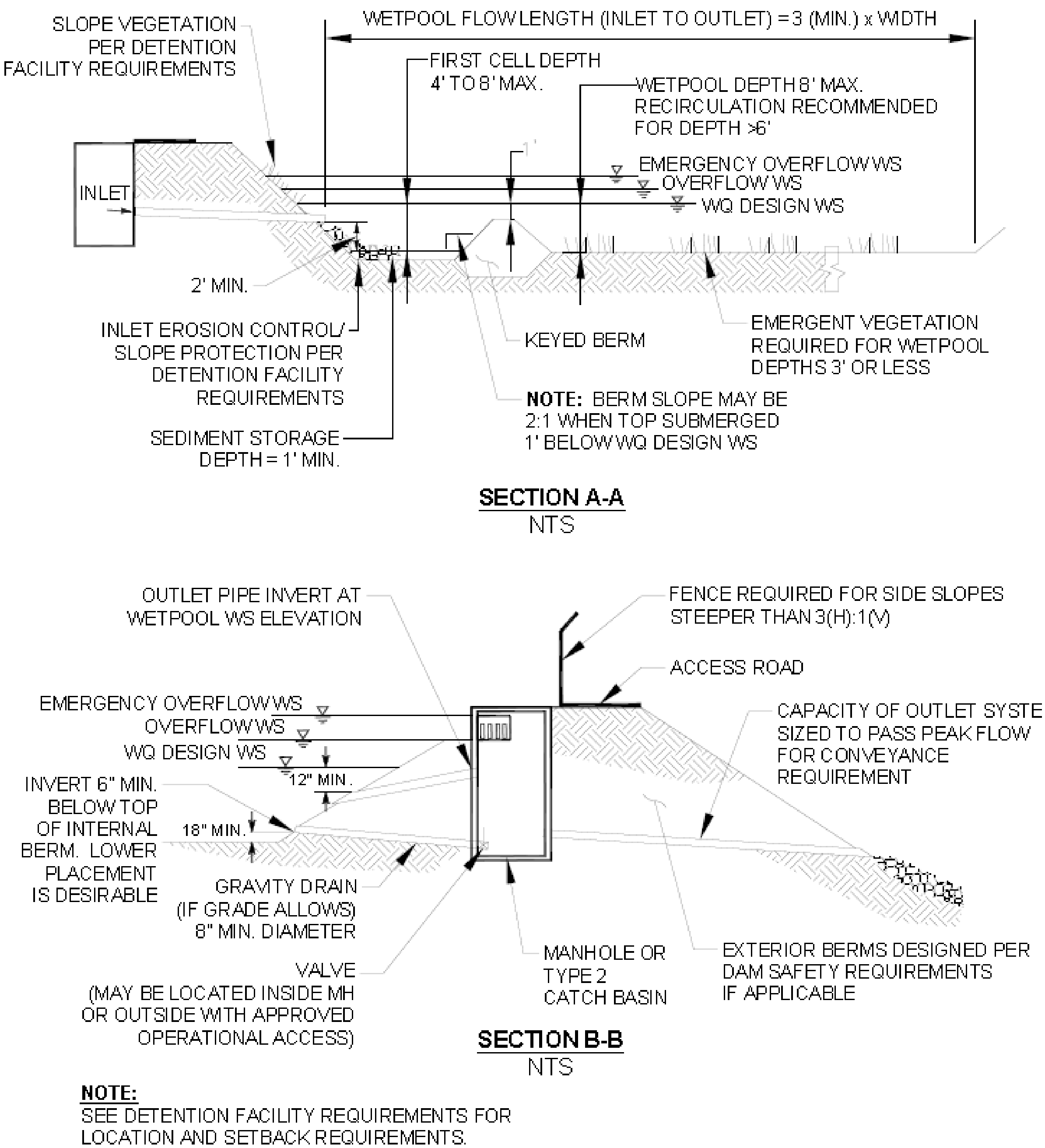
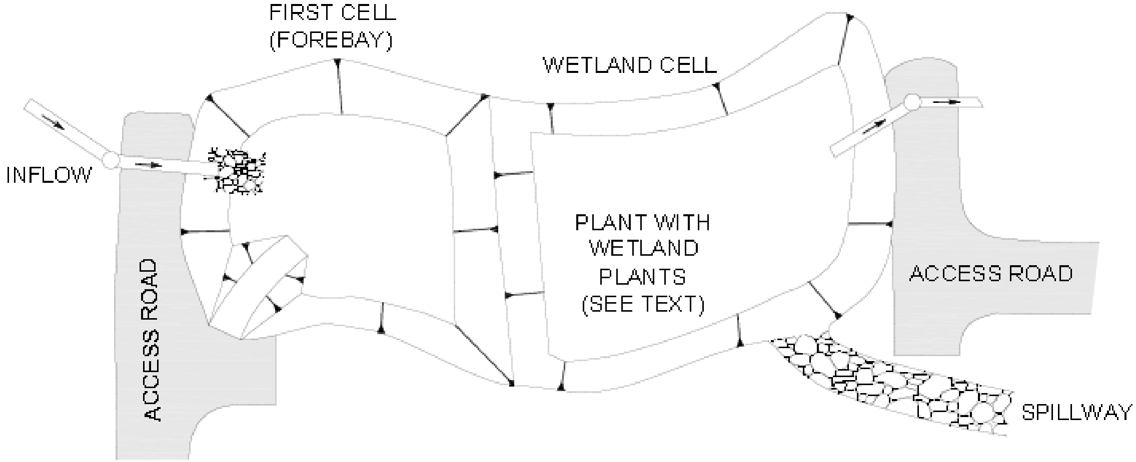
[66] King County Surface Water Design Manual, 2016 https://www.kingcounty.gov/services/environment/water-and-land/stormwater/documents/surface-water-design-manual.aspx

