Water Environment Services Stormwater Standards

April 2023

CLACKAMAS
WATER
ENVIRONMENT
SERVICES

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1. Definitions

Words, terms, and acronyms specific to these Standards are defined below.

1.1 Words and Terms

The Water Environment Services (WES) Rules and Regulations (Rules) contains words and terms that apply to and are consistent across the Rules and all adopted standards. Unless the context specifically indicates otherwise, the following words and terms, as used in these Standards, shall have the meanings hereinafter designated:

Applicant. See the WES Rules.

Approved Point of Discharge. A location down slope from a development that the District has deemed adequate to accept stormwater flows from all or a portion of the Development area.

Best Management Practice (BMP). See the WES Rules.

BMP Sizing Tool. A computer program, approved by the District, for use in calculating the required size of Stormwater Management Facilities (SMFs). This tool is limited to a set list of pre-defined SMFs.

Board. See the WES Rules.

Bond. See the WES Rules.

Building Drain. See the WES Rules.

Building Sewer. See the WES Rules.

Contractor. A person duly licensed or approved by the State of Oregon to perform the type of work to be done under a permit or contract.

Conveyance System. See the WES Rules. As relates to these Standards, conveyance system refers to the stormwater and surface water conveyance system and includes sewers SMFs, drainageways, detention facilities, infiltration facilities, pretreatment facilities.

Debris. Discarded human made objects that would not exist in an undeveloped stream corridor or wetland. Debris includes, but is not limited to, tires, vehicles, litter, scrap metal, construction waste, lumber, plastic, or Styrofoam. Debris does not include objects necessary to a use allowed by Section 709, or ornamental and recreational structures. Debris does not include existing natural plant materials or natural plant materials that are left after flooding, downed, or standing dead trees, or trees that have fallen into protected water resources.

Design Storm. The distribution of rainfall intensity over time, identified to have a probability of recurrence, given in years (i.e., 5-year design storm).

Detention. The release of surface water runoff from a site at a slower rate than it is collected by the drainage system, the difference being held in temporary storage.

Developer. See the WES Rules.

Developer's Engineer. See the WES Rules.

Developer's Engineer's Inspector, or **Engineer's Inspector**. The Developer's Engineer's Inspector(s) shall be the Developer's Engineer of record, or recognized as representatives of the Developer's Engineer, and their duties shall be to approve materials and workmanship as required by the plans and specifications in accordance with District Stormwater Standards.

Development. See the WES Rules.

Discharge. See the WES Rules.

District. See the WES Rules.

District Employee or **District Personnel**. See WES Rules.

Disturbed Area or **Disturbance.** Areas of disturbance for activities defined under "Development". Work area includes areas used for storage of equipment or materials that are used for these activities.

Drainageway. See the WES Rules.

Drywell. An approved receptacle used to receive storm, surface and other water, the sides and bottom being porous, permitting the contents to seep into the ground. A drywell must conform to local agency standards and Oregon Department of Environmental Quality (DEQ) Underground Injection Control (UIC) standards.

Easement. See the WES Rules.

Ecology. The Washington State Department of Ecology.

Emergency. Any anthropogenic or natural event or circumstance causing or threatening loss of life, injury to person or property, and includes, but is not limited to, fire, explosion, flood, severe weather, drought, earthquake, volcanic activity, spills or releases of oil or hazardous material, contamination, utility or transportation disruptions, and disease.

Engineer. See the WES Rules.

Enhancement. The process of improving upon the natural functions and/or values of an area or resource that has been degraded by human activity. Enhancement activities may or may not return the site to a pre-disturbance condition but create/recreate beneficial processes and resources that occur naturally.

Erosion. See the WES Rules.

Fill. See the WES Rules.

Green Infrastructure. A SMF that mitigates stormwater runoff similar to the natural surface hydrological functions through infiltration and/or evapotranspiration, or that involves stormwater reuse.

Hazardous Materials. See the WES Rules.

Impervious Surface. See the WES Rules. For purposes of these Standards, standing water areas of SMFs and wetlands shall be considered as impervious surfaces. Permeable pavement SMFs, such as permeable pavement designed to mimic the natural hydrology of the site, are considered impervious surfaces for the purpose of determining project impervious surface area thresholds but may be used as a SMF to mitigate the stormwater from the impervious surface area.

Inspector. See the WES Rules.

Installer. Either the Owner of the property being served or a Contractor doing work in connection with the installation of a Building Sewer or conveyance system under a permit from the District, City, or County.

Intermittent Stream. See the WES Rules.

Landscape Architect. A registered professional licensed to practice in the State of Oregon by the Oregon State Board of Landscape Architecture.

Mitigation. The reduction of adverse effects of a proposed project by considering, in the following order:

A. Avoiding the impact altogether by not taking a certain action or parts of an action.

B. Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

C. Compensating for the impact by replacing or providing comparable substitute Water Quality Resource Areas.

D. Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.

Municipal Separate Storm Sewer System (MS4). A storm drainage system(s) (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) as defined in 40 Code of Federal Regulations (CFR) 122.26(b)(8).

Native Vegetation. Vegetation native to the Portland metropolitan area provided that it is not invasive non-native or noxious vegetation. See the Portland Plant List maintained by the City of Portland Bureau of Planning and Sustainability.

Owner. See the WES Rules.

Parcel. See the WES Rules.

Permit. See the WES Rules.

Permittee. See the WES Rules.

Person. See the WES Rules.

Pervious Pavement. Surface to walk, drive or park on that may reduce stormwater runoff by allowing water to soak/infiltrate into the ground. Examples are permeable pavers, pervious concrete, and porous asphalt.

Perennial Stream. See the WES Rules.

Plans. Construction plans submitted to the District for review and approval, in accordance with the Stormwater Standards.

Pollutant. See the WES Rules.

Post-Developed Conditions. Refers to the time period, or conditions that may reasonably be expected or anticipated to exist, after completion of the land development activity on a site.

Practicable. Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purpose.

Pre-Developed. See the WES Rules.

Pretreatment Device or Facility. Any structure or drainageway that is designed, constructed, and maintained to collect and filter, retain, or detain surface water runoff during and after a storm event for the purpose of water quality improvement.

Pretreatment or Treatment. A reduction in the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in water to a less harmful state.

Private Stormwater. Flows that include stormwater runoff from private properties (i.e., homes, driveways, roads), that may include pipes and other natural drainageways, creeks, streams.

Private Stormwater System. See the WES Rules.

Professional Engineer (PE). See the WES Rules for the definition of Engineer.

Proprietary Stormwater Treatment Device. A manufactured device, often proprietary, in which stormwater receives treatment before being discharged to the storm drainage system, to a SMF, or to the receiving water. This is a broad category of SMFs with a variety of pollutant removal mechanisms and varying pollutant removal efficiencies.

Public Right-of-Way (ROW). See WES Rules.

Public Stormwater. Public stormwater runoff is defined as flows that include stormwater runoff from public streets that may include pipes, natural drainageways, creeks, streams and rivers.

Public Stormwater Easement. See WES Rules for definition of Easement.

Public Stormwater Mainline. See the WES Rules for Public Mainline. As relates to these Standards, Public Stormwater Mainline refers to the portion of the Public Stormwater System which conveys wastewater through a piping system flowing by gravity.

Public Stormwater System. See the WES Rules.

Redevelopment. See the WES Rules.

Replaced Impervious Surface. The removal of an impervious surface that exposes soil, or native subgrade, followed by the placement of an impervious surface is considered Redevelopment of an impervious surface area. Replacement does not include repair or maintenance activities on structures or facilities taken to prevent decline, lapse or cessation in the use of the existing facility or surface, provided the repair or maintenance activity does not expand the coverage of the existing impervious area. If a proposed Development disturbs native subgrade of an existing impervious surface, then these stormwater standards apply.

Retention. The process of collecting and holding surface water runoff with no surface outflow.

Riparian. Those areas associated with streams, lakes, and wetlands where vegetation communities are predominately influenced by their association with water.

Seasonal High Groundwater. The maximum elevation to which the groundwater can be expected to rise due to a normal wet season.

Sensitive Areas. See the WES Rules.

Service Connection. See the WES Rules.

Sewer. See the WES Rules.

Soil. The upper layer of earth in which plants grow; a black or dark brown material typically consisting of a mixture of organic remains, clay, and rock particles.

Source Control. SMFs and/or specific actions taken that attempt to control high risk pollutant loading from entering the stormwater runoff through site activities and site design.

Storm Drain. See the WES Rules.

Storm Sewer. See the WES Rules.

Stormwater. See the WES Rules.

Stormwater Mainline. See Public Stormwater Mainline.

Stormwater Management. See the WES Rules.

Stormwater Management Facility (SMF). See the WES Rules.

Stormwater Management Plan. A plan that is stamped by a Professional Engineer (PE) and contains specific information regarding plans to locate and construct SMFs and stormwater drainage systems to meet WES performance and design standards.

Stream. See the WES Rules.

Stream, Intermittent. See the WES Rules.

Stream, Perennial. See the WES Rules.

Structure. A building or other major improvement that is built, constructed, or installed, not including minor improvements—such as fences, utility poles, flagpoles, or irrigation system components—that are not customarily regulated through zoning codes.

Utility Facilities. Buildings, structures, or any constructed portion of a system that provides for the production, transmission, conveyance, delivery, or furnishing of services including, but not limited to, heat, light, water, power, natural gas, sanitary sewer, stormwater, telephone, and cable television. Utility facilities do not include stormwater pretreatment facilities.

Vegetated Corridor. See the WES Rules.

Waters of the State. See the WES Rules.

WES Rules. WES Rules and Regulations, as adopted by the Board.

Wet Weather. The portion of the year when rainfall amounts and frequency tend to have the most significant effect on erosion prevention and sediment control (October 1 to May 31).

Wetland. See the WES Rules.

1.2 Abbreviations

Unless the text specifically indicates otherwise, the following abbreviations are used in these standards to refer to the following:

Abbreviation	Definition
AASHTO	American Association of State Hwy and Transportation Officials
BMP	Best Management Practice
CFR	Code of Federal Regulations
cfs	cubic feet per second
CKD	cement kiln dust
CLSM	controlled low strength material
CMP	corrugated metal pipe
CN	curve numbers
CTB	cement treated base
DEQ	Oregon Department of Environmental Quality
DSL	Oregon Department of State Lands
DTD	Clackamas County Department of Transportation and Development
EPA	Environmental Protection Agency
EPSC	Erosion Prevention and Sediment Control
FEMA	Federal Emergency Management Agency

Abbreviation	Definition
ft.	feet
fps	feet per second
GIS	Geographic Information Systems
GULD	General Use Level Designation
h:v	horizontal to vertical
HDPE	high density polyethylene pipe
HEC-RAS	Hydrologic Engineering Centers – River Analysis System
HGL	hydraulic grade line
IE	invert elevation
in.	inches
mm	millimeter
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
O&M	Operations and Maintenance
OPSC	Oregon Plumbing Specialty Code
OR	Oregon
ORS	Oregon Revised Statutes
OSHA	Occupational Safety and Health Authority
PDF	Portable Document Format
PE	Professional Engineer
ppm	parts per million
psi	pounds per square inch
PVC	polyvinyl chloride
ROW	Right-of-Way
SBUH	Santa Barbara Urban Hydrograph
sec.	seconds
sf	square feet
SDR	Standard Dimensional Ratio
SMF	Stormwater Management Facility
SWM	stormwater management
SWMM	Stormwater Management Model
SS	Sanitary Sewer
ST	Storm Sewer
SU	Standard Units
Tc	Time of Concentration

Abbreviation	Definition
UIC	Underground Injection Control
UPC	Uniform plumbing code
U.S.	United States
USACE	United States Army Corps of Engineers
WES	Water Environment Services
WPCF	Water Pollution Control Facility
WQRA	Water Quality Resource Area

2. General Information

The stormwater standards in this document describe requirements and methods for minimizing the hydrologic and water quality impacts of development in areas managed by the District. Implementing these standards will help protect water resources which, in turn, will benefit human health, fish and wildlife habitat, recreational resources, and drinking water.

As land is developed, creation of new impervious surfaces and loss of vegetation increases stormwater runoff during rainfall events, altering the natural hydrologic cycle. Without stormwater management, the changes in runoff and/or discharge patterns lead to reduced groundwater recharge and hydromodification of stream channels. The effects of hydromodification include increased erosion of streambanks, increased incision and/or aggradation of stream channels, reduction of high value riparian habitat, impacts to aquatic organisms, and degradation of water quality.

Runoff flowing from roadways, parking areas, rooftops, and other impervious surfaces also collects pollutants that are transported to streams, rivers, and groundwater. Stormwater pollutants are generally separated into the following categories: suspended solids (sediment), oxygen-demanding pollutants, bacteria, organic carbon, hydrocarbons, metals (cadmium, copper, lead, mercury, and zinc), nutrients (nitrogen and phosphorous), and pesticides/ herbicides.

This chapter describes the authority, purpose, applicability, and administrative review requirements of these Standards.

2.1 Authority and Purpose

WES, located in Clackamas County, Oregon, is an intergovernmental entity formed pursuant to Oregon Revised Statutes Chapter 190 for the purpose of providing stormwater and surface water management, including all facilities necessary for collecting, conveying, treating, and disposing of stormwater within its boundaries. It is further declared to be the policy of the District to provide and offer stormwater and surface water management services for such areas adjacent to the District as may, in the judgment of the District, be feasibly served upon such terms, conditions, and rates as the District shall determine, and as provided in other applicable federal and state laws.

The District, through its Director or other authorized designee or representative, shall have the authority to administer all the requirements, regulations, and provisions set forth in these Standards.

The District may promulgate new or amended standards in accordance with the process outlined in the WES Rules.

Conformance with these standards shall not be a substitute for, or eliminate the necessity of, conforming with any and all federal, state, and local laws, ordinances, rules and regulations which are now, or may in the future, be in effect. Other applicable regulations may include the hazardous materials storage requirements of Articles 79 and 80 of the Oregon State Fire Code; the Spill Prevention, Countermeasure, and Containment Regulations of §40.112 of the Code of Federal Regulations (CFR) administered by the Environmental Protection Agency (EPA); the Resource Conservation and Recovery Act; or Willamette Basin Total Maximum Daily Load (TMDL) Programs regulated by the DEQ.

Any provisions or limitations of these standards are suspended and supplemented by any applicable federal, state, or local requirements existing or adopted subsequent hereto which are more stringent than the provisions and limitations contained herein. In the event of a conflict, the most stringent local, state, or federal regulations generally apply.

The purpose of these Standards is to provide a consistent policy under which certain physical aspects of stormwater system design will be implemented. Many of the elements contained in this document are public works oriented and are related to public improvements; however, it is intended these Standards apply to both public and private work designated herein.

2.2 Objectives

The objectives of the Stormwater Standards are as follows:

- Meet federal and state National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permitting requirements.
- Minimize the discharge of pollutants and provide water quality treatment of stormwater runoff to preserve the beneficial uses of drainageways, lakes, ponds, wetlands, and other Sensitive Areas.
- Maintain water quality by protecting Sensitive Areas and the associated vegetative buffers.
- Minimize stormwater runoff volumes and maximize groundwater recharge through the process of infiltration of runoff into vegetated stormwater facilities.
- Maintain the pre-development stormwater runoff characteristics to minimize effects on the drainageways, such as erosion and degradation, generally associated with urbanization.
- Protect the safety of persons and property by safely conveying all stormwater runoff from site development and preventing the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property.
- Construct SMFs which are safe, effective, and economical to maintain and minimize future replacement costs.
- Provide for orderly development by preserving the drainageways and natural storm drainage systems shaped by the existing topography and creating man-made storm drainage systems with adequate capacity for future development upstream.
- Provide guidance to designers and engineers in meeting the requirements of stormwater regulations when developing land and constructing infrastructure within the District.
- Protect soil, groundwater, and surface water by capturing pollutants and reducing impacts to the environment.
- Redirect flows to the sanitary sewer from areas with the potential for relatively consistent wastewater discharges and manage areas that have potential for pollutant releases or spills with containment or disposal.
- Prioritize structural controls over operational procedures to provide permanent and reliable source control.
- Minimize the movement of soil during construction and the associated impacts to water quality through proper erosion prevention and sediment control practices.

2.3 Applicability

These Stormwater Standards shall govern design, construction, and upgrading of all publicly and privately financed Public Stormwater Systems in the District and applicable work within the District, unless it is shown that the District's authority to impose these standards are superseded by another local jurisdiction.

These Stormwater Standards shall govern design, construction, and maintenance of all privately owned stormwater systems in the District, unless it is shown that the District's authority to impose these standards are superseded by another local jurisdiction.

Some facilities may be required to obtain a NPDES Industrial Stormwater General Permit 1200-Z (1200-Z Permit) issued by DEQ before discharging to the District's Public Stormwater System or to Waters of the State. The 1200-Z Permit includes discharge benchmarks for facilities with industrial activities that are exposed to rainfall and stormwater runoff. The state also has water quality standards listed in Oregon Administrative Rules (OAR) 340 Division 041 for discharges to surface waters.

Applicants may be required to obtain an Industrial Wastewater Discharge Permit from the local wastewater service provider for discharges to the sanitary sewer system. Facilities subject to these requirements are generally commercial or industrial. Typical discharges include process wastewater, cooling water, or other discharges generated by some of the sources that are required that drain to a sanitary sewer system.

The requirements presented in these Standards do not exclude or replace the requirements of other applicable codes or regulations, such as the Willamette or Tualatin River Basin TMDL Programs, the Industrial NPDES Permitting Program, or any other applicable federal or state regulations or permit requirements.

All development within Federal Emergency Management Agency (FEMA) regulated streams and floodplain overlay zones may be required to meet the FEMA floodplain requirements and the requirements of the local planning and building authority.

If it is determined by the District that stormwater management or storm drainage system facilities, in addition to the onsite facilities required by these standards, are necessary to manage and protect natural resources, Public Stormwater Systems, and/or private property effectively, the District may require additional facilities or modifications at the sole discretion of the District.

Table 1 lists the stormwater minimum requirements and the applicable design standards within these Standards.

Table 1. Stormwater Minimum Requirements

Threshold	Minimum Requirements
Development or redevelopment proposing < 5000 square feet (sf) of impervious surface areas, including the cumulative impervious surface area that was developed/redeveloped over the last 3 years.	Verify impervious areas through submission of a site plan that shows the exact square footage (< 5,000 sf) of all new or replaced impervious surfaces.
Development or redevelopment proposing ≥5,000 sf of impervious surface areas, including	Submit a Preliminary Site Plan.

Threshold	Minimum Requirements
the cumulative impervious surface area that was developed/ redeveloped over the last 3 years.	Design and construct SMF(s) to meet the flow control, and water quality performance standards. Execute and record an Operations and Maintenance (O&M) Plan for stormwater facilities on private property to ensure the long-term functionality of the SMF(s).
Development or redevelopment proposing ≥ 5,000 sf of impervious surface areas, including the cumulative impervious surface area that was developed/redeveloped over the last 3 years that discharges stormwater runoff to a natural or manmade storm drainage system.	Submit a Downstream Analysis and design Storm Drainage Systems.
Development or redevelopment that is categorized as high risk for increased stormwater pollutant loading	Design and implement applicable source controls.
Development or redevelopment that is proposed to disturb ≥ 800 sf of soil.	Develop Erosion Prevention and Sediment Control (EPSC) Plans and obtain EPSC Permit.
Creation of stormwater	

2.3.1 Stormwater Management Requirements

All new Development and Redevelopment activities that result in 5,000-sf or greater of new or replaced impervious surface area, cumulative over the last 3 years, are subject to the requirements of these Standards for all newly proposed and replaced impervious surface areas within the overall project boundary.

Stormwater runoff from all of the Developed and Redeveloped impervious surface areas shall be treated in accordance with these Standards. Water quality facilities shall be designed to capture and treat the first 1 inch of stormwater runoff from a 24-hour storm event. The water quality facility shall use either an approved vegetated SMF or an approved Proprietary Stormwater Treatment Device.

All projects that discharge into an offsite storm drainage system are subject to storm drainage system and downstream analysis requirements.

All existing site development that desires to change the existing point of discharge and the stormwater runoff from impervious areas exceeds the 5,000-sf impervious threshold shall comply with these Standards, and for design criteria purposes the impervious area will be considered as redevelopment.

All Development and Redevelopment activities that result in the creation of private stormwater facilities must execute and record an Operations and Maintenance Plan.

All private storm drains outside the building envelope shall be designed using these standards, along with the Oregon Structural Code, Oregon Plumbing Specialty Code (OPSC), and/or other applicable codes as appropriate.

The stormwater management requirements are in addition to the applicable source control and erosion control requirements.

Exemptions

Projects in the following categories are exempt from the stormwater minimum requirements:

A. Residential structures being re-built following fire damage, flooding, earthquake, or other natural disasters, as long as the structure is re-built at the same scale and discharging to the same disposal point. Expansions to the original footprint, such as an addition or alteration to the original structure, may trigger stormwater management requirements for the expanded impervious area.

B. Interior remodeling projects and tenant improvements.

C. Stream enhancement or restoration projects as approved by the District.

D. Farming practices as defined by Oregon Revised Statutes (ORS) 30.930 and farm use as defined in ORS 214.200 and including farm roads, including farm structures and farm access roads outside the Urban Growth Boundary where stormwater is managed through dispersion with no direct connection to the public drainage system. Buildings associated with farm practices and farm access roads are subject to the requirements of these standards if there is a direct discharge to a Storm Drainage System. Residential homes proposed to be built on farmland are not exempt from these Standards.

E. Forest practices as defined by ORS 527.610.

F. Modular/temporary structures that will be removed at the completion of the project and do not have a direct connection to the Storm Drainage System.

G. Actions by a public utility or any other government agency to remove or alleviate an emergency condition.

H. Road and parking area preservation/maintenance projects such as pothole and square cut patching, surface sealing, replacing or overlaying of existing asphalt or concrete pavement, provided the preservation/maintenance activity does not disturb the native subgrade or expand the existing area of impervious coverage above the thresholds listed in this section.

I. Underground utility projects that replace the ground surface with in-kind material or materials with similar runoff characteristics.

J. Non-pollution generating, linear projects (e.g., pedestrian and bicycle pathways, sidewalks, trails, and ramps not included in a larger project) that disperse stormwater runoff into vegetated areas, as long as the pathways do not include inlets connected to the Storm Drainage System.

K. Storm Drainage Systems shall be designed to meet the requirements of Section 5, except when the Development/Redevelopment is not above the impervious thresholds listed in this section, and the storm drainage system is located entirely on a privately-owned parcel, is privately maintained, and receives no stormwater from outside the parcel’s property limits. Those systems exempted from the stormwater storm drainage system requirements will remain subject to the requirements of the OPSC and shall be reviewed by the building official.

2.3.2 Source Control Requirements

Source control requirements apply to all developments with high-risk characteristics during new development, redevelopment, tenant improvements, or when existing sites proposing new offsite discharges.

Source controls shall be applied to the areas of the site with high-risk characteristics as well as any areas hydraulically connected to a high-risk area. With redevelopment projects, only areas that are being disturbed with the redevelopment are required to make structural source control changes.

Projects with the following site uses/characteristics are considered to be high-risk and are subject to source control requirements in Chapter 5. :

A. Fuel Dispensing Facilities and Surrounding Traffic Areas
B. Above-Ground Storage of Liquid Materials
C. Recycling and Solid Waste Storage Areas
D. Exterior Storage of Bulk Materials
E. Material Transfer Areas/Loading Docks
F. Equipment and/or Vehicle Washing Facilities
G. Equipment and/or Vehicle Repair Facilities
H. Land with Suspected or Known Contamination
I. Covered Vehicle Parking Areas for Commercial or Industrial Uses
J. Industrial and Commercial High Traffic Areas

Applicants are required to address all high-risk site characteristics listed above. For example, if a development includes both a fuel dispensing area and a vehicle washing facility, the source controls in both those sections will apply.

The source control requirements are in addition to the applicable stormwater management and erosion control requirements. Developments that have existing or proposed offsite SMFs are not exempt from the source control requirements.

2.3.3 Erosion Prevention and Sediment Control Requirements

All development that disturbs in excess of 800 sf of soil shall be subject to the Erosion Prevention And Sediment Control (EPSC) requirements of Chapter 8. The Permittee shall be required to obtain an EPSC Permit, unless otherwise excluded by the District.

The erosion control requirements are in addition to the applicable stormwater management and source control requirements.

2.4 Variance

Alternative materials and methods will only be accepted if the Applicant can demonstrate that the existing standards are not appropriate for a given site and the proposed alternative provides the same or greater level of performance s as defined in these standards. Alternate materials or methods not explicitly approved herein will be considered for approval through the variance process outlined below.