### 4.3.1 WETPOND CROSS SECTION[67]



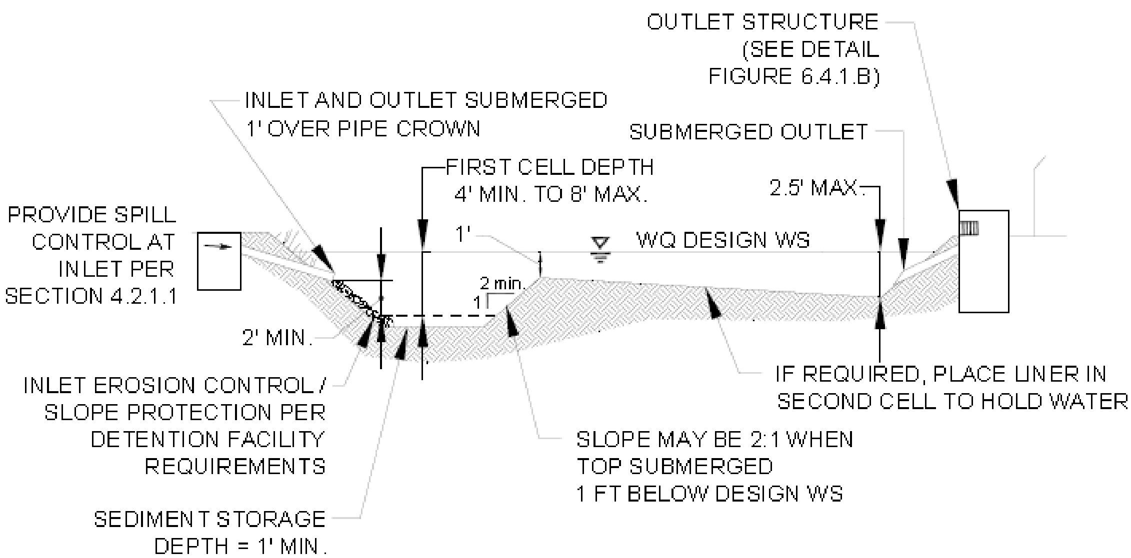

[67] King County Surface Water Design Manual, 2016
https://www.kingcounty.gov/services/environment/water-and-land/stormwater/documents/surface-water-design-manual.aspx