2.4.1 Variance Request

A variance request to the Standards shall be submitted in writing to the District. The written request for a variance should be submitted to the District prior to land use approval if a land use action is required. Land use conditions of approval are commonly written so there is little, if any, flexibility after land use approval is issued. If land use approval has already been issued or is not required, then the variance request should be submitted in writing along with the first plan review submittal.

Once the District approves the plans, a variance request will only be accepted at the discretion of the District, and if the request is the only feasible solution without regards to delays or cost. Only minor variance requests will be considered during the construction phase of the project to address a specific design or construction problem. It is the responsibility of the Applicant to obtain all approvals from any local, county, state or federal authority having any jurisdiction or permitting of the activities before proceeding with an approved variance.

This written request shall include the following:

A. The desired variances(s);

B. The reason(s) for the request(s);

C. A comparison between the specification(s) and standard(s) and the variance(s) for performance, function, maintainability, safety, etc.;

D. References to regionally and/or nationally accepted standards, records of successful use by other agencies or other supportive information.

2.4.2 Criteria for Variance

The District may grant a variance when the request does not compromise the following: public safety, environmental protection, maintenance/repair/replacement, and when any one of the following conditions are met:

A. Topography or other geographic conditions impose an environmental or safety concern and the request is considered an equivalent alternative, which can accomplish the intent and criteria that is provided in these standards.

B. A minor change to the standard is required to address a specific design or construction problem which, if not enacted, will result in an unreasonable or disproportionate burden or obstacle to development. The financial viability of meeting the requirements of these design standards is not in itself a justification for a design exception.

C. The variance request is in the public interest and requirements for safety, function, appearance, and maintainability are based upon sound engineering and functionality of the proposed system is a feasible alternative.

All requests will be evaluated on a case-by-case basis, and approval of alternative materials and methods for one development proposal will not imply an approval under similar circumstances in another proposal. Approval of a variance, or denial of a site-specific request shall not constitute a precedent for use at other locations with potentially similar circumstances.

2.4.3 Review Process

The request for variance shall be reviewed by the District. The District shall make one of the following decisions:

A. Approve as proposed, or

B. Approve with changes, or

C. Deny with an explanation.

It is the responsibility of the Applicant to obtain all approvals from any local, county, state or federal authority having any jurisdiction or permitting of the activities before proceeding with an approved variance.

2.4.4 Appealing Variance Request Decision

The Applicant may make a written request to the District to appeal the variance request decision as outlined in the appeals process contained in Section 3.7 of the District Rules and Regulations.

3. General Stormwater Standards

Chapter 3 of the Stormwater Standards presents an overview of the general policies, methods, and processes associated with the Stormwater Standards as a whole.

3.1 General Policy

Public improvements are conditioned through the development review and land use approval process, described, and administered under the local planning department administering the zoning and development ordinance, or by federal, state, or other local government regulation. These Stormwater Standards cannot provide for all situations and are intended to assist, but not to substitute for competent work by design professionals. It is expected that the design professionals will bring to each project the best of skills from their respective disciplines.

These Stormwater Standards are not intended to limit unreasonably any innovative or creative effort that could result in better quality, cost savings, or both.

General stormwater requirements for all projects and developments are as follows:

A. The District does not allow the diversion of stormwater runoff from one watershed to another watershed.

B. All public storm drainage systems shall be gravity systems without the use of pumps or other mechanical means to convey or transport stormwater.

C. The Approved Point of Discharge for all stormwater may be a piped system or open channel as approved by the District. All outfalls to an existing or proposed stormwater facility, stormwater system, drainageway, or surface water system shall be approved by the District.

D. The Approved Point of Discharge for surface water, stormwater and/or groundwater shall not be a sanitary sewerage system, except as provided in Chapter 5.

E. No project shall directly or indirectly discharge, to the public storm system, any quantity of stormwater, pollutant, substance, or wash water that will violate the Discharger's permit (if one is issued), the District's NPDES MS4 permit, or other environmental laws or regulations.

3.2 Development Policy

Requirements for development of a property or a tract of land are as follows:

A. Design of surface water and stormwater systems must include provisions to control runoff from impervious and pervious areas within and upstream of the development without exceeding capacities of available facilities and downstream drainageways.

B. Development proposals shall maintain the natural drainage pathways for seasonal and intermittent drainages or provide alternate manmade natural drainage pathways.

C. Pre-existing surface or subsurface drainage, caused or affected by development, shall not flow over adjacent public or private property in a volume, flow rate or location significantly different from that which existed prior to development, but shall be collected and conveyed to an acceptable point of discharge as approved by the District.

D. Surface drainage entering a development from offsite areas shall be intercepted at the naturally occurring locations. Offsite surface drainage shall be conveyed through the site in a separate stormwater drainage system and will not be mixed with the stormwater collected

and treated within the onsite SMFs unless the onsite SMFs are designed to manage and treat the additional flows from the upstream drainage basin(s) assuming full development potential.

E. When an Approved Point of Discharge is located and/or conveyed on an adjacent private property, the Applicant shall be responsible to acquire all applicable downstream private and/or Public Stormwater Easements. An easement is not necessary if the point of discharge is considered an intermittent stream, perennial stream, river, wetland, or natural resource.

F. In compliance with Oregon Drainage Law, development shall not adversely impact downstream properties. Stormwater runoff from a development shall be safely conveyed to prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property.

G. Development shall not cause or increase flooding of adjacent or downstream property. An upstream and downstream analysis of the drainage system shall be conducted according to the guidelines in Chapter 7. Open channel and closed conduit systems shall be designed to safely convey the design storms listed in Chapter 7.

H. All development, regardless of permit status, shall keep sediment laden water and any other forms of stormwater pollution from entering natural drainage systems, wetlands, natural resources, and the Public Stormwater System.

I. All development must obtain a Service Provider Letter from the District prior to applying for Land Use/Design Review to the local planning authority. To obtain the Service Provider Letter from the District the Applicant must demonstrate that the proposed development is viable in accordance with District Rules and Standards. The Service Provider Letter will only be issued once the Applicant has provided sufficient plans, reports, and studies needed for preliminary review by the District. Based on the preliminary review, the District may request additional information prior to issuance of the letter or as part of the forthcoming land use application. Receipt of the Service Provider Letter does not imply that all District requirements have been met or guarantee that land use approval for the development will be granted. Service Provider Letter submittal requirements are found in Appendix A.

J. Developments subject to O&M requirements are required to submit an O&M Plan and shall include an agreement that allows District Personnel access to the SMFs for inspections or abatement of a public nuisance or to correct a violation of these Standards.

K. All publicly maintained SMFs shall be fully located in the Public ROW or within a tract of land that has adequate maintenance access and rights dedicated to the District, and the Storm Drainage System(s) shall be located within an easement or tract of land that has rights dedicated to the District.

L. District maintained SMFs shall be fully located in the Public ROW or within a tract of land with an easement granted to the District. Both tracts of land and easements with rights granted to the District shall include the minimum access requirements in accordance with Section 6.4.1 to accommodate perpetual maintenance of the infrastructure. The Owner shall provide the District with all necessary documentation granting such easements and dedications. Upon approval of the easement document, the District will either process the easement or require the Applicant, at their own expense to process and record the document as a land record with the Recording Division of Clackamas County. The District will not approve the final construction plans until all public and private easement documents have been completed and recorded to the satisfaction of the District.

M. A public drainage easement is required on existing open drainages that conveys Public Stormwater.

N. The District requires vegetated buffers in Water Quality Resource Areas (WQRA) to protect the water quality of water resources, which include perennial and intermittent streams and wetlands as outlined in the WES Rules and the Buffer Standards.

3.3 Engineering Policy

It shall be the policy of the District to require compliance with ORS 672 for Professional Engineers, Surveyors, Photogrammetrists, and Geologists.

All engineering plans, Stormwater Management Plans, stormwater reports, infiltration reports, geotechnical reports, or documents shall be prepared by a registered PE or by a subordinate employee under the Engineer's direction and shall be stamped with the Engineer's seal and signed to indicate the Engineer's responsibility for the design. It shall be the Engineer's responsibility to review any proposed Public Stormwater System, variance, or other change with the District prior to engineering or proposed design work, to determine any special requirements and/or whether the proposal is permissible. A "Plans Approved for Construction" (or equivalent) stamp of the District on the Plans, etc., for any project, does not in any way relieve the Engineer of responsibility to meet all requirements of the District or obligation to provide a Public Stormwater System in accordance with the District Rules and Stormwater Standards, and protect life, health, and property of the public. The District reserves the right to change the Plan for any project prior to final acceptance at any time it is determined that the full requirements of the District Rules have not been met.

All drawings submitted for approval shall be stamped and signed by a registered PE. No plan review or approval shall be made without the Plans being stamped and signed by the PE.

3.4 Stormwater Standard Detail Drawings

The District's Standard Drawings shall be used for public and private development projects and cannot be modified by designers, unless approved by the District on a project-by-project basis. It is the responsibility of the Engineer to incorporate the standard detail drawings as originally intended. See Appendix C for the District's Stormwater Typical Drawings and Standard Details.

3.5 Approval of Alternate Materials and Methods

Any substitution of materials or alternate methods not explicitly approved herein will be considered for approval as set forth in Section 2.4 of these Standards. Persons seeking such approvals shall make application in writing. Approval of any deviation from these Standards shall be provided in writing. Approval of minor matters will be made in writing, if requested.

Any alternative materials and/or methods must meet or exceed the minimum requirements set forth in these Standards.

The written request is to include, but is not limited to, the manufacturer's specifications and testing results, design drawings, calculations, reason and justification, and other pertinent supporting information.

Any deviations or special problems shall be reviewed on a case-by-case basis and approved by the District. When requested by the District, full design calculations shall be submitted for review with the request for approval.

3.6 Special Design Applications

Special applications not covered in these Standards require review and approval by the District. Submittal of full design calculations, supplemental drawings, and other information shall be required before any approval is considered.

4. Public Stormwater System Expansion

WES owns and maintains public stormwater and surface water assets in Rate Zones 2 and 3. This chapter only applies to development proposals that require construction of public stormwater assets that are intended to be conveyed to the District. The provisions presented in this section of the Stormwater Standards specify the responsibilities of the parties involved and the process followed by the District prior to acceptance of public stormwater improvements that are not constructed by the District. These requirements are intended to meet the goals and objectives of the District in combination with all other state, federal, county, and local laws and ordinances.

4.1 Public Stormwater System Expansion Approvals

The District must issue approvals for storm system expansion prior to the commencement of construction of any Public Stormwater System. Approvals for storm system expansion shall be issued by the District in accordance with these Standards. Approvals for storm system expansion are required to construct or reconstruct any Public Stormwater System, including inlets, sewers or conveyance system, stormwater facility, or underground injection control (UIC) facility, which are owned by, or intended to be conveyed to, the District. All other stormwater sewer piping not intended to be conveyed to the District shall be permitted by the local plumbing authority.

The Developer and the Developer's Engineer shall submit a signed Stormwater Engineering Agreement on a District-supplied form (form can be found online) which outlines the responsibilities of the Developer and Developer's Engineer, with regard to surveying, costing, design, inspection, testing, certification, and as-built requirements of the District for acceptance of the proposed Public Stormwater System project.

If required, the Developer's Engineer, Contractor, Applicant, District, and/or other related agency representatives will hold a pre-construction meeting to share information and requirements as specified in the stormwater report and/or engineered Stormwater Management Plans. The pre-construction meeting may be arranged by the Developer's Engineer to be held at either the District, County, or City offices prior to any public storm system approvals. Attendees must include the Developer, Developer's Engineer, Contractor, and the District representatives. Other interested parties may also attend the meeting. The purpose of the meeting is to discuss issues surrounding the project including, but not limited to, materials, construction, standard detail drawings, sequencing, testing, and inspection requirements. If requested by the District, the Contractor shall present certification by the State of Oregon and any other licensing body having jurisdiction over the work to demonstrate appropriate construction qualifications.

It is the sole responsibility of the Developer, Developer's Engineer, and Contractor to obtain all other applicable authorization from local agencies, state, and federal approvals prior to proceeding with any construction that is approved by the District.

4.2 Project Construction

The requirements for project construction are defined in the following subsections.

4.2.1 Variance or Deviation from the Approved Plans

No variance, deviation, or minor change from the approved Plans and specifications shall be made without the prior written approval of the District. When any variance or deviation of the approved Plans is requested by the Developer's Engineer, two sets of Plans showing the revisions shall be submitted to the District for approval. No construction of the modified section can commence until these revised Plans are reviewed and approved by the District. Approvals shall be made by the District in writing.

4.2.2 Inspection and Testing

The Developer's Engineer is responsible for all testing and inspection services as required by the District and to certify the material, construction, and testing results to the District. The Developer's Engineer or the Engineer's Inspector shall be allowed full access to all parts of the work; and shall be furnished with every reasonable facility for ascertaining whether or not the work, as performed, is in accordance with the requirements and intent of the approved Plans and specifications.

The Contractor shall furnish, at the Contractor's own expense, such samples as are customarily required for testing purposes. The District does not furnish inspection of storm sewer construction. For this reason, it is imperative that the Developer and/or the Contractor provide prompt and complete notification to the Developer's Engineer and the District as to the progress of the construction of storm sewer improvements.

Notification must be given to the Developer's Engineer when the following work is to be scheduled:

A. Excavation and installation of the Public Storm Sewer.

B. Compaction testing/proof roll of trench backfill and fill areas.

C. Construction of structures (including manholes, service connections, and cleanouts).

D. All required manhole and storm sewer line testing, including vacuum, air, mandrel, and video testing.

Failure to give the Developer's Engineer proper notification (48 hours) of the Contractors work schedule may invalidate the work performed and make necessary, testing and inspection from an independent testing laboratory for compliance with the District's construction specifications. Such tests shall be furnished, at no expense to the District.

Upon final completion of the construction, the Developer's Engineer will certify that the post construction as-built drawings are complete in all respects and the SMF and Storm Drainage System were built per the approved construction documents.

At a minimum, the following shall be done prior to requesting the final inspection of the stormwater facilities:

A. Clean all SMFs of sediment and debris.

B. Submit a Certification of Completion to certify that the project was constructed in accordance with the approved plans and District standards.

C. Submit as-built drawings according to Section 4.3.4.

D. Submit storm video testing and reports for all public storm systems that were constructed.

E. Submit engineer inspection reports.

F. Submit final construction cost data for the public storm systems that were constructed.

4.3 Acceptance and Warranty

Acceptance of the Public Storm System will be made in writing by the District after all conditions of the public storm system expansion have been met. The following outlines the District's post-construction requirements prior to final acceptance.

4.3.1 Video Inspection of Sewers

If the construction included storm sewers, after the Developer's Engineer certifies the construction is completed, then the entire Public Storm Sewer System shall be video inspected and recorded prior to the District conducting the final construction inspection in preparation of the acceptance of the Public Storm Sewer System. All pipes shall be thoroughly flushed immediately prior to the video inspection.

The video recording shall:

A. Be in color electronic format acceptable to the Developer's Engineer and be continuous from beginning to end of each pipe run.

B. Be clear, usable, and free of visual distortions; the image in the video shall appear level.

C. Include a visual footage meter recording on the tape.

D. Include a voice recording of suspected deficiencies.

E. Provide a means of gauging the depth of deflection within the pipe system.

F. Be performed by experienced personnel trained in locating pipe and grade breaks, obstacles, and service connections by remote video inspection utilizing a 360º pan and tilt camera.

G. Identify visually, with audio and on the written report, the location of the beginning and end of each pipe run, the lineal feet of pipe, all deficiencies, the name of the company creating the tape recording, name of the operator, and date and time of the recording.

H. Include a 360-degree inspection of each joint.

I. Include a clear view up each Service Connection.

J. Identify groundwater infiltration sources associated with construction or material defects.

K. Video inspection for District review shall be performed at the end of the project once all construction is complete.

The Developer's Engineer shall review the video recordings and inspection report(s) prior to submitting them to the District.

The video and report shall record all horizontal and vertical deflection in the piping system. Any vertical deflection is unacceptable. Horizontal deflection that creates a half-inch belly in the Public Storm Sewer System is unacceptable. The Developer's Engineer shall be immediately notified, the deficiency corrected, and re-videoed prior to submitting the final video inspection and report to the District.

Once the Developer's Engineer has reviewed and approved the video recording in accordance with the Stormwater Standards, a copy of the video recordings, and written inspection report(s) shall be submitted to the District for review and approval. Illegible, or incomplete video, or inspection report(s) will be returned to the Developer's Engineer.

The District shall approve the video recording prior to scheduling the District inspection of the Public Storm Sewer System.

4.3.2 Test Results

The installation and/or construction of Public Stormwater System in accordance with the District Standards, including infiltration testing, vegetation planting, mainline, manhole, and service connection testing shall be observed by the Developer's Engineer or Engineer's Inspector and the results shall be certified to the District on the approved District forms (form can be found online). All required testing, including but not limited to pervious pavement testing, infiltration testing, or facility testing shall be performed.

4.3.3 Service Connection Drawings

If applicable, provide appropriate information to locate newly installed Storm Sewer Service Connection for each lot or parcel within the project boundaries. Provide stationing, depth, and horizontal dimensions at the end of the pipe to permanent physical objects in the field to assure that the service connection can be located after construction is completed. Service connection drawings shall become the property of the District and are public records. The form can be found online.

4.3.4 As-built Plan Requirements

The Developer's Engineer is responsible for record keeping, inspection, and preparation of the as-built drawings. Final as-builts drawings will be submitted as detailed in Appendix A. For all Public Storm Systems, the Developer's Engineer shall submit certified as-built plan and profile drawings. Record drawings shall be submitted for all other connections to the Public Storm system. As-built drawings shall meet the District's requirements and shall be of archival quality. Each page shall be stamped and signed by the Developer's Engineer and state, in writing, that this is an as-built drawing. As-built drawings shall become the property of the District and are public records.

Drawings shall also be submitted electronically in a release of AutoCAD and Portable Document Feature (PDF) file acceptable to the District. The electronic submittal shall become the property of the District.

4.3.5 Certification of Completion

A stamped and signed Certificate of Completion (form can be found online) shall be provided by the Developer's Engineer. This statement certifies to the District that all construction methods, workmanship, and materials, have been inspected, tested by approved methods, and found to conform to the approved Plans and the specifications of the District.

4.3.6 Final Inspection

A final inspection of the Public Stormwater System by the Developer's Engineer shall be conducted to determine that the construction was completed in conformance with Plans, specifications, and these Standards. The Developer's Engineer shall inspect and verify

that all newly constructed structures meet the District's Stormwater Standards. Once inspected and verified, the Developer's Engineer may notify the District upon completion of construction and request a final inspection conducted by District Personnel. Any deficiencies resulting in non-acceptance of the work shall be identified in writing and presented to the Developer's Engineer for correction. Upon correction of the noted deficiencies the Developer's Engineer shall inspect and verify corrections have been made and then notify the District and request a re-inspection. If the work is accepted, the Developer's Engineer will be notified.

4.3.7 Construction and Engineering Cost

The Developer's Engineer shall calculate and submit on District forms the actual construction and engineering cost of the Public Stormwater System. The Construction and Engineering Cost Data Sheet can be found online. District plan review fees shall be based on the cost to construct the Public Stormwater System.

4.3.8 Letter of Conveyance

The Developer/Owner shall convey (at no cost to the District) all right, title, and interest in the Public Stormwater System to the District. The Certificate of Completion form can be found online.

4.3.9 Warranty Bond

A warranty bond or cash security in an amount equal to 25 percent of the actual construction and engineering cost to complete the Public Stormwater System shall be provided to the District by the Developer/Owner at no cost to the District. This surety bond shall guarantee the workmanship and materials of the Public Stormwater System for a minimum period of 2 years from the date of acceptance by the District unless a longer period is required by the District. A sample Warranty Bond form can be found online. Upon default, the District may draw upon the surety or available funds to remedy violations or required corrections. The different types of acceptable surety are provided in Appendix A.

4.3.10 Letter of Acceptance

Upon completion of all the approval requirements, District Rules, and these Standards, the District shall issue a letter stating the District will accept for ownership and maintenance the public storm system expansion and specify the date the warranty period will begin.

4.3.11 Warranty Period

The Developer/Owner or Contractor's warranty period shall be in effect for a minimum period of 2 years from the date specified in the Letter of Acceptance unless a longer period is required by the District.

Prior to the end of the warranty period, the District will conduct a warranty bond inspection of the public stormwater expansion and notify the Developer/Owner, or the Developer's Engineer of any deficiencies found. The request and scheduling of the warranty bond is the responsibility of the Developer/Owner. Any faulty workmanship and/or defective materials which are discovered within the warranty period shall be corrected and/or replaced by the Developer/Owner at no expense to the District. Such warranty period and warranty bond may be extended upon the disclosure of a defect for

a minimum of 2 years after the correction of the defect is completed at the sole discretion of the District.

All repair work required during the warranty period shall be performed within 30 days of issuance of written notification to the Developer/Owner. Emergency work performed by the District and all work performed by the District due to the nonperformance of the Contractor shall be reimbursed to the District within 30 days of invoice. If the Contractor fails to reimburse the District in 30 days, the District may file a bond claim.

After the warranty inspection and completion of all work required to bring the Public Stormwater System into conformance with these Standards, all sureties shall be released unless the warranty period and warranty bond is extended at the sole discretion of the District.

5. Source Controls

This chapter presents the source control requirements for site uses and characteristics that have the potential to generate higher levels of pollutants than typical stormwater runoff.

The site characteristics/uses in this chapter have been identified as potential sources of chronic loadings or acute releases of pollutants such as oil and grease, toxic hydrocarbons, heavy metals, toxic compounds, solvents, abnormal pH levels, nutrients, organics, bacteria, chemicals, and suspended solids. This chapter presents controls for managing these pollutants at their source.

5.1 General Requirements

The following requirements apply to all sites subject to source control.

5.1.1 Signage Requirements

Informational signage is required for some site uses and activities that have the potential to contaminate stormwater. Proper signage addresses good housekeeping rules and provides emergency response measures in case of an accidental spill.

All signage shall conform to the following requirements:

A. Signs shall be located and plainly visible from applicable activity areas.

B. More than one sign may be needed to accommodate larger activity areas.

C. Signs shall be water and weather resistant.

D. Signs shall include the following information:

   a. Safety precautions

   b. Immediate spill response procedures (for example: “Turn the valve located at...” or “Use absorbent materials”)

   c. Emergency contact(s) and telephone number(s)

E. Signs may need to be in more than one language if required to communicate effectively with employees and delivery personnel.

F. Signs may need to meet retro-reflectivity standards dependent on the use and intent of the sign.

5.1.2 Spill Control

Spill response supplies, such as absorbent material, containment booms, and protective clothing, shall be available at all potential spill areas. Any applicable spill response supplies need to be clearly marked and located where the signage is posted and near the high-risk activity area. The spill response supplies should be appropriate to the nature of the potential risk present at the site. More than one spill response kit may be necessary to accommodate larger activity areas.

Employees should be familiar with the site’s O&M Plan; the site’s Spill Prevention, Countermeasure, and Containment plan; and/or proper spill cleanup procedures.

5.1.3 Public Sanitary Sewer Discharge Permit

Many source control strategies require a connection of private stormwater drains to the public sanitary sewer system. Connection/discharge to the public sanitary sewer system requires prior written approval by the District. A request to discharge to the public sanitary system shall be submitted as part of the permitting process. All impervious surface areas that can drain into the public sanitary sewer shall be designed in a manner to eliminate stormwater runoff from entering the sanitary sewer system. The separation of stormwater into the sanitary sewer system is generally accomplished by covering the impervious area that drains into the sanitary sewer and grading the area in a manner that separated the flows.

5.2 Source Control Requirements

Applicants shall show the locations of proposed structural source controls (including spill control manholes and shutoff valves) and include documentation of high-risk site uses and the applicable source controls as part of the Stormwater Report and Stormwater Plans (see **Appendix A** for submittal requirements).

5.2.1 Fuel Dispensing Facilities and Surrounding Traffic Areas

These requirements apply to all development where vehicles, equipment, or fuel tanks are refueled on the premises, whether it is a gas station, a single-pump maintenance yard, or a small-sized fuel tank. A fuel dispensing facility is defined as the area where fuel is transferred from bulk storage tanks to vehicles, equipment, and/or mobile containers (including fuel islands, above- or below-ground fuel tanks, fuel pumps, and the surrounding pad). Propane tanks are exempt from these requirements.

Any discharge or point of connection to the public or private stormwater system must obtain authorization and permitting by the District. Discharges of hydrocarbons are prohibited to the public sanitary and stormwater sewer systems. When a containment or emergency storage device is used, the Owner or responsible person shall contact the District's Environmental Monitoring Division for authorization to open any valve and discharge any substance to a public sanitary or stormwater sewer system. The District shall determine the conditions to discharge or dispose of the substance to safeguard the environment, public health, and safety.