## 4.3.2 CONSTRUCTED WETLAND[68]




**PLAN VIEW Option A**
NTS

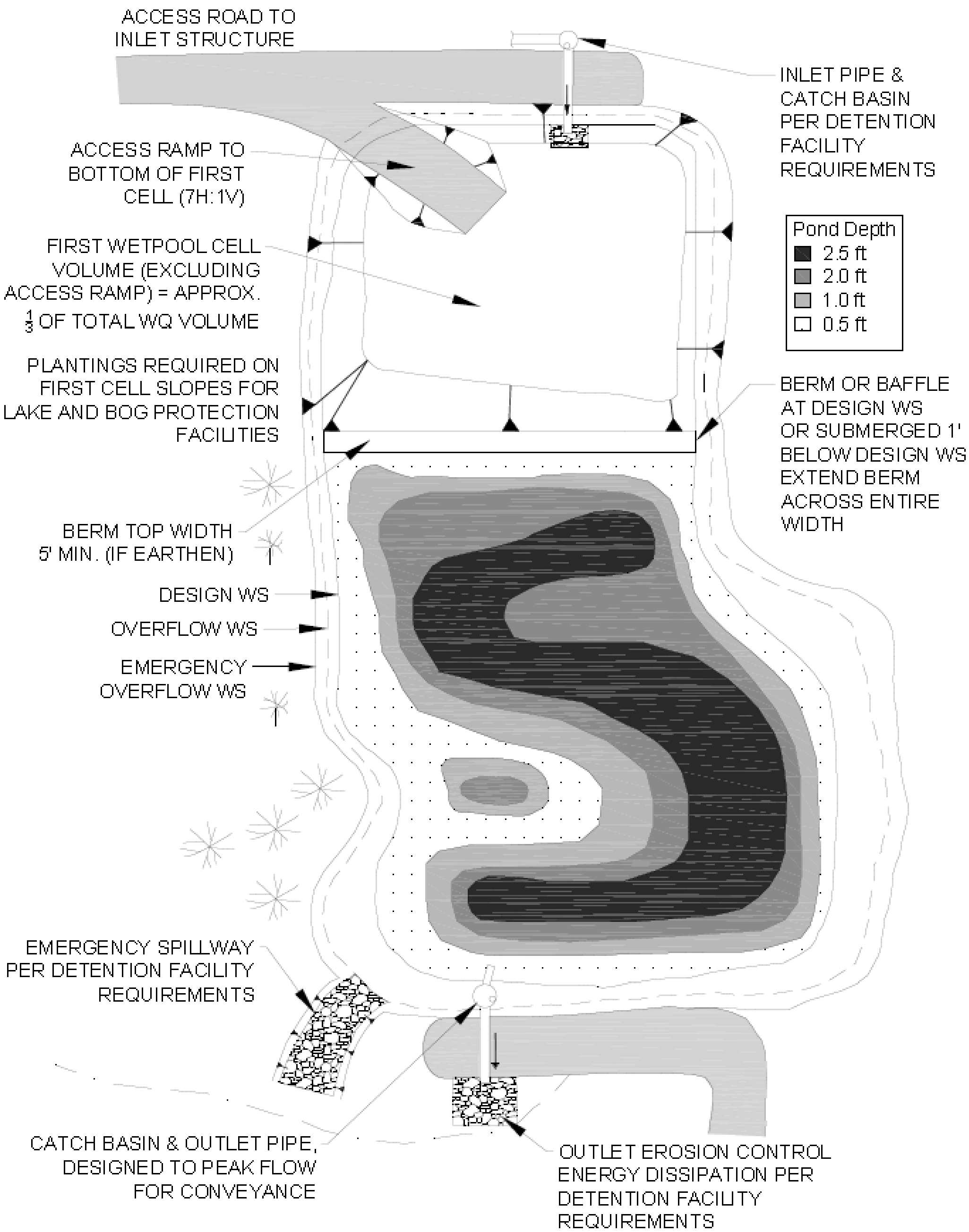
**NOTE:**
SEE DETENTION FACILITY REQUIREMENTS FOR LOCATION AND SETBACK REQUIREMENTS.