Underground storage tanks or installations requiring a Water Pollution Control Facility (WPCF) permit are exempt from these requirements but must go through DEQ's WPCF permit process.

Cover

The fuel dispensing area shall be covered with a permanent canopy or roof so precipitation cannot come in contact with the fueling activity area. Rainfall shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

Covers 10 feet high or less shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated fueling activity area it is to cover.

Covers higher than 10 feet shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated fueling activity area it is to cover.

Pavement

A paved fueling pad of concrete shall be placed under and around the fueling activity area and shall meet all applicable building code requirements. Sizing of the paved area shall be adequate to cover the activity area, including placement and number of the vehicles or pieces of equipment to be fueled by each pump. Fuel pumps shall be located a minimum of 10 feet from the edge of the fueling pad.

Drainage

The impervious area beneath the cover shall be hydraulically isolated from the surrounding area through grading, berms, or drains.

Drainage from under the cover that is hydraulically isolated shall be directed to the sanitary sewer system. When connecting to sanitary sewer, an oil/water separator shall be installed to collect and detain the runoff from under the cover of a fuel dispensing area. Unless the District requires a different volume, the minimum storage capacity of the oil/water separator and, if needed, an upstream storage sump/vault shall be 1,000 gallons. A flow-stop or shut-off valve is required downstream of the oil/water separator prior to connection with the public sanitary sewer system.

Surrounding runoff must be directed away from the hydraulically isolated fueling pad to a stormwater discharge point that meets all stormwater management requirements of these standards and other applicable code requirements.

Traffic pathways that surround fueling pads are considered high use/high-risk areas and will require a valve on the storm drainage system. Valves installed on storm drainage systems must be installed downstream of all applicable private SMFs to accommodate spill containment. These valves must be left open to facilitate stormwater flows during normal conditions, and immediately closed in the event of a spill.

Pretreatment: Oil/Water Separator

Runoff from the fuel dispensing area is required to be pretreated in an oil/water separator with coalescing plates prior to being discharged into the spill control manhole. The purpose of the device is to treat runoff from washing down and cleaning of the fueling area and to prevent small spills from entering the spill control manhole.

Coalescing plate separators shall be designed to achieve a 100 parts per million (ppm) non-polar oil and grease limit in the effluent from the peak flow generated by the washing activity. Testing information must be submitted by the manufacturer of the unit that supports the 100 ppm effluent standard at the calculated flow rate.

At a minimum, the device will be sized to treat the standard flow from a 5/8-inch hose which is estimated to be 10 gallons per minute.

Each device shall be verified with the vendor to assure the treatment and flow rate capacity are within the parameters of the device.

Separator details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.

All separators shall be maintained per the manufacturer specifications and the private maintenance plan approved by the District.

Spill Control Manholes

A spill control manhole shall be installed as the last device inline to collect and retain the runoff from the fuel dispensing area. The spill control manhole shall have a downstream inline valve prior to point of discharge into an approved storm drainage system. Spills and contaminants are treated and contained within the pretreatment device and spill control manhole until authorization is obtained by the District to release the substance into an Approved Point of Discharge or dispose of it appropriately offsite. In general, with District approval of the acceptable level of contaminants and release method, the contaminants are allowed to be discharged into the public sanitary sewer system. The shut-off valve shall be located below the outlet elevation, and the manhole shall have a minimum dead storage capacity of 60 cubic feet in volume between the invert elevation (IE) of the inflow pipe and the IE of the discharge pipe for storage of oil, grease, and solids. The tee section shall extend 18 inches below the outlet elevation. The manhole shall be located on private property and accessible for operation and maintenance activities.

Shut-Off Valves

Shut off valves are required to protect the public or private sanitary or storm drainage systems from risks that may present a danger or risk to the environment, public health, and safety.

Shut-off valves are required for any of the following situations:

A. Site or activity areas are exposed to corrosives or oxidizers that can harm storm drainage system components (such as, but not limited to, battery acid).

B. Substances (such as, but not limited to, oil and grease) that do not settle or remain in one location and are capable of being dissolved in or float on water. These substances can spread rapidly into downstream storm drainage system and disposal systems, causing widespread impacts and difficult cleanup situations.

C. Substances that are known to infiltrate through soils and contaminate groundwater.

D. Traffic pathways that surround fueling pads are considered high use/high-risk areas and will require a valve on the storm drainage system. Valves installed on storm drainage systems shall be installed downstream of all applicable private SMFs to accommodate spill containment. These valves shall be left open to facilitate stormwater flows during normal conditions, and immediately closed in the event of a spill.

E. Fueling pads require a valve downstream of the spill control manhole. Valves installed on sanitary sewer systems shall be installed before the public sanitary sewer system tie-in. These valves shall be kept closed and opened upon approval by the District. The valve shall be closed immediately after the approved discharge activities are completed.

F. Shut-off valves shall be located on private property and downstream of all SMFs. All valves shall be installed and maintained per the manufacturer’s recommendations and the private maintenance plan approved by the District. The Applicant must also obtain a plumbing permit from the local building authority to install plumbing on private property.

Bulk Fuel Terminals

Bulk fuel terminals, also known as tank farms, require the following:

Secondary containment equal to 110 percent of the product's largest container or 10 percent of the total volume of product stored, whichever is larger.

A. A separate containment area for all valves, pumps, and coupling areas, with sub-bermed areas either in front of or inside the main containment areas. These sub-bermed areas shall have rain shields and be directed to a public sanitary sewer system with a valve maintained in the closed position to control unauthorized discharges. If no public sanitary sewer is available, drainage shall be directed to a temporary holding facility for proper disposal and may require a WPCF permit from the Water Quality Division of DEQ.

B. An impervious floor within all containment areas is required to prevent spills from contaminating the groundwater.

C. Truck loading and off-loading areas shall be covered to prevent spills from entering the public sanitary or storm system. To prevent the discharge of spills a shut-off valve is required as identified for fuel dispensing facilities.

D. Shut-off valves shall be installed for the drainage of the required containment facilities for a tank yard. The valves shall be installed downstream of the primary containment area and kept closed. Valves installed for the drainage of the truck pad and sub-bermed containment areas shall be installed downstream of the SMFs including the spill control manhole.

E. Approval of a batch discharge from the District is required before discharging a containment area into a public sanitary or stormwater system. This approval will determine appropriate disposal methods, identify pretreatment requirements (if applicable), and approval of the discharge. Pretreatment and testing may be required to establish the specific characteristics of the substance to be discharged. Contact the District's Environmental Monitoring Division to request authorization for batch discharge.

F. Underground fuel tanks less than 4,000 gallons in size are subject to additional permitting requirements by DEQ, and tanks larger than 4,000 gallons are referred to the EPA. For technical questions and permitting, call DEQ's Northwest Region Portland office and ask for the Underground Storage Tank Permitting Department. The installations of underground storage tanks are subject to all requirements and permits per the local building authority and OPSC.

Additional Requirements

A. Track spill control manhole and shut-off valve installations.

B. Installation, alterations, or removal of above-ground fuel tanks larger than 55 gallons, and any related equipment may be subject to additional building permit and fire department requirements. For technical questions and permitting, contact the local building authority and the District's Development Review Division.

5.2.2 Above-Ground Storage of Liquid Materials

These requirements apply to all development where there is any exterior storage of liquid chemicals, food products, waste oils, solvents, process wastewaters, or petroleum products in above-ground containers, in quantities of 50 gallons or more. This includes both permanent storage and temporary storage areas.

Containment

Liquid materials shall be stored and contained in such a manner that if the container(s) is ruptured, the contents will not discharge, flow, or be washed into a drainageway, public storm or sanitary sewer system. A containment device and/or structure for accidental spills shall have capacity to capture a minimum of 110 percent of the product's largest container, or 10 percent of the total volume of product stored, whichever is larger.

Double-walled containers may be exempt from these spill containment requirements.

Quantity thresholds of products that are generally exempt from these spill containment measures include: Janitorial, cleaning, office and stationary supplies packaged for consumer use in containers less than 100 pounds net weight or 15 gallons net volume are exempt from spill containment measures.

Note: This does not include cleaners or solvents used for cleaning machinery or motor vehicle and machine parts.

Cover

Storage containers (other than tanks) shall be completely covered so rainfall and stormwater runoff cannot come in contact with them. Runoff shall be directed from the cover to a SMF that meets all applicable code requirements.

Covers 10 feet high or less shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

Covers higher than 10 feet shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

Pavement (Impervious Surface)

An impervious surface storage area is required unless otherwise approved by the District's Development Review Division. The storage area shall be an impervious surface area and shall meet all applicable zoning and building code requirements. Compactors, containers, and drop boxes shall be located on a level Portland Cement concrete pad, a minimum 4 inches thick, at ground level or other location compatible with the local collection service franchisee's equipment at the time of construction. The pad shall be designed to discharge surface water runoff to avoid ponding. Sizing of the impervious areas shall be adequate to cover the area intended for storage.

Drainage

All impervious storage areas shall be hydraulically isolated through grading, berms, or drains, such as:

A. Covered storage areas. Significant amounts of precipitation are not expected to accumulate in covered storage areas, and drainage facilities are not required for the contained area beneath the cover. If the Applicant elects to install drainage facilities, the drainage from the hydraulically isolated area shall be directed to an approved pretreatment, containment facility and point of discharge.

B. Uncovered storage areas with containment. Water will accumulate in uncovered storage areas during and after rain. Any contaminated water cannot simply be drained from the area. It must be collected, inspected, and possibly tested at the expense of the Owner before proper disposal can be determined and authorized.

Frequent draining may be required during the wet season, which may prove costly. Some type of monitoring may also be needed to determine the characteristics and level of contamination of the stormwater.

All substances and methods discharged to the sanitary sewer shall be authorized by the District prior to release. The District considers these batch discharges and shall require pretreatment prior to discharge. An industrial discharge permit may be required. Pretreatment requirements shall be set as part of the discharge approval process, based on the types and quantities of material to be discharged. A discharge evaluation shall be performed before connection to a sanitary sewer or storm sewer system. Testing may be required to establish characteristics of the wastewater or contaminated stormwater and to verify that local discharge limits are not exceeded. For batch discharge applications and industrial discharge permit requirements, call the District's Environmental Monitoring Division.

Additional Requirements

A. Covered storage areas: A shut-off valve may be required for the covered storage area if the Applicant proposes to install drainage facilities to an approved public sanitary sewer connection. The District will make this determination based on the type of material stored and the proposed point of discharge.

B. Uncovered storage areas: A shut-off valve shall be installed in the storage area so excess stormwater can be drained out of the activity area and directed either to the storm drainage facilities (if clean) or into the public sanitary sewer or authorized pretreatment facility (if contaminated). Except when stormwater is being discharged, the valve shall always be kept closed so any spills within the activity area can be effectively contained.

    a. Tank farms shall follow the criteria established for bulk fuel terminals in Section 5.2.1. Exceptions may be granted, based on the product being stored. Requests for an exception will require an additional review process and may delay issuance of related building permits.

    b. Storage of reactive, ignitable, or flammable liquids shall comply with the Uniform Fire Code as adopted by the State of Oregon. These source controls are intended to complement, not conflict with, current fire code requirements. None of these requirements shall exclude or supersede any other requirements in this manual, other District permit requirements, or State and Federal laws pertaining to water quality. Contact the District for further information and requirements.

5.2.3 Recycling and Solid Waste Storage Areas

These requirements apply to all commercial and industrial development with facilities that store recycling materials and/or solid wastes (both food and non-food wastes). A solid waste storage area is a place where solid waste containers are collectively stored. Solid waste receptacles may include, but are not limited to compactors, containers, carts, barrels, dumpsters, and garbage cans. These requirements also apply to areas used to collect and store refuse or recyclable materials. This applies to multi-family residential sites of five or more units if a shared trash collection area is proposed. However, these requirements do not apply to single-family homes or debris collection areas used for temporary storage of wood pallets or cardboard.

The following design requirements apply for approval of solid waste storage and handling activity areas in the District. All receptacles used for storage of solid waste and recyclables (except cardboard) are required to be designed by the manufacturer to fully contain liquid waste if maintained properly and must remain in properly functioning condition throughout their period of use. Per the most current version of the Clackamas County Solid Waste and Recyclable Material collection code, containers used to store cooking oils, grease, or animal renderings for recycling or disposal shall not be located in the principal recyclable materials or solid waste storage areas.

These materials shall be stored in a separate storage area designed for such purpose. Restaurants and other businesses that collect and store oil and grease shall create a separate space under their covered enclosure to store the oil/grease container that does not block access to garbage, food, and recycling containers. Material collection, containers used to store cooking oils, grease, or animal renderings for recycling or disposal shall not be located in the principal recyclable materials or solid waste storage areas. These materials shall be stored in a separate storage area designed for such purpose.

Cover

Restaurants and other businesses that collect and store oil and grease shall create a separate space in accordance with local zoning and building codes. Additional details on these requirements can be found in the local Solid Waste and Recyclable Material collection code.

A permanent canopy, roof, or awning may be required to cover the solid waste storage area and shall be constructed to cover the activity area so rainfall and stormwater runoff cannot come in contact with the waste materials being stored. The cover shall be sized relative to the perimeter of the hydraulically isolated activity area it is to cover. Runoff shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

If the structure is covered, then the Building Drain shall be connected to the public sanitary sewer in accordance with local building and plumbing codes. If the structure is not covered, it cannot be drained into the public sanitary sewer system. Uncovered structures shall drain into the storm drainage system with the applicable oil/water separator and cartridge filter water quality treatment.

Pavement

If a paved waste storage area is required. The structure and impervious surface area shall be designed and constructed in accordance with all applicable zoning, building and plumbing codes. The pad shall be designed to discharge surface water runoff to avoid ponding. Sizing of the paved area shall adequately cover the activity area intended for refuse storage, or the trash compactor(s) and associated equipment.

Isolation

Hydraulic isolation shall be provided for the solid waste storage activity area and shall be designed to prevent uncontaminated stormwater runoff from entering the area and carrying pollutants away. Runoff occurring outside the hydraulically isolated area shall be directed to a stormwater disposal point that meets all applicable code requirements. This can be achieved by reverse grading at the perimeter of an activity area, perimeter curbing or berming, or the use of area drains to collect and divert runoff.

Drainage

The paved area under the cover shall be hydraulically isolated, meaning no stormwater draining into or liquids draining out of the covered storage area. Hydraulic isolation may include installation of a berm or grading that prevents uncontaminated stormwater from running into the waste storage area and ensures that any fluid under the enclosure drains to the sanitary system. An oil/water separator may be required as pretreatment before discharging to the sanitary system, per Section 5.1.3.

Non-gravity Option

Activity areas that do not have gravity sanitary sewer service may be allowed to install a pressurized system in accordance with local building and plumbing codes. With these types of installations, the following items shall be provided at the time of building permit application:

A. Verification or evidence that gravity service cannot be obtained.

B. Details of an electronic sump pump system equipped with a float switch.

C. District approval.

Pressurized system installations are considered “permanent equipment” and deemed the Owner’s liability in the event of system failure or if the property becomes vacated.

The local building and plumbing codes authorities will review all sump pump or sewage ejector installations for compliance with the UPC and Oregon State Plumbing Specialty Code.

5.2.4 Exterior Storage of Bulk Materials

These requirements apply to developments that stockpile or store materials in outdoor containers that may erode or have negative stormwater impacts. The materials are separated into the following three categories, based on risk assessments for each material stored: high-risk, low-risk, and exempt materials.

These include, but are not limited to, the types found in **Table 2**. Materials with any of the following characteristics are exempt from these requirements:

A. Have no measurable solubility or mobility in water and no hazardous, toxic, or flammable properties.

B. Exist in a gaseous form at ambient temperature.

C. Are contained in a manner that prevents contact with stormwater (excluding pesticides and fertilizers).

Cover

Low-risk materials shall be covered with a temporary plastic film or sheeting at a minimum.

High-risk materials shall be permanently covered with a canopy or roof to prevent stormwater contact and minimize the quantity of rainfall entering the storage area. Runoff shall be directed from the cover to an approved stormwater disposal point that meets all applicable code requirements.

Table 2. Stormwater Impacts of General Material Types

High Risk Materials • Recycling materials with potential effluent (including mercury containing items) • Corrosive materials (e.g., lead-acid batteries) • Storage and processing of food items • Chalk/gypsum products • Feedstock/grain • Material by-products with potential effluent • Fertilizer • Pesticides • Oily or otherwise contaminated vehicle/equipment parts • Lime/lye/soda ash • Animal/human wastes
Low Risk Materials • Recycling materials without potential effluent • Used tires • Non-oily scrap or salvage • Treated lumber • Metal • Sawdust/bark chips • Sand/dirt/soil (including contaminated soil piles) • Material by-products without potential effluent • Unwashed gravel/rock • Compost • Asphalt • Non-leaking vehicles in stages of disassembly
Exempt Materials • Rock • Finished untreated lumber • Rubber and plastic products (hoses, gaskets, pipe, etc.) • Clean concrete products (blocks, pipe, etc.) • Glass products (new, non-recycled) • Inert products

Covers 10 feet high or less shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

Covers higher than 10 feet shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

Pavement

Low-risk material storage areas are not required to have an impermeable surface.

High-risk material storage areas shall be impervious beneath the structural cover. Sizing of the impervious surface area shall adequately cover the activity area intended for storage.

Drainage

Low-risk material storage areas are typically allowed in areas served by standard SMFs. However, all erodible materials being stored must be protected from rainfall and stormwater runoff.

If materials are erodible, a structural containment barrier shall be placed on at least three sides of every stockpile. The barrier shall be tall enough to prevent the contained and uncontaminated area from mixing stormwater runoff into the storage area with the stored materials as a result of being blown or washed away. If the area under the stockpile is paved, the barrier can be constructed of asphalt berms, concrete curbing, or retaining walls. If the area under the stockpile is unpaved, sunken retaining walls or ecology blocks can be used. The Applicant shall clearly identify the method of containment on the building and/or site plans.

For high-risk material storage areas, the paved area beneath the structural cover shall be hydraulically isolated through grading, structural containment berms or walls, or perimeter drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. If significant amounts of precipitation are not expected to accumulate in covered storage areas, drainage facilities are not required for the contained area beneath the cover. If the Applicant elects to install drainage facilities, the drainage from the hydraulically isolated area shall be pretreated and connected to a point of discharge approved by the District. In such a case, an evaluation will be done to determine if an NPDES Discharge permit is required.

Additional Requirements

A. Storage of pesticides and fertilizers may need to comply with specific regulations outlined by DEQ. For answers to technical questions, call DEQ's Northwest Region Portland office.

B. A sampling manhole or other suitable stormwater monitoring access point may be required to monitor stormwater runoff from the storage area. This may apply to certain types of storage activities and materials if an alternative source control is proposed. The District's Development Review Division will review for applicability of this requirement.

C. Hazardous materials signage shall be provided at the storage area where hazardous materials or other materials of concern are stored. Signage shall be located so it is

plainly visible from all storage activity areas. More than one sign may be needed to accommodate large storage areas.

D. A shut-off valve may be required for the structurally covered storage area if the Applicant elects to install drainage facilities and discharge into a sanitary system. The District's Development Review Division will make this determination based on the type of material stored and the proposed system receiving the discharge.

5.2.5 Material Transfer Areas/Loading Docks

These requirements apply to all developments proposing the installation of new material transfer areas, or structural alterations to existing material transfer areas (e.g., access ramp regrading, leveler installations).

The requirements apply to all material transfer areas, including loading/unloading docks, bay doors, and any other building access point(s) with the following characteristics:

A. The area is designed (size, width, etc.) to accommodate a truck or trailer being backed up to or into it; and,

B. The area is expected to be used specifically to receive or distribute materials to and from trucks or trailers.

The requirements may not apply to areas that are used only for mid-sized to small-sized passenger vehicles and that are restricted (by lease agreements or other regulatory requirements) to storing, transporting, or using materials that are classified as domestic use: Primary educational facilities (elementary, middle, or high schools), buildings used for temporary storage (a lease agreement will need to be provided), and churches. Contact the District's Development Review Division for help in determining if requirements apply.

Pavement

An impervious surface area such as asphalt or concrete shall be placed underneath and around the loading and unloading activity area and shall meet all applicable building code requirements. This will reduce the potential for soil contamination with potential impacts on groundwater and will help control any acute or chronic release of materials present in these areas.

Isolation

The first 3 feet of the paved/covered area of a loading dock, measured from the building or dock face, shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away.

Bay doors and other interior transfer areas shall be designed so that stormwater runoff does not enter the building. This can be accomplished by grading or drains.

Drainage

Drainage from the hydraulically isolated, covered loading dock area shall be directed to a pretreatment facility and then the sanitary sewer. Surrounding runoff and drainage from the access ramp shall be directed away from the hydraulically isolated area to a SMF that meets all applicable requirements of this manual.

Areas which cannot gravity discharge may be allowed to install a pressurized system. With these types of installations, the following items shall be provided at the time of building permit application:

A. Proof that a gravity system cannot be obtained.

B. Details of an electronic sump pump system equipped with a float switch.

C. A point of discharge approved by the District.

Pressurized system installations are considered “permanent equipment” and deemed the Owner’s liability in the event of system failure or if the property becomes vacated.

The local building authority will review all sump pump or sewage ejector installations for compliance with the UPC and OPSC. The District’s Development Review Division will review the pressurized systems for compliance with the Standards.

Bay Doors and Other Interior Transfer Areas. Because interior material transfer areas are not expected to accumulate precipitation, installation of floor drains is not required or recommended. It is preferable to handle these areas with a dry mop or absorbent material. If interior floor drains are installed, they shall be plumbed to an approved pretreatment facility and discharge into the public sanitary sewer.

Shut-off Valves

A shut-off valve downstream of the transfer area may be required to prevent spills and contamination from leaving this area. The District’s Development Review Division will make this determination, based on the type of material being transferred, pretreatment facility and the Approved Point of Discharge.

Shut-off valves are required to protect health, safety and the environment from spills and substances that may provide a risk. Shut-off valves are required for any of the following situations:

A. Site activity areas that are exposed to corrosives or oxidizers that can harm storm drainage system components (such as battery acid).

B. Substances (such as oil and grease) that do not settle or remain in one location and are capable of being dissolved in or float on top of water. These substances can spread rapidly into downstream systems, causing widespread impacts and difficult clean-up situations.

C. Substances that are known to infiltrate through soils and contaminate groundwater.

Valves located in material transfer areas are typically left open to facilitate drainage during normal conditions, and immediately closed in the event of a spill.

Prior to transfer activities of harmful substances, the valves shall be closed and reopened only after the transfer is complete. The shut-off valves must be located on private property and downstream of the exposed area’s collection system.

All valves shall be installed and maintained in accordance with manufacturer specifications. For additional information about installation of shut-off valves contact the local building authority.

Addition Requirements

Bay doors and other interior transfer areas shall provide a 10-foot “no obstruction zone” beyond the entrance within the building. This will allow the transfer of materials to occur with the truck or trailer end placed at least 5 feet inside the building, with an additional staging area of 5 feet beyond that. The “no obstruction” zone shall be clearly identified on the site plan at the time of the building permit application and shall be painted at the facility with bright or fluorescent floor paint.

5.2.6 Equipment and/or Vehicle Washing Facilities

These requirements apply to all development within designated equipment, vehicle washing or cleaning areas. This includes smaller activity areas, such as wheel-washing stations. Residential sites are exempt.

Cover

The washing area shall be covered with a permanent canopy or roof so precipitation cannot come in contact with the washing activity area. Precipitation shall be directed from the cover to a SMF that meets all applicable code requirements.

A. Covers 10 feet high or less shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated washing activity area it is to cover.

B. Covers higher than 10 feet shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated washing activity area it is to cover.

Pavement

The wash pad area shall be impervious surface such as asphalt or concrete placed under and around the washing activity area and shall meet all applicable building code requirements. Sizing of the paved area shall adequately cover the activity area, including the placement of the vehicle or piece of equipment to be cleaned.

Drainage

The paved area beneath the cover shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. Drainage from the hydraulically isolated area shall be directed to a pretreatment facility and then the sanitary sewer. If connected to the public sanitary sewer, and, depending on the washing compounds used (i.e., brighteners), an industrial discharge permit to the public sanitary sewer system may be required. For further questions, contact the Development Review Division. Surrounding runoff shall be directed away from the hydraulically isolated washing pad to a SMF that meets all applicable requirements.

Oil Controls

All vehicle and equipment washing activities shall be equipped with an approved oil/water separator system. The system shall comply with the public sanitary sewer discharge limits. For discharge requirements and limitations to the public sanitary sewer system contact the District's Environmental Monitoring Division.

For washing areas protected with a cover or located inside a structure, the following design criteria apply to oil/water separators discharging a public sanitary sewer system:

A. Baffled oil/water separators and spill control (SC-type) separators shall not be allowed for use with equipment and/or vehicle washing applications. Note: Activities and processes of a washing facility change over time, and the introduction of heat and surfactants may occur.

B. Coalescing plate separators shall be designed to achieve a 100-ppm non-polar oil and grease limit in the effluent from the peak flow generated by the washing activity. Testing information must be submitted by the manufacturer of the unit that supports the 100-ppm effluent standard at the calculated flow rate.

a. The minimum design flow rate shall be 10 gallons per minute which is the estimated flow from a 5/8-inch hose.

b. For specially designed washing units, check the vendor specifications for maximum flow rates.

C. Any pumping devices shall be installed downstream of the separator and pretreatment facility to prevent oil emulsification.

D. Separator details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.

E. All separators shall be maintained per the manufacturer specifications and District approved maintenance plan.

Onsite wash recycling systems may be used for oil control as long as they can meet effluent discharge limits for the public sanitary sewer system. A detail of the wash recycling system and vendor specifications identifying effluent efficiencies shall be submitted as part of the building plans at the time of the building permit application.

5.2.7 Equipment and/or Vehicle Repair Facilities

These requirements apply to all development within designated equipment or vehicle repair including areas conducting body work.

Cover

Repair areas shall be located indoors so precipitation cannot come in contact with the repair area. Precipitation shall be directed from the repair facility roof to a SMF that meets all applicable District requirements.

Floors

The floor shall be impervious material such as concrete.

Drainage

The exterior of the repair area shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. Runoff shall be directed away from the hydraulically isolated repair area to a SMF that meets all applicable requirements.

Storage

Interior: Chemicals used for cleaning machinery or motor vehicle and machine parts (including, but not limited to, lubricants, used fluids, solvents, cleaners, etc.) of any quantity must be stored in or on secondary containment structures.

Exterior: Chemicals and materials must be stored in a manner consistent with the requirements set forth in Section 5.2.2 and Section 5.2.5.

Oil Controls

All vehicle and equipment repair areas with floor drains and/or shop sinks must have an approved oil/water separator system and comply with the District's sanitary sewer discharge standards. Details on oil/water separator design criteria are located in Section 5.2.1.

5.2.8 Land with Suspected or Known Contamination

These requirements apply to all development projects that disturb property at risk, suspected, or known to contain pollutants in the soil or groundwater. This includes development that is surrounded by properties found to have trace pollutants. These requirements will also be applied to any property that is seeking to make a new connection to a public storm system or drainageway from a property that is at risk, suspected, or known to contain pollutants in the soil or groundwater. To avoid confusion with references to water quality pollutants throughout this manual, this section refers to pollutants as contaminants and/or contamination.

Because of local, State, and Federal regulations, special handling and management of soils, groundwater, and surface drainage may be necessary. As a result of these regulations, sites with suspected or known contamination require a more detailed review process that may delay issuance of related site plan and building permit approvals. Applicants are advised to contact the Development Review Division early in the planning process (before plan submittal) if they are aware or suspect the site has contaminants or is adjacent to a contaminated site.

To research contaminant information, refer to DEQ's Environmental Cleanup Site Information database.

A. If records indicate there is a potential of contamination on the site, the Applicant must contact DEQ prior to pre- and post-construction activities. For technical questions related to site contamination and clean-up, contact the Land Quality Division of DEQ.

B. All regulatory divisions or departments of DEQ referenced in this section can be reached by calling DEQ's Northwest Region Portland Office.

C. If a Phase 1 DEQ Site Assessment was required, the report will be submitted to the District for review.

D. If contamination is discovered subsequent to site plan approval the Owner shall immediately take steps to protect health, safety and the environment and contact the District and DEQ. Plan approval is suspended until the contamination issues are resolved.

Contaminants have the potential to become entrained and transported through exposure to construction activities and post-construction design elements of a development. The requirements in this section apply to:

A. Excavation and stockpiling of contaminated soils (soil management)

B. Disposal or re-use facilities related to groundwater, foundation or footing drains, interior floor drains in basements or sub-grade structures, construction dewatering, and surface stormwater treatment and storm drainage systems.

Stormwater discharges from sites suspected of contamination, whether proposed as a temporary construction connection or as permanent connection to any public storm, sanitary sewer system or drainageway, will require a special authorization from the District and Environmental Monitoring Division. After reviewing the proposal and a characterization of the contaminants on the site, the District and/or Environmental Monitoring Division will make one of the following decisions:

A. Approve discharges to the public storm and/or sanitary sewer system with restrictions such as described in these pages or as is necessary given the nature of the discharge.

B. Require the Applicant to obtain an NPDES permit from DEQ for the anticipated discharge prior to connection to a public system.

C. Require the Applicant to obtain a District's Industrial Pretreatment Permit.

D. Deny the request to discharge to the public storm and/or sanitary sewer system.

E. Allow unrestricted connection to the public storm and/or sanitary sewer system, with an approved monitoring/testing structure.

Contaminants, media, and site conditions are unique to each parcel of land. Sites at risk for contamination shall therefore be reviewed on a case-by-case basis.

Soil Management

Stockpiles of contaminated soils shall be covered with temporary plastic film or sheeting to prevent stormwater from contacting them.

Stockpile perimeters shall have a containment barrier on all four sides of every stockpile to prevent stormwater run-on and material run-off. Barriers can consist of concrete curbing, silt fencing, or other berm materials, depending on the activity, size, and resources available.

Areas under stockpiles of contaminated soils are not required to be paved. However, an impervious layer shall be placed beneath the stockpile to protect uncontaminated areas from potential leachate.

Construction Dewatering

For technical assistance on obtaining a batch discharge approval for construction dewatering activities, contact the District's Development Review Division. The following requirements apply:

A. Construction dewatering discharges from contaminated sites to the District's stormwater system are prohibited. Upon approval by the District, these waste streams may be discharged to the sanitary sewer if the discharge meets all standards detailed in Section 5.1.3.

B. Laboratory analysis reports with data for all pollutants of concern will be required.

C. Installation of required pretreatment technology, an approved sampling point, and/or a meter may be required by the District prior to any discharge to the sanitary sewer is permitted.

D. Contact the District for further information on discharging water to the sanitary sewer system.

E. If onsite infiltration is the proposed method for disposal, authorizations are required from the District and the Land and Water Quality Divisions of DEQ. Private infiltration facilities for construction dewatering shall be located and maintained on private property outside the Public ROW.

F. If a public sanitary system is the proposed method of disposal, authorizations are required from the District including the Environmental Monitoring Division and will be allowed only if extensive pretreatment is implemented and the discharge is approved by the District. All groundwater and surface water discharges to a sanitary sewer system shall meet local discharge limits and will be subject to all fees and discharge volume charges.

G. If a Public Stormwater System is the proposed method of disposal, evaluations of discharge to the public storm system will be based on whether discharges meet, or can be pretreated to meet, requirements of the District, NPDES Discharge Permit or other State and Federal regulations for the receiving drainageway.

H. If a drainageway is the proposed method for disposal, authorizations are required from the District, Land and Water Quality Divisions of DEQ.

Post-Construction Surface Drainage Systems

If onsite infiltration is the proposed method for disposal, authorizations are required from the District, Land Quality, and Water Quality Divisions of DEQ. Private infiltration facilities shall be located and maintained on private property, outside the Public ROW.

If a drainageway is the proposed method for disposal, authorizations are required from the District, the Army Corps of Engineers (USACE), and both the Land Quality and Water Quality Divisions of DEQ.

If an offsite public storm or sanitary sewer system is the proposed method for disposal, authorization is required from the District. Evaluations for discharges from sites with suspected contamination will be based on the following:

A. Surface drainage systems that are not exposed to industrial activities, contaminated soils, or subsurface discharges are not assumed to contain contaminants and do not pose a threat to public infrastructure. All discharges to a public sanitary sewer system will require an additional review and approval process.

B. A permanent monitoring and testing point may be required to ensure compliance with discharge regulations. If monitoring is necessary, a permanent structure (such as a sampling manhole or flow-through vault) shall be constructed per District Standards and installed on the discharge line.

Laboratory Analysis Reports

Laboratory analysis reports are required to identify the characteristics and levels of contamination in the soils and groundwater of a site.

The District will determine the applicable process to review the laboratory reports to determine regulatory authority and requirements. Testing and analysis are highly recommended prior to submitting the site plan. DEQ permitting and/or review may be required if contaminants are found and the levels of contamination appear to exceed the District discharge regulations. This may delay issuance of the site plans and related building permits.

Laboratory analysis reports shall include the following information:

A. Analysis reports shall identify the elevation of the seasonal water table and identify the depth of any perched water aquifers.

B. Analysis reports shall identify the method of laboratory testing, the detection level and analytical method used for detection, and the depth of any found contaminants in the soils.

C. Minimum test parameters for baseline contaminants shall include metals (arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, and zinc); total petroleum hydrocarbons; and benzene, toluene, ethyl benzene and xylene.

D. Test parameters may be required to include other contaminants identified through historical data, research, and environmental assessments.

Additional Requirements

Typical structural controls that would need District approval include containment areas, shut-off valves, oil/water separators and pretreatment facilities. If an Applicant requests an alternative or exception to any of the source controls identified in this section, the Applicant shall engage with District staff. These types of requests require an additional review process and may delay issuance of the site plans and related building or development permits.

5.2.9 Covered Vehicle Parking Areas for Commercial and Industrial Uses

These requirements apply to all development with a covered vehicle parking area, except single-family and duplex residential sites. Projects that add a cover to an existing parking structure are not required to meet these requirements unless the project expands or replaces existing impervious surfaces.

A. Stormwater runoff from the top floor of a multi-level parking structure shall be directed to a SMF and Approved Point of Discharge that meets all requirements of these Standards.

B. Significant amounts of precipitation are not expected to accumulate in covered vehicle parking areas, and drainage facilities are not required for the lower floors. If the Applicant elects to install drainage facilities, the drainage from the lower floors of a multi-level parking structure shall be directed to the public sanitary sewer system. Prior to discharge all applicable pretreatment and/or oil water separator requirements shall be met.

C. The surrounding uncovered portions of the site shall be designed so precipitation and stormwater runoff does not enter the covered parking areas. This can be accomplished through grading and/or drains.

D. Single-level covers (canopies, overhangs, and carports) are exempt from the requirements of this section.

5.2.10 Industrial and Commercial High Traffic Areas

These requirements apply to all new development with vehicle parking areas for developments zoned industrial or commercial with high-traffic volumes. High-traffic volumes are defined as an average daily traffic of 2,500 vehicles, consistent with DEQ's Industrial Stormwater Best Management Practices Manual (February 2013).

Industrial and commercial high-traffic areas with a drainage area of over 10,000 sf directed to a single shall have an adequate oil control facility located upstream of the SMF. Parking areas of over 10,000 sf that are divided into drainage areas of less than 10,000 sf do not require this pretreatment.

Oil Controls

An oil/water separator with coalescing plates shall be installed between the surface drainage catchment structure and the stormwater management treatment facility. The purpose of the device is to treat and prevent hydrocarbons from entering the SMF. This device shall be maintained per the manufacturer's specifications and the approved operations and maintenance plan.

Coalescing plate separators shall be designed to achieve a 100-ppm non-polar oil and grease limit in the effluent from the peak flow generated by the washing activity. Testing information must be submitted by the manufacturer of the unit that supports the 100-ppm effluent standard at the calculated flow rate.

Flow rates will be determined by the drainage area served by the device. The device will be sized to treat the Water Quality Design Storm as specified in Section 6.1.1.

For Proprietary Stormwater Treatment Devices (see Section 6.5.10), check the vendor specifications for design flow rates.

Oil controls and pretreatment facility details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.

All oil controls and pretreatment facilities shall be maintained per the manufacturer specifications and the approved operation and maintenance plan.

6. Stormwater Management Facility Design

SMFs include a variety of methods to mitigate stormwater runoff and remove pollutants from stormwater, including detention, infiltration/retention, sedimentation, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Infiltration is the preferred method to address stormwater runoff for water quality and flow control requirements. In some cases, using a combination of SMFs may be the most effective strategy for removal of specific pollutants of concern in designated high-risk areas.

This chapter describes the methods and criteria for designing SMFs to meet water quality and flow control performance standards. Additional structural source controls may be required for certain types of development categorized as high risk for pollutants as described in Chapter 5.

The District's Stormwater Standards guide the design of Stormwater Management Plans for new development and redevelopment projects. Site-specific Stormwater Management Plans are most effective when developed early in the site planning process. Strategies for meeting the requirements in these standards depend on several site factors, including soil infiltration capacity, available infrastructure, proposed development plans, and downstream conveyance. The plan review and approval requirements are specific to each jurisdiction and may vary from one application, submittal, and building permit to another. To obtain further information on a specific plan review or permit process, contact the District.

6.1 Stormwater Management Performance Standards

Applicants of projects subject to stormwater review must demonstrate that the proposed project will include SMFs that meet water quality and flow control performance standards.

6.1.1 Water Quality Performance Standard

SMFs shall be designed to capture and treat 80 percent of the average annual runoff volume, to the maximum extent practicable with the goal of 80 percent total suspended solids removal. In this context, "maximum extent practicable" means less-effective treatment may not be substituted when it is practicable to provide more effective treatment. Based on local rainfall frequency and intensity, the required treatment volume equates to a Water Quality Design Storm of 1.0 inch over 24 hours. SMFs for water quality shall be designed in conformance with the design guidelines in this section.

Hydrodynamic separators, when used as a sole method of stormwater treatment, do not meet the "maximum extent practicable" requirement for stormwater treatment effectiveness with regard to these Standards.

6.1.2 Flow Control Performance Standard

Flow control facilities shall be designed so that the duration of peak flow rates from Post-Development Conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42 percent of the 2-year peak flow rate up to the 10-year peak flow rate. A hydrologic/hydraulic analytical model capable of performing a continuous simulation of peak flow rates from local long-term rainfall data must be used to determine the peak flow rates, recurrence intervals, and durations. SMFs for flow control shall be designed in conformance with the design guidelines in Section 6.4.

Flow control is not required for projects that discharge directly to the Willamette River, the Tualatin River, or the Clackamas River, provided that all of the following conditions are met:

A. The project site is drained by a storm drainage system that is composed entirely of man-made conveyance elements (e.g., pipes, culverts, ditches, outfall protection, etc.) and the storm drainage system extends to the ordinary high-water line of the exempt water body.

B. The entire length of the storm drainage system between the project site and the exempt receiving water shall have sufficient hydraulic capacity to convey discharge from the proposed development of the site and the existing development condition from the remaining drainage area contributing to the storm drainage system for the 25-year storm event, based on the conveyance of the design storm as outlined in Section 7.3.

C. Any erodible elements of the man-made storm drainage system must be adequately stabilized to prevent erosion under the conditions noted above.

D. The constructed storm drainage system does not result in an inter-basin transfer of runoff, as determined by the District.

Projects that are exempt from flow control are still subject to the other requirements outlined in these standards, including requirements to provide erosion and sediment control, water quality treatment, storm drainage systems, downstream storm drainage system analysis and applicable source controls.

In designated basins with limited downstream conveyance capacity, flow control shall be designed to reduce the 25-year, 24-hour, post-developed runoff rate to the 2-year, 24-hour pre-developed discharge rate. If there are segments of the downstream Conveyance System that can be upgraded, this additional flow control requirement may still require downstream stormwater conveyance system improvements in order to safely convey all existing and proposed stormwater runoff generated from the upstream and onsite drainage basins.

The District has identified the following drainage basins as having limited downstream capacity within portions of the existing associated stormwater Conveyance System:

A. Cedar Creek Basin (see **Figure 1**)

B. Johnson Creek Basin (see **Figure 2**)

C. Upper Kellogg Creek Basin (see **Figure 3**)

D. Tributary Basin of Mt. Scott Creek (see

E.