**SECTION VIEW Option A**
NTS

68 King County Surface Water Design Manual, 2016
https://www.kingcounty.gov/services/environment/water-and-land/stormwater/documents/surface-water-design-manual.aspx

## 4.3.3 CONSTRUCTED WETLAND[69]




**PLAN VIEW Option B**
NTS

[69] King County Surface Water Design Manual, 2016 https://www.kingcounty.gov/services/environment/water-and-land/stormwater/documents/surface-water-design-manual.aspx

# Appendix G. Additional Resources

*Ballard Roadside Raingardens, Phase 1 – Lessons Learned,* Shanti Colwell, Tracy Tackett, Green Stormwater Infrastructure Program, Seattle Public Utilities
https://www.epa.gov/sites/production/files/2015-10/documents/gi_ballardproject.pdf

*Construction Depot Safety and Health Newsletter for the Oregon Construction Industry, Oregon* OSHA
https://osha.oregon.gov/pubs/newsletters/resource/Pages/index.aspx

*Design & Construction Standards*, Clean Water Services (2019)
https://www.cleanwaterservices.org/permits-development/design-construction-standards/

*Don't Lose Your LID – Learn These Lessons for Effective Stormwater Drainage,* Steven D. Trinkaus, PE, Informed Infrastructure (2016)
https://informedinfrastructure.com/23002/dont-lose-your-lid-learn-these-lessons-for-effective-stormwater-drainage/

*Emerging Best Management Practices in Stormwater: Addressing Galvanized Roofing*, Pacific Northwest Pollution Prevention Resource Center (2014)
*http://pprc.org/wp-content/uploads/2014/09/Emerging-BMPs_Galvanized-Roofs_2014.pdf*

*Federal-aid Highway Program Programmatic User's Guide*, ODOT (2016)
http://www.oregon.gov/odot/geoenvironmental/pages/index.aspx

*Green Infrastructure Design and Implementation,* Environmental Protection Agency *(*EPA)
https://www.epa.gov/green-infrastructure/green-infrastructure-design-and-implementation

*Indicator Bacteria Removal in Storm-water Best Management Practices in Charlotte, North Caroline,* J. M. Hathaway; W. F. Hunt; and S. Jadlocki, Journal of Environmental Engineering American Society of Civil Engineers (2009)
https://ascelibrary.org/doi/10.1061/%28ASCE%29EE.1943-7870.0000107

*International Stormwater BMP Database,* Water Environment Reuse Foundation, Environmental & Water Resources Institute/ASCE, EPA, U.S. Department of Transportation, American Public Works Association, Wright Water Engineers, Inc., Geosyntec consultants
http://www.bmpdatabase.org/help.html

*Large Volume Storms and Low Impact Development,* EPA
https://www.epa.gov/sites/production/files/2017-10/documents/lid_fs10_rainfall_epa_508.pdf

*Low Impact Development Construction Guide*, Version 1.0, Credit Valley Conservation (2012)
http://www.creditvalleyca.ca/wp-content/uploads/2013/03/CVC-LID-Construction-Guide-Book.pdf

*Low Impact Development Handbook*, Clean Water Services (2021)
https://cleanwaterservices.org/development/dnc/lida/

*Low Impact Development in Coastal South Carolina: A Planning and Design Guide*. Ellis, K., C. Berg, D. Caraco, S. Drescher, G. Hoffmann, B. Keppler, M. LaRocco, and A.Turner. ACE Basin and North Inlet – Winyah Bay National Estuarine Research Reserves, 462 pp. (2014) http://www.scseagrant.org/pdf_files/LID-in-Coastal-SC-low-res.pdf

*Minnesota Stormwater Manual Design criteria for infiltration,* Minnesota Pollution Control Agency
https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_infiltration

*National Engineering Handbook Part 630 Hydrology, Chapter 7 Hydrologic Soil Groups,* USDA NRCS (2007)
https://www.owp.csus.edu/lidtool/Content/PDF/SoilHydGrp.pdf