F. **Figure** 4)

Figure 1. Cedar Creek Basin

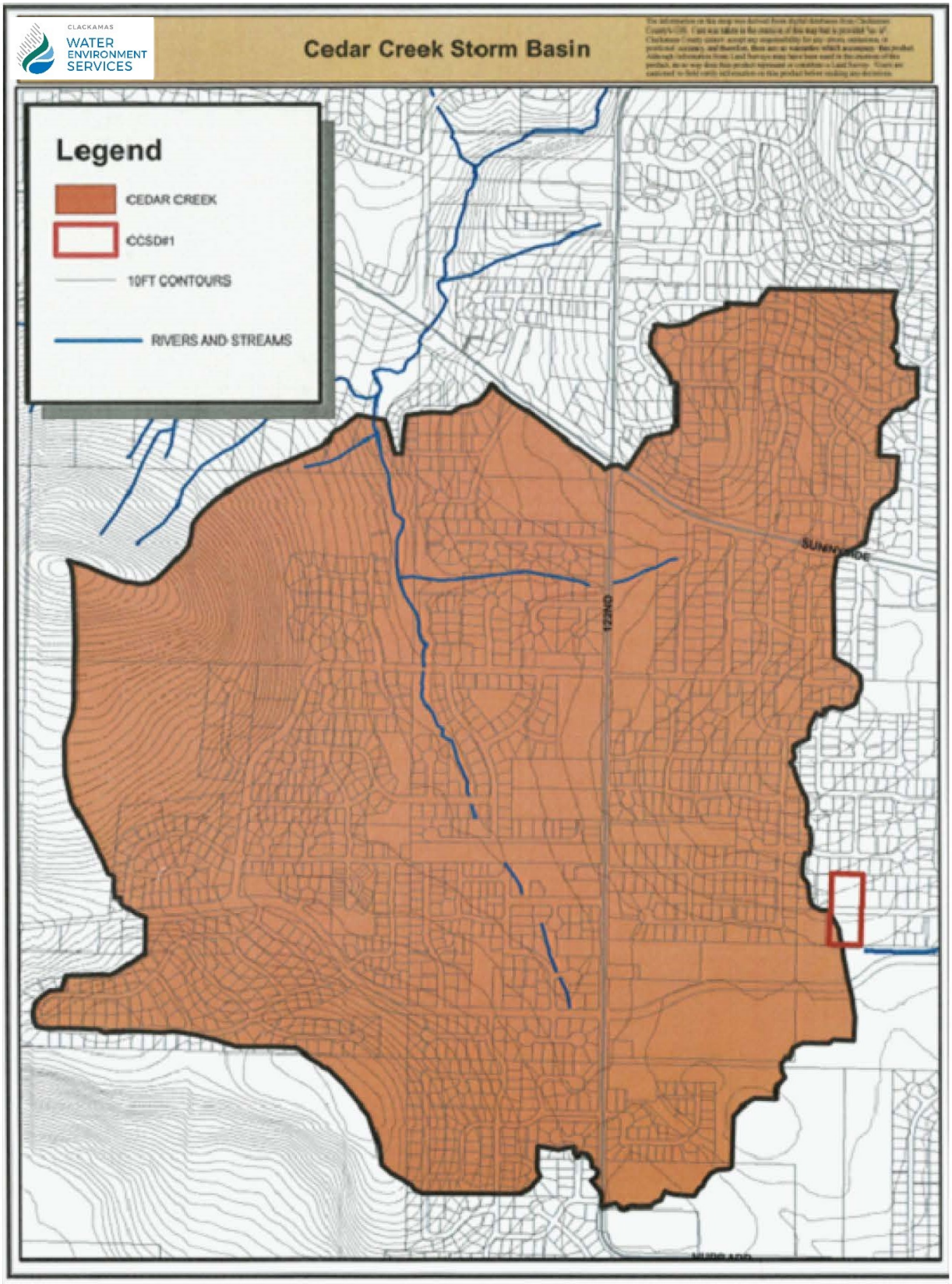


Figure 2. Johnson Creek Basin

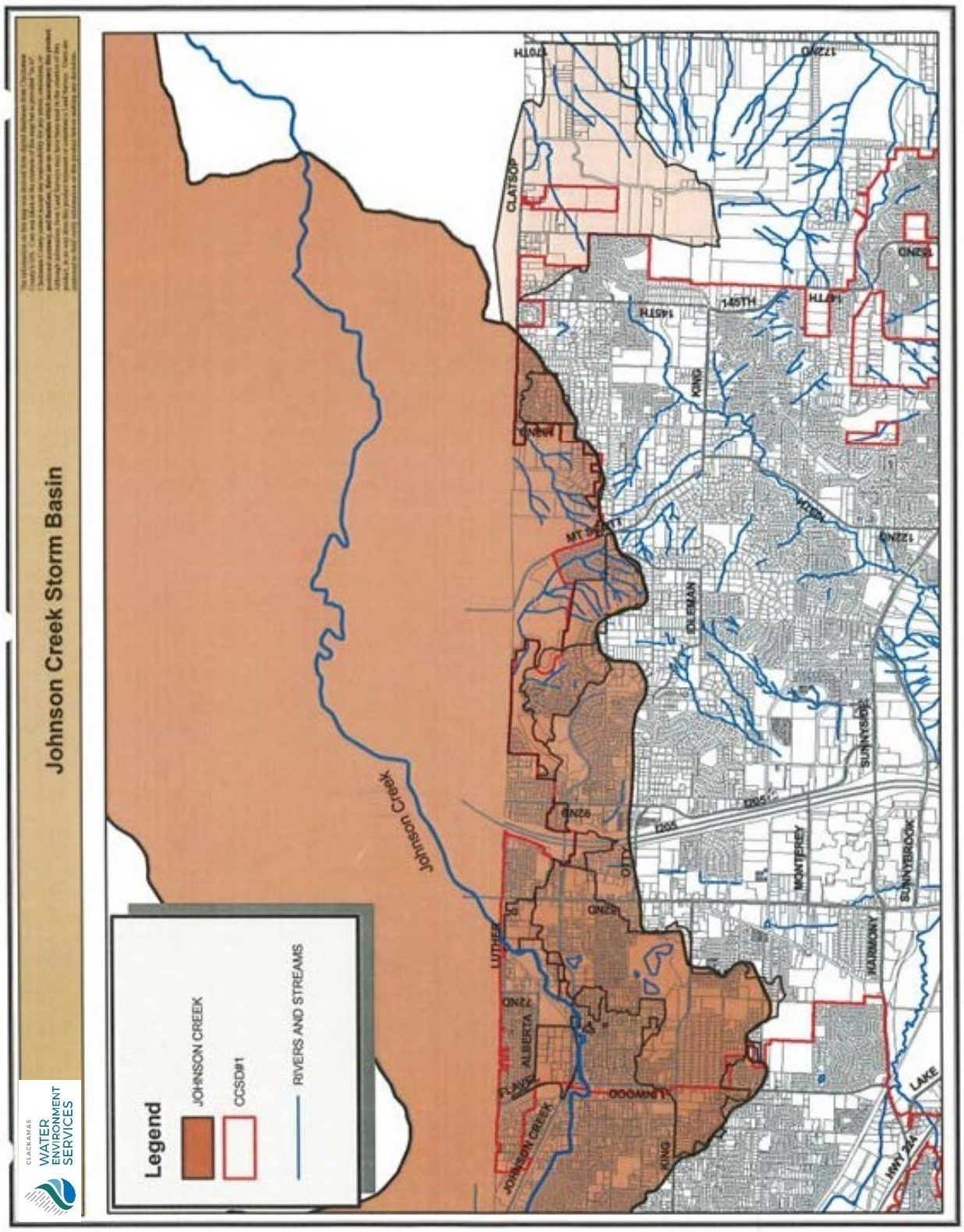


Figure 3. Upper Kellogg Creek Basin

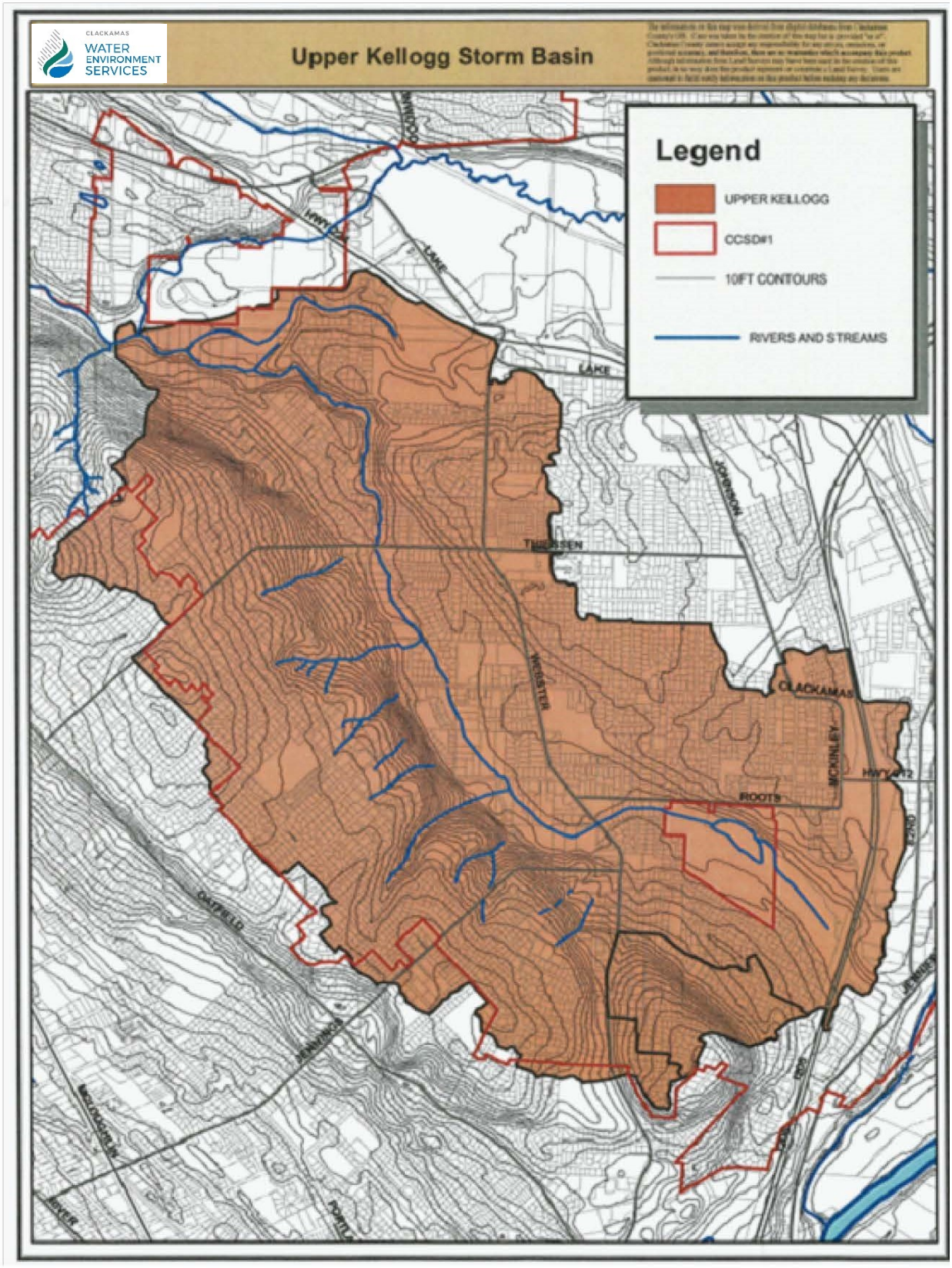
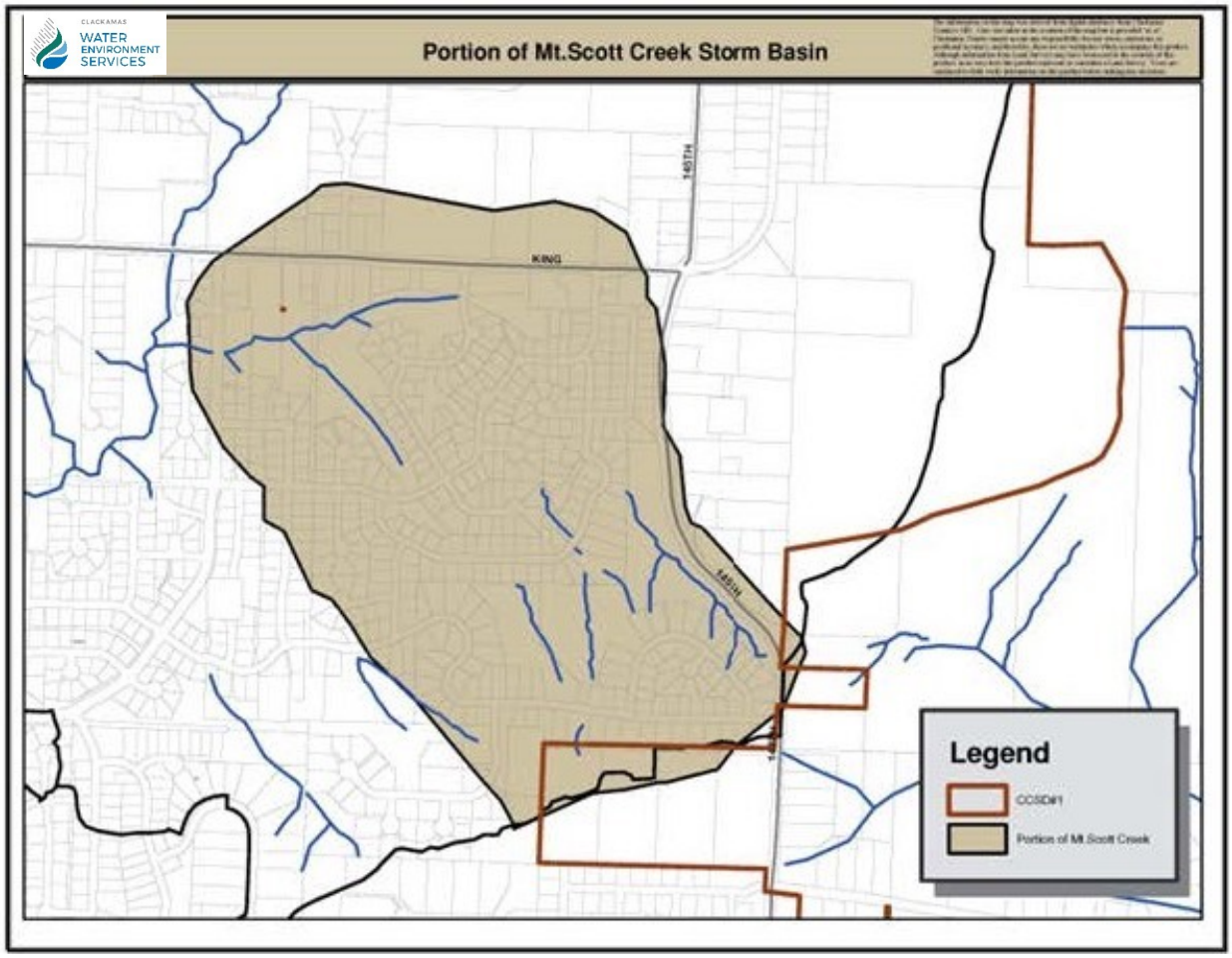


Figure 4. Tributary Basin of Mt. Scott Creek



6.1.3 Emergency Overflow Pathway

For all projects with SMFs, an overland emergency overflow pathway must be identified and/or designed that allows runoff from large storm events to discharge without risk of injury or property damage. The emergency overflow pathway must be incorporated into the design to show how flow will escape from the site during rainfall events larger than the design storm and/or from failure of the primary stormwater storm drainage system. If a Storm Drainage System is used as a component to convey the emergency overflow pathway, then the structure(s) and system shall be designed to convey the 100-year Design Storm.

The Applicant shall identify the proposed 100-year emergency overflow pathway. If downstream properties are impacted by the 100-year storm event, then the Applicant shall provide additional flow control or secondary SMFs to mitigate the potential impact.

6.1.4 Fee In Lieu

When a proposed development is unable to meet the flow control or water quality performance standards, the District may allow Applicants to pay a fee in lieu of stormwater management improvements. In such a case, the fee shall be based on a proportional cost for the District to construct an equivalent SMF including costs for land acquisition, design, construction, maintenance, and administration.

The financial viability of designing and constructing onsite or offsite SMFs is not a justification to use the fee in lieu program. Applicants must demonstrate that the proposed development site has one or more physical limitations that prevent the installation of onsite SMFs, and that offsite or regional facilities are not a feasible alternative. All projects should meet the downstream storm drainage system capacity requirements, and provide an emergency overflow pathway, as needed.

6.2 Stormwater Management Facility Sizing Methods

This section explains the methods accepted by the District for determining the appropriate size and configuration of SMFs to achieve the performance standards.

A Stormwater Report that meets the submittal requirements of **Appendix A** must accompany the engineered stormwater plans to demonstrate and document the design, including sizing methods and calculations.

6.2.1 Infiltration

When site conditions allow, infiltration is the preferred strategy to achieve the stormwater management performance standards. When a SMF is designed to fully infiltrate the 10-year, 24-hour Design Storm, the facility is assumed to meet the flow control performance standard without further analysis. Such facilities provide onsite stormwater retention for most rainfall conditions and should only result in partial downstream discharge during events larger than a 10-year storm. When site conditions do not allow infiltration of the full 10-year, 24-hour Design Storm, infiltration can still be incorporated into the flow control facility design to reduce the volume of discharge released from the site. Flow control facilities designed with partial infiltration should include an underdrain, control structure, and overflow system to manage the release rates from the facility. Whether or not infiltration is incorporated into the design, release rates from the facility must meet the flow control performance standard in Section 6.1.2.

When a rain garden, planter, swale, or pond is designed to fully infiltrate the 10-year, 24-hour Design Storm, the facility is also assumed to meet the water quality performance standard, without further analysis. UIC facilities, such as drywells, infiltration trenches, and infiltration chambers may require upstream water quality treatment to meet the water quality performance standards. Refer to the individual facility design requirements in Section 6.5 to determine which infiltration facilities can be used to provide upstream water quality treatment for UICs. When a UIC facility is designed to infiltrate the 10-year 24-hour Design Storm, the Applicant is responsible for demonstrating the proposed UICs will be rule authorized under Oregon Administrative Rules (OAR) 340-44-008 or will obtain an DEQ-issued UIC Permit.

The Applicant shall conduct infiltration testing and establish a design infiltration rate as described in this section. Infiltration testing is required as part of obtaining the Service Provider Letter.

Infiltration may be limited where any of the following conditions exist:

A. Infiltration rates of less than ½-inch per hour.

B. Sites that include steep slopes (>25 percent) and/or geologic hazard zone designation (Subsection 1002.01, Hillsides of the Clackamas County Zoning and Development Ordinance). A geotechnical engineering or geologist report and District approval is required for infiltration facilities located on moderate slopes of 10 to 25 percent.

C. Sites in areas of seasonal high groundwater table. Sites with jurisdictional wetlands or FEMA floodplains may be required to perform a seasonal high groundwater table assessment to determine that the seasonal groundwater table is at least 12 inches below the bottom of proposed non-infiltrating stormwater facilities.

D. Sites within the 2-year time of travel to irrigation or drinking water wells or within the 500-foot horizontal setback from irrigation or drinking water wells are not suitable for UICs, such as drywells or infiltration trenches or galleries. However, green infrastructure facilities that provide water quality treatment in conjunction with infiltration, such as rain gardens, planters, and bioinfiltration swales, may still be used within water pollution control facility (WPCF) permit setback distances.

E. Sites where SMFs would be located on new or existing structural fill material.

F. Sites that have contaminated soils must be evaluated by the DEQ and/or the EPA to determine if areas on the property are suitable for infiltration without the risk of mobilizing contaminants in the soil or groundwater. Documentation showing contamination assessment and determination must be submitted to the District at the time of application.

G. There is a conflict with required source controls for high-risk sites (see Chapter 5).

For sites with limiting conditions, Applicants should document the infiltration limitations and design SMFs that do not use infiltration. Infiltration testing may still be required to document select limitations.

Sites without limiting conditions have the potential to use infiltration as part of the stormwater management strategy. Applicants shall conduct infiltration testing and establish a design infiltration rate for potential SMFs. Infiltration, even at slow rates, has the potential to retain stormwater at the source, recharge groundwater, and reduce offsite flows. Incorporating infiltration into SMF design can also reduce the footprint of required SMFs.

Regardless of the tested infiltration rate of the soils on the site, Applicants must demonstrate that SMFs will meet the performance standards for water quality treatment and flow control detailed in Chapter 6.

Infiltration testing is required to determine the suitability to retain the stormwater runoff.

Infiltration Testing to Establish Site Characteristics and to Assess Stormwater Facility Viability

Infiltration testing should be conducted to establish site conditions and soil strata. Infiltration testing can identify ideal locations for SMFs or to identify where site constraints exist.

Required Infiltration Tests

The type and number of required infiltration tests depends on the size and type of proposed development (see **Table 3** and

Table 4). Infiltration testing shall be conducted according to the specifications in **Appendix A**, or using an equivalent method approved by the District. When a confining layer, or soil with a greater percentage of fines is observed during the subsurface investigation to be within 4 feet of the bottom of the planned SMF, the testing should be conducted within the confining layer

Table 3. Types of Infiltration Tests

Development Size	Test Type	Number of Tests
Development less than 10,000 square feet of impervious area	Basic Method	One test at the location and depth of each proposed SMF
Development equal to or greater than 10,000 square feet of impervious area	Professional Method	See Table 4.

Table 4. Number of Professional Method Infiltration Tests

Type of Development	Location of Infiltration Test	Minimum Number of Infiltration Tests	Maximum Number of Infiltration Tests
Single Family and Partitions	At the location and depth of the proposed SMF(s)	One test per SMF	One test per SMF
Subdivisions	At location and depth of the proposed SMF(s)	One test per SMF	If more than five SMFs are proposed, the District may accept a recommended infiltration rate from a Geotechnical Engineer based on the consistency of the soil classification(s) throughout the site, unless otherwise permitted by the District
Non-single family residential (e.g., multi-family, commercial, industrial, and all other types)	At location and depth of the proposed SMF(s)	One test per SMF	If more than five SMFs are proposed, the District may accept a recommended infiltration rate from a Geotechnical Engineer based on the consistency of the soil classification(s) throughout the site, unless otherwise permitted by the District

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Design Infiltration Rate

When feasible, infiltration is the preferred strategy to satisfy the flow control performance standard. The design infiltration rate shall be determined by the Developer's Engineer conducting the infiltration test. A minimum correction factor of 2 shall be applied to the field-tested infiltration rates to determine the design infiltration rate for SMF design.

The design infiltration rate after applying the safety factor shall not exceed 100 in/hr for non-vegetative facilities, such as drywells or infiltration chambers. Vegetated facilities with growing media shall be designed at a maximum infiltration rate of 6.0 in/hr through the growing media.

SMFs shall be designed with an infiltration component, unless otherwise stipulated by the design professional. If the SMF cannot be designed to fully infiltrate the 10-year storm event, then an underdrain and outflow will be required to safely convey the discharge from the SMF to an approved discharge point. If the proposed facility does not have an approved discharge point, then it must be designed to fully infiltrate the 25-year storm event as required by the District.

6.2.2 Water Quality Facility Sizing

Water quality SMFs shall be sized to capture and treat 80 percent of the average annual stormwater runoff with the goal of 80 percent total suspended solids removal. This is equivalent to treating runoff from the first 1.0 inch of an individual 24-hour storm event.

The water quality design volume or flow rate shall be determined through one of the following methods:

A. The water quality design volume for volume based SMFs (constructed wetlands, ponds, planters, rain gardens, and bioinfiltration swales) shall be calculated as the total runoff volume from a storm with 1.0 inch of precipitation. Volume analysis may be performed using a hydrograph analysis program or spreadsheet tools. (Refer to Chapter 7. and **Appendix D** for design limitations and calculation references when using the Santa Barbara Urban Hydrograph [SBUH], Technical Release 55 (TR-55), or SWMM method for sizing water quality treatment.) The City of Portland's Stormwater Management Manual Presumptive Approach Calculator is not approved for use to meet WES Water Quality Facility Sizing.

B. The design flow rate for flow based SMFs (filter strips and most manufactured treatment systems) shall be calculated as the peak discharge from design storm with the following peak rainfall intensities:

    a. Design storm intensity for online facilities of 0.18-inches per hour (in/hr)

    b. Design storm intensity for offline facilities of 0.10 in/hr

C. Use a continuous simulation hydrologic/hydraulic model analysis that addresses the design equivalent of capturing and treating 80 percent of the average annual stormwater runoff.

D. Volume calculations using the 1.0-inch Design Storm and the following equation:

$$V_{imp} \text{ or } V_{perv} = 3{,}630 * A * \frac{\left(P_{design} - 0.2 * \left[\frac{1{,}000}{CN} - 10 \right] \right)^2}{\left(P_{design} + 0.8 \left[\frac{1{,}000}{CN} - 10 \right] \right)}$$

where:

V = runoff volume (impervious or pervious), cubic feet

A = drainage area, acres

P = design precipitation depth, inches (assumed to be 1.0 for water quality sizing)

CN = National Resource Conservation Service (NRCS) curve number, unitless (see **Appendix D**)

6.2.3 Flow Control Facility Sizing

To design for flow duration matching, a hydrologic/hydraulic analytical model capable of performing a continuous simulation of peak flow rates from local long-term rainfall data must be used to determine the peak flow rates, recurrence intervals, and durations.

The Developer's Engineer may use any analytical model capable of performing a continuous simulation of peak flows from long-term local rainfall records. Regardless of how the stormwater calculations are performed, the report submitted to the District must show how the proposed SMFs meet the flow control performance standards. Creation of

a continuous simulation hydrologic model for a specific development site requires specialized expertise and usually takes additional time and expense to develop and review. The Applicant may be required to pay additional fees to the District to review the Stormwater Management Plan developed using other modeling methods. These fees will be used to pay for a third-party peer review of the stormwater report, hydrologic model, and facility design.

6.3 General Design Requirements

When a SMF is required, green infrastructure, such as planters, swales, rain gardens, ponds, and other vegetated facilities are the preferred strategy to meet the stormwater management requirements for water quality treatment and flow control. The best way to control the rate and duration of runoff is through the incorporation of infiltration using green infrastructure.

6.3.1 Allowable Facilities

While the District provides design guidance for numerous public and privately maintained SMF types, not all facilities are acceptable for use in every jurisdictional area. **Table 5** and **Table 6** provide lists of facilities that are approved for use in different parts of the District. The tables cover areas managed by the District, the City of Happy Valley, and the Clackamas County Department of Transportation and Development (DTD).

Applicants should consult with District and local agency staff to understand the types of SMFs that could be approved for use on the project.

If a proposed facility meets the DEQ criteria for a UIC, the Applicant shall comply with UIC requirements and prepare appropriate registration information for DEQ.

Table 5. Facilities Allowed by the District

	Facilities within a Public Street/ROW❶	Publicly Maintained Facilities❶❸	Privately Maintained Facilities❷
Stormwater Planter	YES	YES	YES
Rain Garden	YES	YES	YES
Vegetated Swale	YES	YES	YES
Filter Strip	YES	YES	YES
Drywell	YES	YES	YES
Infiltration Gallery or Trench	NO	YES	YES
Constructed Wetland	NO	YES	YES
Detention or Infiltration Ponds	NO	YES	YES
Structural Detention	NO	YES	YES
Manufactured Treatment	YES	YES	YES
Sheet Flow Dispersion	YES	YES	YES
Pervious Pavement	NO	YES	YES
Green Roof	NO	NO	YES

Notes:

❶ Publicly Maintained Stormwater Facilities - Stormwater Facilities and storm drainage systems that convey stormwater runoff from any Public Rights-of-Way must be maintained by a public agency.

❷ Privately Maintained Stormwater Facilities - Stormwater runoff fully contained on private property and mitigated through a privately owned facility must be maintained by the Owner(s). An on-site maintenance agreement must be recorded as a land record specifying the minimum required amount of maintenance in accordance with District Rules and Standards.

❸ Pervious pavement constructed within the Public ROW requires the approval of the local roadway authority.

Table 6. Facilities Allowed by Happy Valley and DTD

	Facilities within a Public Street/ROW ❶	Publicly Maintained Facilities ❶	Privately Maintained Facilities ❷
Stormwater Planter	YES	YES	YES
Rain Garden	YES	YES	YES
Vegetated Swale	YES	YES	YES
Filter Strip	YES	YES	YES
Drywell	YES (with WES maintenance)	YES (with WES maintenance)	YES
Infiltration Gallery or Trench	NO	NO	YES
Constructed Wetland	NO	YES	YES
Detention or Infiltration Ponds	NO	YES	YES
Structural Detention	YES	YES	YES
Manufactured Treatment	YES (WES maintenance for DTD facilities)	YES	YES
Sheet Flow Dispersion	YES (WES maintenance for DTD facilities)	YES (WES maintenance for DTD facilities)	YES
Pervious Pavement	NO	NO	YES
Green Roof	NO	NO	YES

Notes:

❶ Publicly Maintained Stormwater Facilities - Stormwater Facilities and storm drainage systems that convey stormwater runoff from any Public Rights-of-Way must be maintained by the public.

❷ Privately Maintained Stormwater Facilities - Stormwater runoff fully contained on private property and mitigated through a privately owned facility must be maintained by the Owner(s). An on-site maintenance agreement must be recorded as a land record specifying the minimum required amount of maintenance in accordance with District Rules and Standards.

6.3.2 Alternative Facilities

Applicants may propose SMFs that are not allowed as per Section 6.3.1. Such a proposal will require the Applicant to submit a request for a variance per Section 2.4. Alternate facilities must be designed to meet the performance standards outlined in Section 6.1.

6.4 General Facility Design Requirements

The following design requirements apply to all SMFs. Additional facility specific design criteria are included in Section 6.5.

6.4.1 Location and Setbacks

Applicants must review local zoning, building and plumbing code requirements to understand setback requirements for SMFs. The minimum setback for a stormwater facility is 5 feet from a property line, unless more distance is specified by the Developer's Engineer, geotechnical engineer, and/or by local and state minimum setback requirements. See District Buffer Standards for further information on the design requirements for vegetated facilities and buffer areas.

In addition, stormwater facilities that incorporate an infiltration component are subject to all local and state minimum setback requirements. A geotechnical report is required to determine setbacks from slopes for infiltration facilities installed near slopes ≥15 percent or within 200 feet of a steep slope hazard area or landslide hazard area.

Easements and Setbacks

Piped storm drainage systems shall generally be located in the Public ROW. Public storm drainage system facilities not located in the Public ROW shall be located within an easement granted to the District.

When design conditions require locating storm drains in easements, the storm drain shall typically be centered in the easement.

An easement shall be centered on the pipe centerline, unless otherwise approved by the District, and easements shall typically be exclusive. Combined easements shall be a minimum of 20 feet wide with a minimum separation of 5 feet between utilities and be approved by the District on a case-by-case basis.

All public manholes, junction or inlet structures in easements shall be accessible to District personnel at all times. A minimum 15-foot-wide access easement is required between the nearest ROW and each structure. Paved or gravel access road maybe be required by the District, if access is deemed necessary, and otherwise unavailable.

Unless shown on a proposed plat of subdivision, all onsite easements shall be furnished to the District for review, approval, and recordation prior to approving the Stormwater Management Plan.

All offsite easements shall be furnished to the District for review, approval, and recordation prior to approving the Stormwater Management Plan.

The District may require that an area of 5 feet in all directions from the edge of a public manhole, catch basin, cleanout, or field inlet be encompassed in a Public ROW or easement granted to the District.

Access easements shall be provided to all stormwater structures such as manholes, catch basins, and other related structures, as required by the District.

When a pipe will be stubbed, the easement shall extend a minimum of 5 feet past the end of the stub.

The center of the storm pipes in an easement shall be located no closer than 5 feet from the easement line.

The following easement requirements are the minimum requirements established to maintain, repair and/or replace the stormwater infrastructure or open storm drainage system.

A. Easements shall be minimum 15 feet wide for pipes up to 24 inches in diameter.
B. Easements for pipes over 24 inches in diameter shall be 20 feet wide or greater as determined by the District.
C. The District may require wider easements for large trunk sewers, sewers greater than 10 feet deep and areas with topographic constraints such as steep slopes or sites where maintenance, repair or replacement would require a wider easement.
D. A reduced easement width must be approved by the District.
E. Easement widths shall be increased as required in 5-foot increments as per **Table 7**.

Table 7. Minimum Pipe Size per Minimum Easement Width

Pipe Size (inches)	Minimum Easement Width (feet)
6–12	15
15 < 24	15
24 < 54	20
> 54	30

When a conservation easement is not required, the minimum open storm channel easement width shall extend 5 feet from each side of the top of bank of the open channel.

Structures constructed within easements shall meet the following requirements:

A. Structures constructed within easements shall require an encroachment agreement with the District. Approval of the encroachment is at the discretion of the District and may involve the imposition of specific conditions in the granting of such. The Applicant will complete an encroachment agreement application and pay all applicable charges and fees.
B. The encroachment agreement shall allow the District to remove the structure, as needed, to access the storm drainage system. Replacement of the structure shall be at the Owner’s expense.
C. The District may require increased protection for the storm drainage system in the vicinity of an encroachment. All special protection requirements and plans will be reviewed and approved by the District. All review and/or approval costs associated with this provision will be paid by the Applicant.

6.4.2 Outlet Structures

SMFs designed as flow through systems shall have a perforated pipe underdrain system to convey water from the facility to a flow control structure and/or downstream storm drainage system.

Orifice sizes for SMFs will be specified by the BMP Sizing Tool results. Orifices shall be located to prevent clogging and blockages. Outlet structures (orifices, weirs, overflow risers, etc.) shall be configured to operate as passive systems and shall not require adjustments during normal operation.

Flow control structures shall be located in an enclosed structure, outside the open water storage area, in a location that provides sufficient maintenance access for a minimum of 20 feet. Flow control manholes shall have solid locking covers, however open grates may be permitted.

Outlet structures and overflow configurations must address the 100-year overflow pathway requirements in Section 6.1.3.

Additional outlet requirements for specific facility types are addressed in Section 6.5.

6.4.3 Stormwater Facility Signage

All vegetated and porous SMFs, including permeable surfaces such as pervious pavement shall have at least one informational sign that is clearly visible and legible to the public.

The Permittee shall install the applicable sign(s) before the District deems the project is completed, and/or prior to the issuance of the Certificate of Occupancy Permit.

Signs for publicly maintained SMFs require the following:

A. The Permittee shall be responsible for obtaining and installing the stormwater facility sign at their own expense.

B. The material shall be aluminum with green reflective sheeting and silk screen lettering or equal as approved by the District.

C. The minimum sign size shall be 12 by 18 inches. The maximum sign size shall be 24 by 30 inches.

D. The sign shall be affixed to metal signpost, or facility fencing.

E. The sign shall be installed near the stormwater facility in a location highly visible to the public.

F. The sign shall be created and installed in accordance with the Standard Detail Drawing D.26 SWM ST-3.0 Storm – Surface Water Facility Signs.

G. An electronic file format of the sign is available upon request from the District.

H. Signs may be available for purchase from the District.

Signs for privately maintained vegetated SMFs shall be provided by the Permittee and will include:

A. Description of the facility and its purpose

B. Contact information for maintenance complaints or to report a problem

Signs for privately maintained permeable surfaces, such as pervious pavement, shall be provided by the Permittee and will include at least the following information:

A. Description of the facility and its purpose

B. Contact information for maintenance complaints or to report a problem

C. Operations and maintenance instructions, such as:

    a. Avoid tracking or piling dirt, mud, or sediment on the driveway.

    b. If debris is tracked onto the driveway surface, clean by using a vacuum-type street cleaner during dry weather.

    c. Maintain vegetation along the sides of the driveway to help keep erosion and sediment laden water from clogging the surface.

    d. Do not place any sealants on the driveway.

6.4.4 Soil Mixes for Stormwater Management Facilities

Vegetated facilities require a soil/landscape system that simultaneously supports plant growth, soil microbes, water infiltration, nutrient and pollutant adsorption, sediment and pollutant filtration, and pollutant decomposition. Therefore, the soil mix selected for a facility is critical to its success.

Facilities that include soil, such as swales, planters, curb extensions, and basins, must use the Blended Soil Specification for Vegetated Stormwater Systems from the most currently adopted City of Portland's Standard Construction Specifications in section 0104.14(d), titled Stormwater Facility Blended Soil. See the City of Portland's Stormwater Management Manual website[1] for information about the most current soil specification information and a list of stormwater facility blended soil vendors and haulers.

6.4.5 Planting and Irrigation

SMF planting guidelines are included in **Appendix B**. Planting plans must meet the following requirements:

A. Establish and implement procedures such as control of the following: invasive weeds, animal and vandal damage, mulching, re-staking, and watering to the extent needed (as determined by the District) to ensure plant survival. Plastic and mesh tubes are prohibited and shall not be used within a publicly maintained facility.

B. Stormwater facilities located in the Public ROW are not permitted to include trees.

C. Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions (see **Appendix B**).

D. For facilities located in riparian corridors, all plants within the facility area shall be appropriate native species from the plant list found in **Appendix B** of the Buffer Standards.

E. No nuisance, invasive, or prohibited plants shall be used in any stormwater facilities.

[1] See https://www.portland.gov/bes/stormwater/swmm.

F. The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.

G. Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation once established.

H. Side slopes of planted areas shall not exceed 3h:1v.

The Developer's Engineer or Landscape Architect shall determine the appropriate irrigation strategy to maintain the plant survivability. Temporary irrigation systems must be fully removed by the Developer before the District releases the storm warranty bond.

6.4.6 Pond Embankment, Retaining Walls, Fencing, Gates and Handrails

Pond embankments and retaining walls are allowed to impound water to enhance the functionality of the SMF.

Pond Embankments

Pond embankments must be constructed with a maximum slope of 3h:1v on the upstream and downstream face. Side slopes within the pond must be sloped no steeper than 3h:1v below the maximum water surface elevation, unless otherwise approved by the District.

Retaining Walls

Retaining walls greater than 4-feet in height shall have a professional structural or geotechnical engineer registered in Oregon provide stamped design calculations and detail drawings required for the retaining wall construction, per local building code requirements. Stormwater ponds that require retaining walls will be limited to the height of 10 feet above the vegetated surface elevation for 50 percent of the circumference of the facility, and 6 feet for the remaining portion of the circumference, unless otherwise approved by the District.

Retaining Wall Ownership

The District shall not have any maintenance or ownership responsibility for retaining walls. The Owner of the property (HOA) shall be responsible for the maintenance, repair and/or replacement of the retaining wall(s) within the public easement(s) or tract(s). The ownership and maintenance responsibility for the retaining wall shall be clearly specified in the CCRs and/or within the stormwater maintenance plan.

Fencing, Gate and Handrails

A minimum 6-foot high fence is required to be constructed around the parameter of all publicly maintained stormwater facilities with a designed water depth greater than 3 feet. Publicly maintained stormwater facility must provide a maintenance access gate with a minimum opening width of 12 feet wide that consists of two 6-foot sections. Fencing or handrails may be required along the top of the retaining wall in accordance with local zoning and building codes.

6.4.7 Public Maintenance Access

Publicly maintained stormwater facilities and structures must provide an access road designed and constructed for the intended use and purpose for accessing and maintaining the proposed SMFs. District maintained facilities should be located adjacent

to the Public ROW. Public maintenance access roads shall be designed and constructed to the minimum standards as specified in Table 8.

A. Maintenance road access for District-maintained facilities shall be shown on the recorded plat and be situated in a separate tract and identified with the specific and intended use for maintenance access.

B. The District may require additional protection for access roads, including fencing, signs and/or bollards to restrict public access. Minimum maintenance access of 20 feet to structures is required.

C. All access roads must be rated for a minimum of 80,000 pounds.

Table 8. Access Road Specifications

SLOPE	DESIGNATION	WIDTH		SURFACE	DESIGN NEEDS	STRUCTURAL SUPPORT
		TOTAL	ROAD			
< 8%	EASEMENT	15-ft	12-ft	GRAVEL	N/A	8-INCH GRAVEL FILTER FABRIC
>8% < 12%	TRACT	15-ft	12-ft	2-INCH A.C.	W/O TURNAROUND	8-INCH GRAVEL FILTER FABRIC
12% - 15%	TRACT	20-ft	15-ft	2-INCH A.C.	W/ TURNAROUND W/ LANDING	8-INCH GRAVEL FILTER FABRIC
>15%	**CONTACT DISTRICT**					

General Requirements

A Profile of the access road is required.

Maximum grade:

A. 15 percent with a maximum 3 percent cross-slope.

B. Special permission is required for grades over 15 percent.

Minimum width of surface:

A. 12 feet on straight runs and 15 feet on curves.

B. Curves will be designed with a minimum 40-foot interior radius.

C. Access will extend to within 10 feet of all pollution control structures unless otherwise approved by the District.

D. Access roads in excess of 150 feet in length is required to have a turnaround.

E. Turnaround is required when access is taken from a collector or arterial roadway.

Provide a minimum 12-foot wide double opening gate at the entrance of the stormwater facility maintenance access.

Access Road Contained Within a Tract of Land

All publicly maintained stormwater facilities must provide an access road in accordance with these Standards and must be contained within a Tract of Land that has a WES storm drainage easement.

Design

Access Road:

A. Horizontal curves
    a. Minimum Radius for (inside) = 40 feet
B. Vertical Curves
    a. Vertical Curves
        i. Crest maximum K = 4
        ii. Sag maximum K = 6

    Where K = L/A

    L= algebraic difference in grades percent

    A= length of vertical curve (feet)

Landing:

A. Maximum slope = 4 percent
B. Minimum length of 40 feet

Turnaround:

A. Design per Clackamas County Roadway Standards – Detail C350
B. Maximum cross slope = 4 percent
C. Minimum width of the access road 12 feet
D. Minimum radius for (inside) = 30 feet

Typical Surface:

Three 3-inches of class “B” asphaltic concrete and 2 inches of ¾”-0” compacted crushed rock; over 8 inches of 1½”-0” compacted crushed rock; over subgrade compacted to 95 percent AASHTO T-99.

The Developer’s Engineer may submit a certified road design capable of supporting a 30-ton maintenance vehicle in all weather conditions.

Driveway Access:

All access roads shall have a standard driveway with 6 inches of concrete over 2 inches of gravel. The plan will include design of strengthened sidewalk sections (6 inches of concrete minimum) where maintenance vehicles will cross. (See D600 Clackamas County Department of Transportation).

The final plan will have to show how maintenance equipment will safely access the pond. At least one side of the detention pond is required to have an access suitable for maintenance equipment (backhoe etc.). Direct access to the pond must be 15 feet wide and slopes of 4h:1v or flatter.

6.4.8 Private Maintenance Access

Privately maintained facilities shall be located in a manner so that the facility can be safely and efficiently maintained. Egress and ingress access routes shall be clear of any obstacles and constructed of a sufficient surface to safely convey the size and weight of vehicles, and equipment necessary to maintain, repair and replace the SMF.

6.4.9 Underground Injection Control Registration

Infiltrators and infiltration trenches are generally classified as UICs by DEQ. The District will evaluate each case and may accept ownership and/or maintenance responsibility for UICs. For UICs on private property, with the exception of single-family residential roof and footing drains, there is a requirement to register the UICs and provide site inventory data to DEQ.

Any proposed UIC facility shall be rule authorized pursuant to OAR 340-44-008, have an DEQ-issued UIC permit associated with the facility, or have a notice of intent to issue a UIC permit.

6.5 Stormwater Facility Design Requirements

The following section includes SMF design guidelines for facilities approved for use in the District. Typical facility drawings are included in **Appendix C**.

6.5.1 Stormwater Planter

Stormwater planters are walled basins that capture and treat runoff through a combination of vegetation and an engineered soil mix called biofiltration soil medium. Planters may also be used for flow control when designed with infiltration or with an underdrain with controlled outlet.

Planters treat stormwater through sedimentation of particles in ponded water; filtration and phytoremediation through contact with vegetation; and biodegradation and adsorption of pollutants through contact with soil organisms and chemical soil processes. Planters and rain gardens provide similar treatment and flow control performance, though planters require less space than rain gardens to treat the same contributing area.

General Stormwater Facility Requirements

Water quality pretreatment is generally not required.

Stormwater facilities shall be designed to treat the entire inflow.

An infiltration test shall be conducted at the location and depth of the facility.

SMFs shall have a minimum separation of 3 feet from the bottom of the facility to the seasonal high groundwater elevation or other layer that limits infiltration (e.g., bedrock, clay lens).

If infiltration is used as a design component to determine retention, then the maximum draw down time is 24 hours.

Native soil infiltration rate shall be at least 0.25 in/hr for an infiltration planter. If the infiltration rate is less than 0.25 in/hr, an underdrain is required. For native soil infiltration rates between 0.25 and 2.0 in/hr, the engineer shall determine the need for an underdrain based on design performance calculations.

Water quality planters shall be located prior to the flow control facility, and not be located downstream of detention.

Planters are designed with vertical walls and may require a structural engineer to design (because of their structural walls).

Planters receiving stormwater from downspouts need energy dissipation at the downspout outlet and planters receiving water from the street need a sediment forebay to facilitate maintenance.

Lined flow-through planters may not have setback requirements from building foundations. Check with local building code division to confirm the setback of these facilities from building, structures, and property lines.

Planters shall be designed to consider safety issues (including pedestrian safety). Curbing, fencing, railings, or placing planters above grade may be necessary. Planters located within the ROW shall be approved by the local roadway authority.

Dimensions

Drain rock depth is 18 inches.

Minimum bottom width: 2.0 feet.

Minimum orifice size: filtration facilities 0.5-inches, all other 1.0 inches.

Minimum freeboard: 2.0 inches, if contributing area is less than 5,000 sf; 6.0 inches for larger contributing areas.

Maximum ponding depth: 12.0 inches.

Depth of biofiltration mix: 18 inches minimum.

Materials

When required, waterproof liners shall be 30 mil polyvinyl chloride (PVC) membrane or equivalent.

Planter walls and bottom (when needed) shall be made of concrete. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater shall not be used.

Drain rock is required below the biofiltration soil mix. For infiltration planters, use 0.75 to 1.5 inches of washed drain rock. Drain rock shall conform to Oregon Department of Transportation (ODOT) Standard Specifications 00430.11 or AASHTO No. 4.

When used, underdrains shall be a minimum of 4-inches diameter for private facilities and a minimum of 6 inches for publicly maintained facilities. Underdrains shall be slotted or perforated PVC that conforms to American Society for Testing and Materials (ASTM) D 3034, with a pipe stiffness of 46 pounds per square inch (psi) or a minimum standard dimensional ratio (SDR) of 35 or approved equal. Installation and testing requirements shall conform to the current OPSC and ODOT Standard Specification 02415.50 for PVC pipe. Slotted perforations (0.064-inch-wide x 1.00 inch-long, spaced 0.3-inch on center) are preferred and less susceptible to clogging.

Drain rock and biofiltration soil mix shall be separated by a 2-inch to 3-inch choker course layer. Choker course shall conform to ODOT Standard Specifications 00430.11.

Biofiltration soil mix must support long-term plant and soil health and provide treatment for water as it moves through the soil column. See Section 6.4.4 for soil mix requirements.

Plant selection shall follow the Planting Guide in **Appendix B**. Plant selection shall be based on water level tolerances during the rainy season, as well as the ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in the proposed planter. Planters shall be designed so that they do not require mowing.

6.5.2 Rain Garden

Rain gardens are vegetated depressions that capture and treat runoff with a combination of vegetation and biofiltration soil medium. Rain gardens may also be used for flow control when designed to infiltrate or with an underdrain with controlled outlet.

Rain gardens treat stormwater through sedimentation of particles in ponded water, filtration, and phytoremediation through contact with vegetation, and biodegradation and adsorption of pollutants through contact with soil organisms and chemical soil processes. Rain gardens are ideal for residential and small commercial sites, within parking lots, and along roadways. They can help fulfill landscaping requirements.

Rain gardens may take a variety of shapes to fit the site layout. Rain gardens may be round, linear, or irregular shape and can have multiple distinct depressions, called cells, which can be linked hydraulically via overflow structures or berms.

Site Requirements

Pretreatment is not required.

An infiltration test shall be conducted at the location and depth of the facility.

Rain gardens shall have a minimum separation of 3 feet from the bottom of the facility to the seasonal high groundwater elevation or other layer that limits infiltration (e.g., bedrock, clay lens).

If infiltration is used as a design component to determine retention, then the maximum draw down time is 24 hours.

The native soil infiltration rate shall be at least 0.25 in/hr for an infiltration rain garden. If the infiltration rate is less than 0.25 in/hr, an underdrain is required. For native soil infiltration rates between 0.25 and 2.0 in/hr, the engineer shall determine the need for an underdrain based on design performance calculations.

Water quality raingardens shall not be located downstream of detention.

Dimensions

Minimum drain rock depth is 18 inches.

Minimum bottom width: 2.0 feet

Planted side slopes: no steeper than three horizontal to one vertical (3h:1v). Rock or concrete walls may be used for areas that require steeper side slopes.

Minimum orifice size: filtration facilities 0.5-inches, all other 1.0 inch.

Minimum freeboard: 2.0 inches, if contributing area is less than 5,000 sf; 6.0 inches for larger contributing areas.

Maximum ponding depth: 12.0 inches.

Depth of biofiltration mix: 18 -inches minimum.

Materials

When required, waterproof liners shall be 30 mil PVC membrane or equivalent.

Drain rock is required below the biofiltration soil mix. For infiltration rain gardens, use 0.75 to 1.5 inches of washed drain rock. Drain rock shall conform to ODOT Standard Specifications 00430.11 or AASHTO No. 4.

When used, underdrains shall be a minimum of 4-inches diameter for private facilities and a minimum of 6 inches for public facilities. Underdrains shall be slotted or perforated PVC that conforms to ASTM D 3034, with a pipe stiffness of 46 psi or a minimum SDR of 35 or approved equal. Installation and testing requirements shall conform to the current UPC and ODOT Standard Specification 02415.50 for PVC pipe. Slotted perforations (0.064-inch-wide x 1.00 inch-long, spaced 0.3-inch on center) are preferred and less susceptible to clogging.

Drain rock and biofiltration soil mix shall be separated by a 2- to 3-inch choker course layer. Choker course shall conform to ODOT Standard Specifications 00430.11.

Biofiltration soil mix must support long-term plant and soil health and provide treatment for water as it moves through the soil column. See Section 6.4.4 for soil mix requirements.

Plant selection shall follow the Planting Guide in **Appendix B**. Plant selection shall be based on water level tolerances during the rainy season, as well as ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in the proposed rain garden. Rain gardens shall be designed so that they do not require mowing.

6.5.3 Vegetated Swale

Vegetated swales are gently sloping, landscaped depressions that collect, convey, and treat stormwater runoff with a combination of vegetation and a biofiltration soil medium. Swales may also be used for flow control when designed with infiltration or with an underdrain with controlled outlet. Vegetated swales are designed much like rain gardens, but with a sloping bottom.

Vegetated swales reduce stormwater flow rates, volume, and temperature and improve water quality. Pollutants are removed as runoff passes through the vegetation and soil media and is collected in an underlying layer of gravel or drain rock. Swales are ideal for residential and small commercial sites, within parking lots, and along roadways. They can help fulfill landscaping requirements.

Site Requirements

Pretreatment is not required.

An infiltration test shall be conducted at the location and depth of the facility.

SMFs shall have a minimum separation of 3 feet from the bottom of the facility to the seasonal high groundwater elevation or other layer that limits infiltration (e.g., bedrock, clay lens).

If infiltration is used as a design component to determine retention, then the maximum draw down time is 24 hours.

The native soil infiltration rate shall be at least 0.25 in/hr for an infiltration swale. If the infiltration rate is less than 0.25 in/hr, an underdrain is required. For native soil infiltration

rates between 0.25 and 2.0 in/hr, the Developer's Engineer shall determine the need for an underdrain based on design performance calculations.

Water quality swales shall not be located downstream of detention.

Dimensions

Longitudinal Slope: range is from 0.5 to 6 percent (for steeper sites, use check dams or similar features to slow flow velocity and create step pools to promote infiltration.) See also Section 7.4 and Typical Facility Drawings and associated notes in **Appendix C**.

Minimum drain rock depth is 18 inches.

Minimum bottom width: 2.0 feet.

Planted side slopes: no steeper than three horizontal to one vertical (3h:1v). Rock or concrete walls may be used for areas that require steeper side slopes.

Minimum orifice size: 0.5-inches.

Minimum freeboard: 2.0 inches, if contributing area is less than 3,000 sf; 6.0 inches for larger contributing areas.

Maximum ponding depth: 12.0 inches.

Depth of biofiltration mix: 18 inches minimum.

Materials

When required, waterproof liners shall be 30 mil PVC membrane or equivalent.

Drain rock is required below the biofiltration soil mix. For infiltration swales, use 0.75 to 1.5 inches of washed drain rock. Drain rock shall conform to ODOT Standard Specifications 00430.11 or AASHTO No. 4.

When used, underdrains shall be a minimum of 4-inches diameter for private facilities and a minimum of 6 inches for public facilities. Underdrains shall be slotted or perforated PVC that conforms to ASTM D 3034, with a pipe stiffness of 46 psi or a minimum SDR of 35 or approved equal. Installation and testing requirements shall conform to the current UPC and ODOT Standard Specification 02415.50 for PVC pipe. Slotted perforations (0.064-inch-wide x 1.00 inch-long, spaced 0.3-inch on center) are preferred and less susceptible to clogging.

Drain rock and biofiltration soil mix shall be separated by a 2-inch to 3-inch choker course layer. Choker course shall conform to ODOT Standard Specifications 00430.11.

Biofiltration soil mix must support long-term plant and soil health and provide treatment for water as it moves through the soil column. See Section 6.4.4 for soil mix requirements.

Plant selection shall follow the Planting Guide in **Appendix B**. Plant selection shall be based on water level tolerances during the rainy season, as well as ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in the proposed swale. Swales shall be designed so that they do not require mowing.

6.5.4 Filter Strip

Filter strips are gently sloped areas intended to remove pollutants using sheet flow that runs off adjacent impervious surfaces. Filter strips are vegetated with grasses and densely spaced groundcovers that filter pollutants and reduce the velocity of stormwater.

Filter strips are a good choice for use adjacent to uncurbed roads where a gravel shoulder or shallow gravel strip helps to uniformly distribute flow. They can also be good choices for small projects; for example, to provide water quality treatment for roof or driveway runoff before it is discharged into a drywell, infiltration trench, or other facility.

Site Requirements

Pretreatment not required.

Filter strips are appropriate for all soil types.

Flow shall be distributed evenly along the length of the strip. This may require additional structures or design features to fully spread point discharges along the length of the strip.

Filter strips shall be a minimum of 50 feet from wetlands, rivers, streams, and creeks.

The maximum flow path distance of the contributing impervious surface shall be 100 feet to prevent concentrated flow.

Dimensions

Slope (measured in the direction of flow): 0.5 to 10 percent

Minimum width: 5 feet, measured in the direction of flow

Maximum slope of contributing impervious area (measured in the direction of flow): 6 percent. Steeper slopes may be allowed with an appropriate energy dissipation structure between the impervious area and filter strip.

Maximum design flow depth: 1.0 inch for water quality flow.

Maximum design velocity: 0.5-feet per second for water quality flow.

The filter strip width and slope shall be determined through iterative calculations, using the following two equations:

$$y = \left(\frac{Q_{design} * n}{1.49 * T * \sqrt{S}} \right)^{0.6} \qquad V = \frac{Q}{T * y}$$

and

where:

Q = water quality flow rate, cubic feet per second

T = filter strip width (measured in the direction of flow), feet

S = filter strip slope (measured in the direction of flow), feet per feet

y = flow depth, feet (maximum 0.083)

n = Manning's roughness coefficient, unitless

V = flow velocity, feet per second (maximum 0.5)

Materials

Plant selection shall follow the Planting Guide in **Appendix B**. Establish dense plant growth of groundcovers, herbaceous plants, and shrubs, with a goal of 95 percent coverage. Filter strips often experience moist soil conditions during the wet, rainy season and dry soil conditions during warm summers. Plant selection should respond to specific site conditions for each facility.

6.5.5 Drywell

A drywell is an underground perforated pipe or chamber that collects stormwater runoff and gradually discharges it into underlying soils.

Drywells are “Class V Injection Wells” under the federal Underground Injection Control Program (OAR Division 44). UICs are either classified as exempt (no registration required), authorized by rule, or authorized by permit. Designers are urged to review current regulations and UIC registration materials from DEQ.

Drywells do not provide water quality treatment, so water quality treatment is required before stormwater discharges into drywells. Drywells utilized exclusively to infiltrate the roof runoff from one single-family residential roof are exempt, and a silt trap is the only pretreatment necessary. An approved water quality pretreatment device is required for multiple single-family residential roofs to discharge into a common drywell. Where space is available, rain gardens are preferred to manage residential runoff because they provide both treatment and flow control (and are not regulated UICs). The intent of this section is to support compliance with the water quality treatment requirements as specified by the State of Oregon UIC regulations.

Site Requirements

Native soil design infiltration rate shall be at least 2.0 in/hr. Apply a factor of 2 to the tested infiltration rate to determine the design rate.

Bottom of drywells and other types of stormwater injection devices shall be at least 3 feet above seasonal high groundwater or impermeable layer.

The edge of excavation for the drywell shall be at least 10 feet from building foundations, unless otherwise specified by the local building code division.

Drywells are not allowed on slopes of 15 percent or more.

Drywells are not allowed in areas with existing soil or groundwater contamination

Drywells may be allowed to be located under the travel surface within the Public ROW. The minimum setback from the edge of the travel lane is 5 feet. Check with the local roadway authority,

Soil surrounding the drain rock, surrounding the drywells shall be native, uncompacted soil.