*ODOT Hydraulics Manual*, ODOT (2014)
https://www.oregon.gov/odot/hydraulics/Docs_Hydraulics_Manual/HDM_Complete.pdf

*ODOT Standard Opertaion Manual for Water Quality Filter Strips and Bio-slopes (2018)*
https://www.oregon.gov/ODOT/hydraulics/drainagefacility/DFI_D00601.pdf

*PAH Chemical Action Plan*, Washington Department of Ecology, pub no. 12-07-048 (2012)
https://fortress.wa.gov/ecy/publications/documents/1207048.pdf

*Porus Pavement EcoVative Conference and Trade Show,* Oregon Metro (2010)
https://www.oregonmetro.gov/sites/default/files/2014/05/20/porousapril2010web.pdf

*Roofing Materials' Contributions to Stormwater Pollution*, Shirley E. Clark, P.E. D.WRE, M.ASCE; Kelly A. Steele, A.M.ASCE; Julia Spicher, A.M.ASCE; Christina Y. S. Siu; Melinda M. Lalor; Robert Pitt, P.E. D.WRE, M.ASCE; and Jason T. Kirby, A.M.ASCE, Journal of Irrigation and Drainage Engineering, ASCE (September/October 2008)
http://chesapeakestormwater.net/wpcontent/uploads/downloads/2012/01/j20id20roofing2020081.pdf

*Stormwater Facility Fact Sheets*, Fairfax County
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*Stormwater Management Manual*, City of Eugene (2014)
https://www.eugene-or.gov/477/Stormwater-Management-Manual

*Stormwater Management Manual*, City of Portland (2020)
https://www.portlandoregon.gov/bes/80834

*Stormwater Management Manual for Western Washington*, Washington Department of Ecology (2019)
https://fortress.wa.gov/ecy/ezshare/wq/Permits/Flare/2019SWMMWW/2019SWMMWW.htm

*Stormwater Management Manual for Eastern Washington*, Washington Department of Ecology (2019)
https://apps.ecology.wa.gov/publications/documents/1810044.pdf
*Stormwater Management and Vector Breeding Habitats*, United States Department of Health and Human Services, Centers for Disease Control and Prevention

https://www.cdc.gov/nceh/ehs/docs/factsheets/stormwater-factsheet.pdf

*Stormwater Monitoring Two Ecoroofs in Portland, Oregon, USA, City of Portland Bureau of Environmental Services*, Doug Hutchinson, Peter Abrams, Ryan Retzlaff, Tom Liptan
https://www.portlandoregon.gov/bes/article/63098

*Stormwater Phase II Final Rule Post-Construction Runoff Control Minimum Control Measure*, EPA, EPA 833-F-00-009 (revised 2005)
https://www3.epa.gov/npdes/pubs/fact2-7.pdf

*Stormwater Technology Fact Sheet Porous Pavement*, EPA, EPA 832-F-99-023 (1999)
https://nepis.epa.gov/Exe/ZyNET.exe/91018M1N.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1995+Thru+1999&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C95thru99%5CTxt%5C00000032%5C91018M1N.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

*Surface Water Design Manual,* King County, Washington (2016)
https://www.kingcounty.gov/services/environment/water-and-land/stormwater/documents/surface-water-design-manual.aspx

*Template for LID Stormwater Manual for Western Oregon: A Practical Guide for Watershed Health*, Maria Cahill, Green Girl Land Development Solutions LLC (2016)
https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-LID.aspx

*The Climate of Oregon Climate Zone 4 Northern Cascades, Special Report 916,* Oregon State University Agricultural Experiment Station (May 1993)
https://ir.library.oregonstate.edu/concern/administrative_report_or_publications/xs55md034

*The Climate of Oregon Climate Zone 5 High Plateau, Special Report 917,* Oregon State University Agricultural Experiment Station (May 1993)
https://ir.library.oregonstate.edu/concern/administrative_report_or_publications/q524jp826

*The Effects of Water Quality Characteristics on Pollutant Releases from Drainage Materials*, Olga N. Ogburn, Robert E. Pitt and Shirley E. Clark
https://www.chijournal.org/Journals/PDF/R246-13