Drywells are not allowed within 500 feet of drinking water or irrigation wells or within the 2-year time of travel setback to drinking water or irrigation wells.

Infiltration rates shall be tested after construction and testing shall be overseen by the Developer’s Engineer to confirm that the dry well provides adequate infiltration capacity for the relevant design storm.

A water quality pretreatment device is required, unless the drywell is receiving runoff from only one single-family residential roof,

The following facilities are approved for pretreatment:

A. Facilities identified for water quality treatment in Section 6.3.1.

B. Catch basins with a 36-inch sump and trapped outlet (snout).

If the facility is designed to infiltrate the 100-year storm event, then an emergency overflow pathway is not required.

Dimensions

Private: Diameter: 2-feet minimum

Publicly Maintained: 4-feet minimum

The required storage capacity within the drywell structure and surrounding drain rock is determined by subtracting the volume of water that can infiltrate out of the facility within a 24-hour period from the runoff volume generated by the contributing drainage area during a 25-year, 24-hour storm event.

Materials

Place 12-inch minimum layer of 1.50-inch to 0.75-inch round rock that conforms to ODOT Standard Specifications 00430.11 or AASHTO No. 4 between drywell structure and earth wall. The drain rock should extend from 1 foot below the drywell structure up to the lid.

6.5.6 Infiltration Trench or Gallery

An infiltration trench is a linear, gravel-filled trench that distributes stormwater to underlying soils. An infiltration gallery includes underground chambers to increase subsurface storage.

Infiltration trenches that receive only surface runoff (no underdrains or subsurface pipe) are not classified as UICs. Infiltration trenches with underdrains and infiltration galleries are “Class V Injection Wells” under the federal UIC program (OAR Division 44). UICs are classified either as: exempt (no registration required), authorized by rule, or authorized by permit. Infiltration trenches and galleries do not provide water quality treatment, so water quality treatment is required before stormwater discharges into the facility.

Water quality treatment is required before stormwater discharges into infiltration galleries, though galleries used exclusively for single-family residential roof runoff are exempt and a silt trap is the only pretreatment necessary. Where space is available, rain gardens are preferred to manage residential runoff because they provide both treatment and flow control (and are not considered UICs).

An infiltration test shall be conducted at the location and depth of the facility. Designers are encouraged to review current regulations and UIC registration materials from DEQ.

Site Requirements

Trenches or galleries are not approved for slopes greater than 15 percent, unless approved by a geotechnical engineer.

Trenches or galleries within 200 feet of a steep slope or a mapped landslide hazard area require the review and approval of a geotechnical engineer.

Infiltration trenches or galleries are not allowed in the Public ROW.

Trenches shall not be located where they will be subject to vehicular traffic.

Soil surrounding trenches or galleries shall be native, uncompacted soil.

Bottom of trench or gallery shall be at least 3 feet above seasonal high groundwater elevation.

Native soil design infiltration testing rate shall be at least 1.00 in/hr which includes the applicable safety factor of two, therefore the minimum infiltration design rate is 0.50 in/hr.

Trenches or galleries are not allowed within 500 feet of drinking water or irrigation wells or within the 2-year time of travel setback to drinking water or irrigation wells.

Infiltration trenches or galleries shall be located outside of tree protection zones or at least 10 feet from the base of newly planted trees and large shrubs.

Water quality treatment is required unless the infiltration trench or gallery is receiving only single-family residential roof runoff, then an approved pretreatment device will suffice. The following facilities are approved for pretreatment:

A. Facilities identified for water quality treatment in Section 6.3.1.

B. Private catch basins with a 36-inch sump and trapped outlet (snout).

Dimensions

The required storage capacity within the structural chambers and surrounding drain rock is determined by subtracting the volume of water that can infiltrate out of the facility within a 24-hour period from the runoff volume generated by the contributing drainage area during a 25-year, 24-hour storm event.

The maximum draw down time is 24 hours.

Minimum infiltration trench dimensions shall be 12 inches deep and 2 feet wide, filled with drain rock.

An observation well is required for all infiltration galleries and for infiltration trenches that exceed 50 feet in length.

Materials

Drain rock shall be 0.75-inch to 1.50-inch of granular drain backfill material. Drain rock shall conform to ODOT Standard Specifications 00430.11 or AASHTO No. 4.

If applicable, the distribution pipe in an infiltration trench shall be perforated, 6-inch-diameter PVC pipe that conforms to ODOT Standard Specification 02410.70. The IE shall be at least 12 inches below finished grade.

6.5.7 Constructed Wetland

Constructed wetlands are SMFs that are designed to emulate natural wetlands, with shallow water that varies in depth, and varied side slopes. They are saturated or have standing water for part of the year, rather than draining over a short period of time as rain gardens are designed to do. Wetlands are inundated or saturated at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation.

Constructed wetlands present an opportunity to integrate wildlife habitat and a public amenity into the landscape of a large residential, institutional, or commercial development. Constructed wetlands with healthy, thriving plants provide excellent water quality treatment. They require a large surface area and a large contributing area to ensure that wetland conditions are maintained.

Site Requirements

Site shall have adequate space for maintenance access that allows equipment access within 20 feet of the flow control, water quality devices and other structures as specified by the District.

Constructed wetlands are best for Type C and D soils or in areas with a high groundwater table. Soils shall be saturated for a long enough time to maintain wetland vegetation. The soil profile should be investigated to determine whether appropriate site soils exist and if any soil amendments need to be added to assist with initial plant establishment.

Waterproof liners may be used to maintain saturated conditions.

Constructed wetlands may be irregularly shaped, with a sinuous flow path and a variety of side slopes and benches incorporated to maximize plant establishment and diversity.

Vector (mosquito) control is an important design consideration for any facility that has standing water for extended periods of time. Bat boxes, diverse planting, and other design strategies to encourage biological controls can help to keep mosquito populations in balance.

Dimensions

Constructed wetlands can be sized for water quality treatment or a combination of treatment and flow control, similar to ponds. However, constructed wetlands will have a larger surface area, varied side slopes, and shallower ponding areas to maximize water quality treatment.

Two cells are required, with the first cell, the sediment forebay, containing 10 percent of the design volume, unless pretreatment is provided in a different facility. A sediment forebay provides a clear visual indicator of when maintenance is needed.

Water depth in a constructed wetland may vary in the different cells. Determine the average, maximum, and minimum depths for permanent pool in each cell of the wetland.

Design varied side slopes, water depths, and planting zones to provide a variety of habitat and maximize treatment.

Bottom width: minimum 3.0 feet

Maximum ponding depth: 4.0 feet

Average ponding depth: ≤ 2.5 feet

Side slopes: no greater than 5h:1v below maximum ponding depth

Side slopes: no greater than 3h:1v above maximum ponding depth

Materials

When required, waterproof liners shall be 30 mil PVC membrane or equivalent.

Investigate the soil profile and determine whether appropriate site soils exist and if any soil amendments need to be added.

Plant selection shall follow the Planting Guide in **Appendix B**. Plant selection shall be based on water level tolerances during the rainy season, as well as the ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in each of the proposed wetland cells.

Woody vegetation shall be used to provide shade over standing water and to provide structural diversity within the constructed wetland. Shrubs and trees shall be sited to promote long-term health and survival, minimize maintenance, and protect lines of sight. Shrubs and trees shall be located to allow for maintenance access to the treatment area.

Woody vegetation shall not be planted within 20 feet of inlet and outlet structures.

Overflow Spillway

All constructed wetlands shall have an emergency overflow spillway or other overland flow location that will safely pass runoff from the 100-year storm event over the embankment in the event of control structure failure or for storm events that exceed the design of the control structure.

Locate the spillway to direct overflows safely toward the 100-year emergency overflow pathway.

Protect the spillway with riprap or an approved material that extends to and is an appropriate distance beyond the bottom of the berm embankment. Fill the voids of the riprap with soil and vegetate the spillway with grass or ground cover. The selection of the vegetation on the spillway shall consider the required design capacity.

The IE of the spillway shall be a minimum of 6 inches above the 10-year water surface elevation.

Provide a minimum of 12 inches of freeboard through the spillway between the 100-year water surface elevation and the top of the berm.

Alternate methods to accomplish the design intent of the emergency spillway will be acceptable, as long as they accomplish the same level of protection.

6.5.8 Pond

Stormwater ponds can provide water quality treatment, infiltration, and flow control to mitigate post-construction stormwater runoff. Ponds are a good choice where there is a large contributing area draining to a single facility, where there is adequate space to design a pond that can be integrated into the landscaping, and where it is accessible for maintenance. Stormwater ponds can be used to meet both water quality treatment and flow control performance standards. When site conditions allow, ponds should be designed as infiltration facilities or with an infiltration component in addition to a detention component to meet the flow control performance standard. An infiltration test shall be conducted at the location and depth of the facility.

The stormwater report and engineered drainage plans, in addition to documentation of existing and proposed conditions, shall include, at a minimum, the flow control structure rim elevation, the pond grading plan, the outlet pipe IE, the elevation of the top of the berm, the elevation of the top of the overflow structure, all pipe diameters, and any deviation in shear gate/lift assembly from the District's Standard Details.

Site Requirements

Pond type selection shall be appropriate for soil characteristics (e.g., if soils have adequate infiltration capacity, design an infiltration pond rather than a facility with a controlled downstream outlet)

The minimum setback of a pond from the edge of the top of bank, wall, or toe of an embankment to the nearest property line must be horizontal for a minimum of 5 feet, or greater if recommended by a civil or geotechnical engineer.

A geotechnical report is required to determine setbacks of ponds near slopes ≥15 percent or within 200 feet of a steep slope hazard area or landslide hazard area.

Vector (mosquito) control is an important design consideration for any facility that has standing water for extended periods of time. Bat boxes, diverse planting, and other design strategies to encourage biological controls can help to keep mosquito populations in balance.

Dimensions

May include two cells, with the first cell (forebay) containing approximately 10 percent of the design surface area. Forebays simplify maintenance and are strongly encouraged. Maintenance access shall be provided to the forebay.

Maximum side slopes: 3h:1v

Length to width ratio: ≥ 3:1

Materials

When required, waterproof liners shall be 30 mil PVC membrane or equivalent.

Soil amendments shall meet the requirements of Section 6.4.4.

Plant selection shall follow the Planting Guide in **Appendix B**. Plant selection shall be based on water level tolerances during the rainy season, as well as the ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in the pond.

Woody vegetation shall be used to provide shade over standing water and to provide structural diversity within the pond. Shrubs and trees shall be sited to promote long-term health and survival, minimize maintenance, and protect lines of sight. Shrubs and trees shall be located to allow for maintenance access to the treatment area.

Woody vegetation shall not be planted within 20 feet of inlet and outlet structures.

Outlet Structures

Flow Control Structure: Flow control structures for ponds shall be located in an enclosed manhole, outside the open water storage area, in a location that allows equipment maintenance access and access during high flow events. Access to a flow control structure, not located in a public roadway, shall be provided within 12 feet of the edge of a vehicular access, measured from center of flow control structure, when designed to be accessed perpendicularly by the maintenance vehicle and within 6 feet when designed to be accessed from the front of the maintenance vehicle. The flow control structure may be farther from the edge of the roadway if a public access road is provided that allows for maintenance trucks to get within the appropriate distances.

Secondary Outlet. Detention ponds shall have a secondary pond outlet structure, such as a catch basin with grated lid located along an interior side slope. This secondary pond outlet will serve as a backup to convey stormwater to the flow control manhole should the primary pond outlet become clogged. The lip elevation of the secondary pond outlet should be set at approximately the 10-year design water surface. See **Appendix C** for a graphical depiction showing a secondary pond outlet.

Flow control manholes shall comply with District Standard Drawings SWM FC 1.0 through 6.0.

Orifices less than 2.0 inches shall be made of material (e.g., stainless steel, high-density polyethylene pipe [HDPE], or PVC) shall be used to make the orifice plate. The plate shall be attached to the concrete or structure.

Overflow Spillway

In addition to primary and secondary outlets, ponds shall have an emergency overflow spillway that will safely pass runoff from a post-developed 100-year Design Storm to the downstream emergency overflow pathway. The design intent is to protect the integrity of the pond, as well as associated embankments and downstream properties, during large storm events and/or failure of the flow control structure. Secondary spillway shall meet the following criteria:

Locate the spillway to direct overflows safely toward the 100-year overflow pathway.

Locate the spillway in existing soil wherever possible. Protect the spillway with riprap or an approved material that extends to, and is an appropriate distance beyond, the bottom of a berm embankment.

The IE of the spillway shall be a minimum of 6 inches above the 25-year water surface elevation.

Provide a minimum of 12 inches of freeboard through the spillway between the 100-year water surface elevation and the top of the berm.

Alternate methods to accomplish the design intent of the emergency spillway will be acceptable, as long as they accomplish the same level of protection.

Pond Interior Maintenance Access

Design ponds with access suitable for maintenance equipment (backhoe, etc.) to safely access the bottom of the interior of the pond. The purpose of this requirement is to provide an access suitable for sediment removal by District equipment.

The interior pond access will begin at the edge of the required pavement and end at the lowest elevation of the pond. The minimum access requirement is at least 15 feet wide with slopes no steeper than 4:1.

The pond interior access shall be constructed of 8 inches of gravel, pervious pavers, or native vegetation (no trees or shrubs). The access can be constructed of compacted native material suitable for the intended seasonal use. Other materials will be reviewed and approved on a case-by-case basis.

6.5.9 Structural Detention

Structural detention facilities include underground tanks and vaults that temporarily store water must be designed in accordance with the custom pond sizing feature that is part of the BMP Sizing Tool program. Structural detention facilities are appropriate for commercial sites, industrial locations, and multi-family sites. They can be designed to reduce the runoff rate and duration of flow to meet the flow control performance standards. Structural detention facilities alone do not provide water quality treatment, so a separate water quality treatment facility is necessary to meet the water quality performance standards.

Detention pipes and vaults are not allowed for use on developments that convey public waters, such as stormwater runoff from public roadways. Structural detention design shall demonstrate that the facilities have adequate maintenance access of 20 feet to the flow control and water quality structures, can withstand vehicular and other structural

loadings, will be stable, have been designed to counteract buoyancy forces in areas of high groundwater, and that the materials can withstand chemical properties of soils on the site.

The stormwater report and design drawings, in addition to documentation of existing and proposed conditions, shall include, at a minimum, the flow control structure rim elevation, the storage pipe IE, the outlet pipe IE, the elevation of the top of the storage pipe, the elevation of the top of the overflow pipe, all pipe diameters, and any deviation in shear gate/lift assembly from the District's Standard Details.

Site Requirements

Structural detention facilities shall be located to avoid conflicts with other underground utilities.

Regular maintenance is essential to ensure continued function of underground detention facilities. Maintenance access shall be provided to allow sediment removal from the length of the facility and to maintain the outlet control structure. Facility location shall be chosen to maximize access for maintenance and replacement.

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

Dimensions

Detention Pipe:

A. Minimum diameter: 36.0 inches
B. Pipe bottom shall be flat or gently sloped: ≤ 0.5 percent
C. Maximum distance between pipe bottom and finish grade: 20.0 feet
D. Sediment storage depth in upstream standard manhole: 6.0 inches minimum
E. Minimum freeboard: 6.0 inches, measured from the maximum design water surface elevation and the overflow elevation in the control structure.

Detention Vault

A. Vault bottom shall be flat or gently sloped to the center, forming a "V": ≤0.5 percent
B. Minimum sediment storage depth: 6.0 inches
C. Minimum freeboard: 6.0 inches, measured from the maximum design water surface elevation and the overflow elevation in the control structure.

Private facilities may use a 1.0-inch-diameter orifice if the structural detention facility is preceded by an approved water quality filtration device.

Materials

Private Maintained Detention Pipe: Stormwater detention/conveyance pipes that are located solely on private property shall be constructed of a material in accordance with OPSC. A plumbing permit to construct the pipe shall be obtained by the local plumbing authority, and the Developer's Engineer shall certify the infrastructure was constructed in accordance with the approved plans. Galvanized metals leach zinc into the environment, especially in standing water situations. This can result in zinc concentrations that can be toxic to aquatic life. Therefore, galvanized materials shall not be used in stormwater facilities and storm drainage systems.

Publicly Maintained Detention Pipe: For publicly maintained facilities, the detention pipe material shall be concrete. The joints shall conform to technical and manufacturer's specifications.

Detention vaults shall be constructed of structural reinforced concrete (3,000 psi, ASTM 405). All construction joints shall be provided with water stops.

A flow control manhole shall be provided to regulate outflow from the structural detention facility. Flow control manholes shall comply with District Standard Drawings SWM FC 1.0 through 6.0.

Orifice structure material shall be HDPE or PVC. A thin material (e.g., stainless steel, HDPE, or PVC) shall be used to make the orifice plate. The plate shall be attached to the structure.

Access

Detention pipes more than 50 feet long shall provide an access riser at each end for maintenance. Detention pipes over 200 feet long shall have an access riser at the upstream end and access risers at least every 100 feet.

Access for detention vaults may be provided by use of removable panels, hatches, or ring and cover.

36-inch minimum diameter corrugated metal riser-type manholes of the same gauge as the detention pipe material may be used for access along the length of the detention pipe and at the upstream terminus of the detention pipe. The top slab is separated (1-inch minimum gap) from the top of the riser to allow for deflections from vehicle loadings without damaging the riser pipe.

All detention pipe, vault access and control structure openings shall be readily accessible by maintenance vehicles.

Detention pipes and vaults shall comply with the OSHA and Oregon OSHA confined space requirements, which include, but are not limited to, the preparation of ventilation plans and clearly marked entrances to confined space areas.

Internal structural walls of large vaults shall be provided with openings sufficient for maintenance access between cells. The openings shall be sized and situated to allow access to the maintenance “V” in the vault floor.

For detention vaults, the recommended minimum internal height is 7 feet from the highest point of the vault floor (not sump), and the recommended minimum width is 4 feet. However, concrete vaults may be a minimum 3 feet in height and width if there are access manholes at each end, and if the width is no greater than the height. Minimum internal height requirements do not apply for any areas covered by removable panels.

6.5.10 Proprietary Stormwater Treatment Devices

Proprietary Stormwater Treatment Devices are manufactured technologies used to address the stormwater quality impacts of land development, including removing pollutants through physical, chemical, or biological treatment processes. These SMFs rely upon a variety of mechanisms to remove pollutants.

Proprietary Stormwater Treatment Devices include hydrodynamic separators, cartridge filters, and other emerging treatment technologies that are designed to remove pollutants from stormwater. Proprietary devices are generally grouped by their use for pretreatment, oil removal, enhanced treatment, basic treatment, phosphorus removal

and construction pollutant management. There are numerous manufacturers that build Proprietary Stormwater Treatment Devices.

Stormwater treatment technologies are reviewed and certified by several agencies. The District follows the Technology Assessment Protocol – Ecology (better known as the TAPE Program), administered by the Washington State Department of Ecology (Ecology). The District allows the use of Proprietary Stormwater Treatment Devices that have a General Use Level Designation (GULD) for basic, dissolved metals, or phosphorus treatment. Devices with Pilot Use Level Designation or Conditional Use Level Designation are not allowed. The District may require pretreatment facilities to improve the performance of Proprietary Stormwater Treatment Devices.

The Proprietary Stormwater Treatment Devices that have been tested and approved under Ecology's TAPE program are regularly updated on the TAPE Program website.

Proprietary Stormwater Treatment Devices approved by Ecology with GULD and classified as Basic Treatment may be utilized to satisfy the stormwater water quality treatment requirements when sized to capture and treat the first 1 inch of stormwater runoff within a 24- hour period; and are sized as specified in the Ecology-approved GULD.

The use of Proprietary Stormwater Treatment Devices approved by Ecology is allowed for use on privately maintained facilities.

The use of Proprietary Stormwater Treatment Devices that will be maintained by a public agency shall be approved by the District. Any device requiring the replacement of specific manufacture filter cartridges and/or media will not be allowed without the specific approval of the District for SMFs which will be publicly maintained and/or accepts stormwater runoff from public improvements.

Site Requirements

Proprietary Stormwater Treatment Devices for water quality treatment shall not be located downstream of flow control facilities.

Proprietary Stormwater Treatment Devices may be located on a range of site conditions. Site requirements vary by type of system. Review the manufacturer's restrictions and recommendations when selecting an appropriate treatment device and configuration for the development and site conditions.

Proprietary Stormwater Treatment Devices shall be a minimum of 5 feet from structures.

Proprietary Stormwater Treatment Devices that are publicly maintained, and require staff to enter, shall provide a minimum of 78 inches of head room.

The device shall be designed to safely convey the storm event as specified in this chapter, and if applicable provide an emergency overflow pathway.

Devices shall be readily accessible by maintenance vehicles at a minimum distance of 20 feet and in accordance with manufacturer recommendations.

Dimensions

Proprietary Stormwater Treatment Devices may be configured as inline systems or offline systems with high flow bypasses, in accordance with manufacturer specifications.

Proprietary stormwater treatment devices shall be designed to treat the peak flow or total volume from the water quality storm event, as defined in Section 6.1.1

Calculations to determine the required size, number, or configuration of the Proprietary Stormwater Treatment Device must be based on the design guidelines specified in the GULD approval documents from Ecology. When sizing Proprietary Stormwater Treatment Devices for water quality treatment, Applicants shall use the treatment flow rates identified in the TAPE approval documents.

6.5.11 Sheet Flow Dispersion

Sheet flow dispersion is one of the simplest methods of stormwater management. Sheet flow dispersion is the dispersion of concentrated flows from driveways, roadways, or other impervious surfaces through a vegetated pervious area. Because flows are already dispersed as they leave the surface (i.e., not concentrated), they need only traverse a narrow band of adjacent vegetation for effective flow attenuation and treatment.

Sheet flow dispersion is applicable for impervious surfaces with slopes less than 15 percent, such as driveways, sport courts, patios, roofs without gutters, recreational vehicle pads, or other situations where concentration of flows can be avoided.

Sheet flow dispersion is a preferred stormwater management strategy for impervious surfaces in rural areas, driveways, and agricultural buildings. The discharge shall not be directly connected to a drainageway, Storm Drainage System, or other Public Storm System.

Site Requirements

Dispersion is not permitted within potential landslide areas. The District may require a geotechnical report to verify the site soils are suitable for sheet flow dispersion.

Dispersion is not permitted within 10 feet of the top of a slope greater than 25 percent.

Dispersion is not permitted over contaminated sites or abandoned landfills.

For sites with septic systems, the discharge point shall be downgradient of the drain field primary and reserve areas. This requirement may be waived if site topography clearly prohibits flows from intersecting the drain field.

Area receiving flow shall be protected from compaction during construction, or substantial soil amendment may be required prior to final site stabilization.

No erosion or flooding of downstream properties may result.

Dimensions

A 2-foot-wide transition zone to discourage channeling shall be provided between the edge of the contributing impervious area and the downslope vegetation. This may be an extension of subgrade material (crushed rock), modular pavement, drain rock, or other material approved by the District. The transition zone may be narrowed for sidewalks and pathways, if approved by the District.

A 10-foot-wide vegetated buffer shall be provided for up to 20 feet of width of contributing impervious surface. An additional 5 feet of buffer width shall be added for each additional 20 feet of width of contributing area or fraction thereof.

The flow path shall be covered with well-established lawn or landscape area (landscaping with well-established groundcover, or native vegetation with natural groundcover). The groundcover shall be dense enough to help disperse and infiltrate flows and to prevent erosion.

6.5.12 Pervious Pavement

Pervious pavement is a walking or driving surface designed to allow rainfall to percolate into the underlying soil or aggregate storage reservoir beneath the pavement. The wearing course (surface layer) of pervious pavement may be any of the following:

Porous asphalt is open-graded asphalt that allows water to percolate or infiltrate into underlying soils.

Pervious concrete omits fines in the aggregate to create stable air pockets that allow water to drain to the base below. There is an inverse relationship between porosity and strength. As porosity is increased, the structural strength is reduced.

Pavers are generally suitable for pedestrian areas and low traffic parking areas. They are available in a variety of configurations such as rigid concrete or durable plastic grid filled with gravel or a mixture of gravel, sand, and topsoil suitable for vegetation.

Pervious pavement shall be designed only as an impervious area reduction technique to manage direct rainfall. It shall not be designed as a SMF that receives runoff from surrounding areas.

Site Requirements

Surface slope no greater than 6 percent.

Site does not receive high sediment loads. Areas with high volumes of leaf litter can cause clogging, so avoid pervious pavement under large trees.

Adequate separation from underlying seasonal high groundwater table; bedrock or other impermeable layer shall be at least 3 feet below the bottom of the pervious pavement facility.