*The Myth of Native Plant Superiority*, Linda Chalker-Scott, Ph.D., Puyallup Research and Extension Center, Washington State University (2015)
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https://s3.wp.wsu.edu/uploads/sites/403/2015/03/soil-amendments.pdf
https://s3.wp.wsu.edu/uploads/sites/403/2015/03/soil-amendments-2.pdf
https://s3.wp.wsu.edu/uploads/sites/403/2015/03/soil-amendments-3.pdf
https://s3.wp.wsu.edu/uploads/sites/403/2015/03/soil-amendments-4.pdf

*The Oregon Rain Garden Guide,* Sea Grant Oregon, ORESU-H_10-001 (2010)
*http://seagrant.oregonstate.edu/sgpubs/oregon-rain-garden-guide*

*The Stormwater Practioners Guide*, FHWA (December 2018)
https://highways.dot.gov/sites/fhwa.dot.gov/files/docs/federal-lands/construction/27396/cfl-stormwater-guide.pdf

*Urban Hydrology for Small Watersheds,* USDA NRCS Conservation Engineering Division, Technical Release 55 (January 2009)
https://www.nrc.gov/docs/ML1421/ML14219A437.pdf

# Appendix H.

## DEQ 401 Post-Construction Stormwater Management Plan Submission Form

| | |
|---|---|
| **Date** | |
| **Project Name** | |
| **US Army Corps of Engineers Project Number** | |
| **Engineering Company / Address / Phone** | |
| **Stormwater Manual Cited** | |

**Registered Engineer Stamp and Signature:**

### 1. PROJECT INFORMATION

| | | |
|---|---|---|
| **1a** | **Project Description** | |
| **1b** | **Hydrologic Soils Group** | |
| **1c** | **Expected Pollutants of Concern** | |
| **1d** | **Total Area of Project Site** | |
| **1e** | **Total Area of New AND Redeveloped Impervious Surface** | |
| **1f** | **Total Area of Wetlands Impacted** | |
| **1g** | **Total Area of Wetlands Avoided** | |

### 2. STATUS OF RECEIVING WATERS

Water Body Table [Use this table if you are describing more than one waterway, including tributaries and wetlands]
https://www.oregon.gov/deq/wq/Pages/epaApprovedIR.aspx

| WATER BODY NAME / WETLAND | 303 (d) Impairments / TMDLs | TOTAL AREA IMPACTED |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

## 3. GROUNDWATER RESOURCES

| | | |
|---|---|---|
| **3a** | **Drinking Water Source / Management Areas**<br>https://hdcgcx2.deq.state.or.us/Html5Viewer211/?viewer=drinkingwater<br>*Determine if the project is located within these resources.* | |
| **3b** | **Sole Source Aquifer**<br>https://www.epa.gov/dwssa<br>*Determine if the project is located within this resource.* | |
| **3c** | **Depth to Groundwater**<br>*Provide depth to groundwater from lowest point of site during winter months with a piezometer.* | |

## 4. PROXIMAL PERMITS

| | | |
|---|---|---|
| **4a** | **NPDES / Other Permits**<br>https://www.oregon.gov/deq/wq/wqpermits/Pages/Wastewater-Permits-Database.aspx<br>*Determine if other permitted discharges are in or near project site.* | |
| **4b** | **Environmental Cleanup**<br>https://www.oregon.gov/deq/Hazards-and-Cleanup/env-cleanup/Pages/ecsi.aspx<br>*Determine if known or potential contamination from hazardous substances are in or near project site.* | |

## 5. STORMWATER MANAGEMENT PLAN NARRATIVE

| | | |
|---|---|---|
| **5a** | **Describe how stormwater will be treated.**<br>*Low Impact Development is a DEQ preferred stormwater management strategy.* | |
| **5b** | **Calculate the Design Storm, Part 1.**<br>*Design storms are used to determine the size and configuration of stormwater conveyance, storage and treatment facilities. First, use* https://www.weather.gov/owp/hdsc_noaa_atlas2 *to determine the 2-year, 24-hour precipitation storm event.* | |

| | | |
|---|---|---|
| **5c** | **Calculate the Design Storm, Part 2.** | |

| Zone | Location | Storm Factor |
|---|---|---|
| Zone 4 | Northern Cascades | 0.67 |
| Zone 5 | High Plateau | 0.75 |
| Zone 9 | Malheur County | 0.67 |
| Others | Rest of Oregon | 0.5 |

*Oregon's climate varies across the state, and each major climate zone has its own Water Quality Design Storm. Second, multiply Part 1 by the appropriate water quality design storm factor.*

*If the results are less than 0.7 inch, use 0.7 Inch.*

| | | |
|---|---|---|
| **5d** | **Outfall Summary**<br>*Provide a brief description of outfall locations, flow path, and how energy will be dissipated prior to entering a water of the state.* | |

## 6. BEST MANAGEMENT PRACTICE SUMMARY

| | | |
|---|---|---|
| **6** | **Total Volume of Run-on Water Based on the Water Quality Event** | |

Best Management Practice Effectiveness Table [Use this table to describe individual BMPs, include information on connections] *Provide a brief description of how each BMP will treat the pollutants of concern (total suspended solids, metals, herbicides / pesticides, petroleum products, etc.). Please note, stand-alone detention ponds are for pre-treatment and not considered a full BMP for water quality.*

| BMP | CIA Area (sf) | WQ Flow (cfs) | Residence Time | Length (ft) | Width (ft) | Slope (%) | Residence Time (min) | Soil Mix | Seed Mix |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |

## 7. OPERATION AND MAINTENANCE PLAN

| | | |
|---|---|---|
| **7a** | **Responsible Party Name / Address / Phone** | |
| **7b** | **Routine Maintenance Actions**<br>*Provide a brief description of the physical actions routinely taken to maintain BMPs.* | |
| **7c** | **Maintenance Activity Schedule**<br>*Provide a brief description of how and when BMPs are to be monitored and how records will be kept.* | |
| **7d** | **Contingency and Repair Plan**<br>*Provide a brief description of how BMPs will be preserved should hazardous spills or damage to facilities occur.* | |

| | | |
|---|---|---|
| **7e** | **Maintenance Assurance**<br>*Provide documentation to demonstrate associated costs and duration of maintenance for each BMP.* | |

## 8. ENCLOSURES AND APPENDICIES

*Please provide and label enclosures to support this submission form.*
Appendix A: Maps and Exhibits
Appendix B: NRCS Soils Data
Appendix C: Geotechnical Reports
Appendix D: References and Codes
Appendix E: Operations and Maintenance Forms
Appendix F: SLOPES V Information Form and approval confirmation (if applicable)
Appendix G: Department of State Lands Removal Fill Permit, mitigation approval, and wetland bank information (if available)

**Appendix A: Maps and Exhibits Required Elements**
At a minimum, the following map elements are required for DEQ to complete a formal review of stormwater management prior to issuing a 401 Water Quality Certification.

- ☐ Site plans showing the following:
  - ☐ Reference information (e.g., title, north arrow, scale bar, legend, and date)
  - ☐ The pre- and post-construction topography
  - ☐ The pre- and post-impacted wetland features
  - ☐ Avoided onsite wetlands
  - ☐ Buffers for waters of the state to remain onsite (50-ft minimum)
  - ☐ Any features that impact the siting and design of structural stormwater controls
  - ☐ Existing, new, removed, and contributing impervious surface areas
  - ☐ The locations of any infiltration tests
  - ☐ The locations of any depth to groundwater piezometer measurements
  - ☐ The drainage basin for each structural stormwater control
  - ☐ The stormwater conveyance system
  - ☐ Structural stormwater controls and associated planting plans
  - ☐ The discharge point(s) from the structural stormwater controls
  - ☐ The route stormwater flows from the structural stormwater control to the receiving waters
  - ☐ The name(s) and flow direction(s) of the receiving waters
  - ☐ Accurately scaled cross-sectional diagrams of water quality facilities with soils and planting profiles