Pervious pavement is not appropriate for areas at elevated risk of hazardous materials spills such as gas stations.

Minimum infiltration rate of 0.25 in/hr.

Not appropriate for construction over fill soils unless evaluated and approved by geotechnical engineer.

No stormwater run-on allowed.

Pavement design shall demonstrate that pavement structure has the structural strength for anticipated vehicle loadings.

Dimensions

Pervious pavements designed with 6 inches of aggregate storage and a minimum design infiltration rate of 0.25 in/hr are assumed to meet the performance standard to fully infiltrate the 10-year, 24-hour Design Storm.

Pervious concrete wearing course: 4-inch thickness for residential driveway, pedestrian only, private street, parking lot or fire lane; 7-inch thickness for public street. Public streets shall be designed in conformance with the local roadway authority.

Porous asphalt wearing course: 2.5-inch thickness for residential driveway or pedestrian paths; 3 inches for private street, parking lot, or fire lane; 6 inches for public street. Public streets shall be designed in conformance with the local roadway authority.

Pavers shall be designed according to manufacturer recommendations. State size of stone to be used between pavers—sand is not allowed if pavers are used for stormwater treatment or flow control.

Where pervious pavement installations are proposed over fine sediments, provide a 1- to 3-inch-thick leveling course if the pervious pavement surface is open-celled paving grids, interlocking concrete pavers, or porous asphalt concrete.

Minimum depth for aggregate storage reservoir shall be 6 inches for vehicular loading. In addition to structural design considerations, design depth is typically determined by storage depth needed to manage design storm.

Pervious pavements designed with 6 inches minimum of ¾-inch to 2-inch crushed/ washed open graded base material and a minimum design infiltration rate of 0.25 in/hr are assumed to meet the performance standard to fully infiltrate the 10-year, 24-hour Design Storm.

Materials

Leveling course: The leveling course shall consist of uniformly graded, washed aggregate that conforms to AASHTO No. 8 gradation.

Aggregate storage reservoir: The aggregate storage reservoir shall conform to ODOT Standard Specifications 00430.11 granular drain backfill material, AASHTO No. 57, or approved equal.

Porous asphalt: The surface wearing course for porous asphalt shall conform to open-graded, ½-inch or ¾-inch asphalt concrete pavement design from ODOT Standard Specification 00745 or approved equal.

Content: 6.0 to 6.5 percent by weight of total (dry aggregate) mix. Performance Grade: 70-22. Do not use an asphalt cement performance grade less than 70-22 for open-graded, porous asphalt mixes.

6.5.13 Green Roofs

A green roof is a building roof that is partially or completely covered with vegetation and growing media, atop a waterproof membrane; a green roof is also called an eco-roof or vegetated roof. Green roofs include the following elements: a thin, layered system of waterproofing, drainage layers, growing media, and planting to cover impervious roof areas and allow water to be absorbed, detained, and evaporated back into the atmosphere. Proprietary systems are also available using various layers or even modular trays that fit easily on an existing roof.

Green roofs are primarily designed for stormwater management, with aesthetics as a secondary goal. Green roofs are not designed for foot traffic or recreation.

Site Requirements

Flat or slightly sloped roofs on large institutional, commercial, or residential projects. Green roofs work on sloped roofs up to a maximum of 4:12 roof pitch without additional engineering–and can be steeper with intermediate structural support of soils.

Structural Considerations

Shall be able to carry additional loads as determined by a structural engineer (15 to 30 pounds per square foot is typical) to support fully saturated conditions.

These load recommendations do not include snow load.

Access to roof via crane, lift or other device is recommended to load heavy, and bulky materials up to rooftop surface.

Safety line tie-off points, hand holds, or walking surfaces may be necessary to facilitate maintenance.

Green roofs shall include outlets to an approved location from roof drains, scuppers, and other drainage devices.

Dimensions

Green roofs may be designed to meet flow control and water quality performance standards.

The Developer's Engineer is required to provide adequate documentation showing how the planned green roof meets District performance standards for flow control and water quality treatment Materials.

Root barrier/protection layer. A synthetic, non-biodegradable layer shall be placed to protect waterproofing layers and to provide additional protection from roots. Do not use copper or copper hydroxide for a root inhibitor.

Drainage layer/filter fabric. A synthetic or mineral layer shall be placed over the protection layer to allow for water movement under the growing media. The drainage layer shall be ½-inch-deep with a void space of at least 50 percent, covered by a non-woven (needle-punched) filter fabric to separate the drainage layer from the growing media.

Growing media. An engineered growing media mix shall be placed over the filter fabric to a depth of at least 4 inches to meet requirements. It shall contain no fines, weed seeds, or other materials. Provide documentation of saturated weight (field moisture capacity) that has been tested and documented by a third party. The media mix shall consist of 80 to 90 percent pumice or lightweight aggregate and 10 to 20 percent composted, plant-based organic matter.

Mineral mulch. A mulch layer of washed gravel or non-decomposable material (no fines) that will not be moved by wind or water movement shall be placed on top of the growing media.

Planting. Establish dense plant growth of low-maintenance, low-water use succulent vegetation supplemented with some hardy perennials, grasses, and other native, non-woody vegetation. A minimum of 10 species shall be included to promote microclimatic diversity and resilience to the roof, allowing for species to fill in if others are slow to perform. Use 10 percent deciduous species distributed throughout the roof to provide organic matter inputs through leaf litter. Plant selection shall follow the Planting Guide in **Appendix B**.

Proprietary systems may not match these dimensions or materials.

7. Storm Drainage System Design

Storm drainage system design is an integral component of site planning. Acceptable storm drainage system design must strive to maintain compatibility and minimize interference with existing drainage patterns; control onsite and downstream flooding of property, structures, and roadways for design flood events; and minimize the potential environmental impacts of stormwater runoff. Three considerations largely shape the design of these systems: public safety, flooding, and water quality. Stormwater collection systems must be designed to provide adequate surface drainage while at the same time meeting other stormwater management goals such as water quality treatment, stream channel protection, wildlife habitat protection, and groundwater recharge.

Some sites may require two separate storm drainage systems: the localized onsite system and the regional bypass system. The onsite system is generally designed to convey stormwater runoff from the developed areas of the site to the SMFs. The SMFs discharge to the bypass system, which conveys upstream stormwater runoff around or through the developed site and conveys the stormwater to the natural point of discharge downstream. This chapter includes requirements for storm drainage system design.

7.1 General Conditions

This section presents design requirements for open channel and closed conduit storm drainage systems. It also describes requirements and methods used to plan, design and size storm drainage systems. Storm drainage systems are generally made up of four components; stormwater runoff entering the site from upstream drainage areas; stormwater runoff conveyed through the site; the acceptable point of discharge from the site; and stormwater runoff discharged downstream from the site.

Storm drainage systems shall be designed to meet the requirements of Chapter 6, except when the drainage system is located entirely on a privately-owned parcel, is privately maintained, and receives no stormwater from outside the parcel's property limits. Those systems exempted from the storm drainage system requirements will remain subject to the requirements of the OPSC and shall be reviewed by the building official.

7.2 Storm Drainage System Requirements

Planning for the storm drainage system is an essential element in preparing a site plan. Several factors must be considered prior to developing the preliminary design and requesting District approval of the Service Provider Letter.

Storm drainage systems are to be designed to intercept and convey stormwater runoff efficiently enough to meet flood protection criteria. The storm drainage system should complement the ability of the site design and structural stormwater controls to mitigate the major impacts of urban development.

7.2.1 Points of Discharge

The Applicant will establish a proposed point of discharge. A point of discharge shall be approved by the District prior to approving the Service Provider Letter.

Runoff from developed portions of the site drainage area should be discharged at the existing natural drainage outlet or outlets.

Runoff must be discharged in a manner that will not increase flooding to downstream properties.

The Applicant will be responsible for acquiring approval from any other agency having jurisdiction or permitting authority related to the activity. The District may require a copy of other jurisdictional approval(s) prior to approving the plan.

If the point of discharge is an open storm drainage system, then adequate velocity dissipation and/or additional channel protection shall be required to prevent erosion and/or alteration to the existing downstream drainageway.

Any connection to a public or private piped downstream storm drainage system shall be approved by the District. The means and methods of connecting or extending a piped storm drainage system will be consistent with District standards and/or other standards required by agencies having the authority to regulate the connection.

7.2.2 Onsite Storm Drainage System

The site shall be planned and designed to generally conform to onsite natural drainage patterns and discharge to natural drainage paths within a drainage area. These natural drainage paths should be modified as necessary to contain and safely convey the peak flows generated by the development.

Open channel storm drainage systems are preferred over closed conduits where feasible, especially where they might provide opportunities for water quality treatment, some infiltration, wildlife habitat improvement, or emergency overland flood relief routes.

It shall be the responsibility of the Owner to provide a storm drainage system for all stormwater runoff and/or or surface water entering the property from offsite. Surface water, springs, and groundwater shall be incorporated into the drainage design.

An emergency overflow pathway must be identified and/or designed that allows large flow events to discharge without risk of injury or property damage. The emergency overflow pathway must be incorporated into the design and show how flow will escape from the site during rainfall events larger than the design storm events and/or from failure of the primary storm drainage system. Any emergency overflow pathway structures shall be designed for the 100-year Design Storm.

It is important to ensure that the onsite storm drainage system is designed to reduce blockages and flows in excess of the design storm capacity to minimize the likelihood of nuisance flooding or damage to private properties. If failure of these systems and/or drainage structures occurs during these periods, the risk to life and property could be significantly increased.

7.2.3 Upstream Drainage Areas

Developments are required to convey upstream drainage through or around the development in a system the District refers to as a “Bypass System”.

The upstream offsite stormwater or other nuisance surface water runoff will be conveyed through the development in a separate system referred to as the “Bypass System” and will not be mixed with the stormwater collected and treated with onsite SMFs unless the SMFs are designed to include all of the additional flows from the upstream drainage areas(s) assuming full development potential.

Analysis of upstream drainage areas shall assume ultimate build out and/or maximum zoning density in determining the size of the storm drainage system required through the site as specified in this chapter.

Land use zoning adopted by the local planning agency will be used to size the capacity of the bypass system. For areas within the upstream drainage area that currently have a rural zoning designation but have the potential to be incorporated into the Urban Growth Boundary or Reserve, the District will concur with the local planning agency to assign the appropriate zoning designation and/or allowable maximum density to use in the upstream drainage area analysis for ultimate development potential and storm drainage system sizing.

It is important to ensure that the bypass storm drainage system is designed to reduce blockages and flows in excess of the design storm capacity to minimize the likelihood of nuisance flooding or damage to private properties.

If failure of these systems and/or drainage structures occurs during rainfall events in excess of the design storm capacity, the risk to life and property could be significantly increased.

In establishing the layout of stormwater networks, it is essential to ensure that upstream flows will not be redirected onto private property during rainfall events up to the storm drainage system design capacity.

7.2.4 Downstream Analysis

A downstream analysis is required for all projects that exceed the impervious area threshold that requires the Applicant to submit a Stormwater Management Plan designed by a registered PE. A downstream analysis is a field investigation of the existing downstream storm drainage system to determine the capacity of the storm drainage system that will be utilized to safely convey stormwater runoff. Downstream analysis is a mechanism to assure the existing or proposed storm drainage system has adequate capacity to safely convey the stormwater runoff discharged from the development. The analysis will also provide the District with a better understanding of the storm drainage system, so that the District can add problem areas to maintenance work orders or to potential capital project needs.

Any drainage system with a limited or inadequate stormwater conveyance system designated by the District or other governing jurisdictions will be required, if feasible, to improve the downstream Conveyance System capacity. If improving the system is not feasible, the District will determine if additional flow control requirements are an option to develop the property without increasing the potential for downstream flooding during a 25-year storm event. The District or other jurisdiction may designate an area or stormwater Conveyance System as having “limited downstream capacity” based on local knowledge, drainage complaints, engineering study or other information indicating the need for additional flow control requirements for larger storm events. In all cases, an emergency overflow pathway from the developed site to an acceptable point of discharge must be maintained.

The Applicant shall complete the Qualitative Analysis. Depending on the results, the District may require the analysis to extend further downstream, mitigation measures, a Quantitative Analysis, offsite mitigation measures, or additional flow control.

If the proposed stormwater management system for a development or redevelopment project is designed to fully infiltrate the design storm as specified in Chapter 6, then the

Applicant is exempt from the downstream analysis requirements but must still address the 100-year emergency overflow pathway requirement in Section 6.1.3.

When required, the downstream analysis shall evaluate the offsite storm drainage system to the location where the project site contributes less than 15 percent of the upstream drainage area contributing to a public storm drainage system line or drainage channel, or a location 1,500 feet (approximately ¼-mile) downstream of the discharge point from the project site, whichever is greater. The downstream analysis may be stopped shorter than the required distance if the analysis reaches a stream, or river, or a point that is determined at the sole discretion of the District.

Qualitative Analysis

The Qualitative Analysis shall consist of a drainage system map, existing storm drainage systems, drainageways, outfall inspection results, storm drainage system description, and potential problem identification. Depending upon the presence of existing or predicted flooding, erosion or water quality problems, and the proposed design of the onsite drainage facilities, the District may require a Qualitative Analysis further downstream, mitigation measures, or a quantitative analysis.

A drainage area map delineating the onsite and offsite contributing drainage areas upstream and downstream for the site shall be provided. The drainage system map shall be to a defined scale and must show the extent of the drainage system in the downstream analysis area. The drainage system map should also show general land use, topography, and other features impacting the onsite and downstream drainage system. Maps printed from Geographic Information Systems (GIS) or websites may be used as a base for the drainage system map.

The engineer shall physically inspect the existing onsite and offsite storm drainage systems and outfalls in the project area for each discharge location for existing or potential problems and drainage features. An inspection and investigation shall include the following:

A. Information on pipe sizes and slopes, channel characteristics, and drainage structures.

B. Date and weather at time of inspection.

C. Photographs of the existing condition of onsite and downstream drainage features.

D. Existing and potential problem areas.

For each storm drainage system component (e.g., pipe, culvert, outfall, ditch, open channel, tributary, stream), a written description shall be provided of the location, physical description, size, material, flow direction, and field observations. The description shall document points of inflow from adjacent drainage systems. The description shall also identify and describe points where water enters the downstream storm drainage system and the approximate tributary area at each contributing location. The tributary area shall account for upstream, onsite, and downstream contributions and land use conditions.

All existing or potential problems identified during the storm drainage system and outfall inspection shall be documented and described. Problem areas include constrictions or capacity deficiencies in the drainage system, existing or potential flooding problems, erosion, scouring, or bank sloughing in open channels, and erosion or scouring at outfalls. The following information shall be provided for each existing or potential problem area:

A. Magnitude of, or damage caused by the problem.
B. Assumed frequency and duration.
C. Return frequency of storm or flow when the problem occurs.
D. The pre- and post-construction water elevation when the problem occurs.
E. Possible cause of the problem.
F. Current mitigation of the problem.
G. Whether the proposed development or redevelopment activity is likely to aggravate or mitigate the problem.

The descriptions shall be used to determine whether adequate mitigation can be identified or whether more detailed quantitative analysis is necessary.

Quantitative Analysis

Upon review of the qualitative analysis, the District may require a quantitative analysis, depending on the presence of existing or predicted flooding, erosion, or water quality problems and on the proposed design of the onsite drainage facilities. The quantitative analysis includes a hydrologic and hydraulic analysis of each component of the downstream storm drainage system. The analysis may be performed through spreadsheet and backwater calculations or by preparing a hydraulic model of the downstream system.

As-built drawings may be used to obtain structure information for the quantitative analysis. If as-built drawings are used, the engineer is responsible for verifying that all elevations are in the same datum. The District may require a field survey of the existing storm drainage system in the downstream analysis area to inform the quantitative analysis.

The quantitative analysis of the downstream storm drainage system shall assume the following:

A. Project site is developed as proposed with the land use application.
B. The surrounding drainage area is developed at future build out conditions, using the best zoning information available, or a conservative assumption of future build out conditions.
C. Full functionality of the proposed onsite SMFs.
D. The design storm for analysis shall be consistent with the storm drainage system design storms listed in Chapter 6.

The following shall be included as part of the quantitative downstream analysis:

A. Upstream and downstream drainage area maps showing the flow route for both onsite and offsite stormwater.
B. Description of hydrologic calculation parameters and design flows used in the analysis.
C. Capacity and percent full during the design storm in each storm drainage system element.
D. Velocity in each storm drainage system element during the applicable design storm.
E. Headwater and tailwater assumptions.

F. The hydraulic gradeline elevation for the design flow in each storm drainage system component.

G. All calculation assumptions, equations, and outputs used in the analysis. If calculation assumptions are different than typical standards of practice, justification of the parameters is required. When the downstream system includes older or deteriorated pipes, the Manning's n roughness coefficient should be adjusted to account for increased pipe roughness.

If the Applicant is proposing mitigation measures to change the capacity of the downstream storm drainage system, the quantitative analysis shall include calculations for both the existing and proposed storm drainage system.

Offsite Mitigation Measures

Depending on the results of the offsite analysis, the Applicant may be required to provide offsite mitigation measures. Where required, the mitigation will be of a type to be determined by the District. If the downstream analysis identifies outfall or streambank erosion or scour problems, the Applicant shall correct the identified problem areas as a condition of the development activity.

If the downstream storm drainage system does not have the capacity to convey runoff according to the design standards outlined in Chapter 6, the Applicant shall be required to mitigate for the undersized system. The Applicant may elect to mitigate the storm drainage system problem by either correcting the deficiencies in the downstream storm drainage system (piped and open channel systems) or by providing additional onsite flow control beyond what is required in the performance standards in Chapter 5. The additional flow control may be in the form of additional onsite stormwater infiltration, retention, and/or storage, such that the 100-year, 24-hour post-developed peak discharge rate from the site matches the pre-developed peak discharge rate for the same storm event. The additional flow control requirements will take into account the downstream deficiencies and will be determined at the sole discretion of the District.

7.3 Storm Drainage System Design Methods

The following section describes accepted criteria and methods for analyzing and designing storm drainage systems. It is the responsibility of the engineer to determine the appropriate method of analysis in determining the capacity of the proposed storm drainage system.

7.3.1 Design Methodology

Storm drainage systems shall be designed and constructed to carry the design storm flowing full with no pressure flow. Flow conditions in existing pipe systems will be evaluated on a case-by-case basis for adequacy.

Storm drainage systems in the Public ROW shall be designed as gravity systems, without the use of stormwater pumps. Privately-owned and maintained stormwater pumps will only be allowed if the land cannot be developed without pumping the stormwater because of the topology of the property. It shall be the Developer/Owner responsibility to acquire an easement in order to provide the required gravity system. Failure to obtain an easement to safely discharge the stormwater runoff or provide an emergency overflow pathway is not a reason for the District to approve the pumping of stormwater runoff as described in Section 7.11.

Generally, the SBUH method for computing peak discharge is preferred by the District. Other acceptable methods include TR-55, Stormwater Management Model (SWMM), or other standard methods as approved by the District. For drainage areas 10 acres or less, the Rational Method is acceptable.

Manning's Equation shall generally be acceptable for determining pipe or open channel capacity only within a drainageway with an upstream drainage area of 50 acres or less. For larger drainage areas, backwater effects shall be included in determining capacity for a drainageway, typically using Hydrologic Engineering Centers-River Analysis System (HEC-RAS) or equivalent computer modeling software.

7.3.2 Design Event

The design event for sizing each component of the storm drainage system is determined based on the size of the contributing drainage area and the type of storm drainage system being designed. The design events for storm drainage system sizing are listed in **Table 9** below. Design rainfall intensities and 24-hour storm events are described in **Appendix D**.

Table 9. Storm Drainage System Design Storm

Contributing drainage area	Design storm for storm drainage system sizing		
	Storm sewer, culverts, and outfall pipes❶	Creek or stream channels	Bridges
Less than 40 acres	10-year, 24-hour storm	10-year, 24-hour storm	100-year, 24-hour storm
40 to 640 acres	25-year, 24-hour storm	25-year, 24-hour storm	
640 acres or greater	50-year, 24-hour storm	50-year, 24-hour storm	

❶ When a backwater condition exists, the storm drain system shall be designed in accordance with Section 7.3.5.

7.3.3 Rational Method

The Rational Method is most applicable for runoff estimates from small drainages with large amounts of impervious area. When using the Rational Method, refer to the current version of the ODOT Hydraulics Manual for calculation formulas and tables of coefficients. When using the Rational Method, the following limitations shall apply:

Use the Rational Method only for predicting a conservative peak flow rate to be used in determining the required capacity for storm drainage system elements. The Rational Method shall not be used to size SMFs.

The contributing drainage area cannot exceed 10 acres and the time of concentration shall not exceed 100 minutes for a single calculation.

The rainfall intensity (I) should be based on the rainfall intensity, duration, and recurrence curves shown in **Appendix D**.

In computing the Time of Concentration (Tc), for smaller drainage areas, the largest and most significant component in the total Tc is the portion of the time devoted to sheet flow. For this reason, extreme care should be given to determining the true travel time

for the sheet flow component of the Tc. In calculating the total Tc, the following limitations will apply:

A. The flow segment used for the sheet flow component shall not extend for more than 300 feet. The use of a distance of less than 200 feet on a pre-developed condition will require supporting documentation, such as photographs that show evidence of shallow concentrated flow at the point of transition.

B. For segments of the Tc route that flow through closed storm drainage system facilities, such as pipes and culverts, standard hydraulics formulas shall be used for establishing velocity and travel time.

C. For segments of the Tc route that flow through lakes or submerged wetlands, travel time is normally very short. The travel time can be determined using an appropriate storage routing technique, or it can be assumed to be zero.

D. The minimum total Tc used in the runoff calculations shall be 5 minutes.

7.3.4 Hydrograph Method

When storm drainage system design calculations are based on SBUH, TR-55 or the SWMM method, the calculations shall have the following limitations:

The rainfall distribution to be used within the District is the Design Storm of 24-hour duration based on the standard NRCS Type 1A rainfall distribution using the 24-hour precipitation isopluvial maps in the National Oceanic and Atmospheric Administration Atlas 2, Volume 10, Precipitation-Frequency Atlas of the Western United States. The depth of rainfall for the 2 through 100-year 24-hour storm events are provided in **Appendix D**.

Curve numbers shall be derived from the NRCS runoff curve numbers contained in TR 55 Urban Hydrology for Small Watersheds (see **Appendix D**).

Soil types shall be derived from the NRCS Soil Survey for Clackamas County.

A maximum overland distance for sheet flow used in calculations shall be 300 feet.

The minimum time of concentration shall be 5 minutes.

See **Appendix D** for additional guidance on performing hydrograph method calculations.

7.3.5 Capacity Analysis: Non-Pressure Flow

Storm drains that are designed to operate at full or partially full conditions during the design storm are called non-pressure flow. The capacity of pipe systems and open channels, for non-pressure flow conditions, can often be estimated using Manning's Equation for steady uniform flow as follows:

Manning's Equation

$$Q = \left(\frac{1.486}{n}\right) A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

or

$$V = \left(\frac{1.486}{n}\right) R^{2/3} S^{1/2}$$

where: Q = flow in cubic feet per second (cfs)

n = coefficient of roughness

A = cross-sectional area of flow in sf

V = Velocity, fps

R = hydraulic radius in feet = A/WP

(WP = wetted perimeter = length, in feet, of the wetted contact between a flow of water and its containing channel, measured at right angles to the direction of flow)

S = hydraulic slope (or hydraulic grade line) in feet per foot

The hydraulic slope or hydraulic grade line (HGL) is defined by the elevations to which water will rise in small vertical pipes, located at various locations along the flow. In a non-pressure flow condition, the hydraulic slope can be assumed to be parallel with the flow line slope. The HGL is separated from the energy line by the velocity head. The energy grade line is the sum of the HGL, the velocity head, friction loss, and the incidental losses. Manning's Equation does not take into account entrance, exit, bend, and junction losses within catch basins or manholes.

Typical values for the hydraulic roughness coefficient (Manning's n) for conduits and channels can be found in **Table 10** and **Table 11** below. Refer to the current version of the ODOT Hydraulics Manual for additional hydraulic roughness values.

This capacity estimate using the Manning's Equation is acceptable for final design purposes if the storm drainage system does not have tailwater influence (such as discharge into a partially full detention basin) or abrupt changes in channel cross-section or slope that might cause non-uniform flow.

Table 10. Normal Range Hydraulic Roughness Coefficient (Manning's n) for Conduits

Type of Pipe Material	Manning's n (normal)
Concrete	0.013
Ductile iron	0.012
Corrugated metal (CMP) - annular - 2-2/3" x 1/2"	0.024
CMP - annular – 3" x 1"	0.027
CMP - annular – 6" x 2"	0.032
CMP - helical- 2-2/3" x 1/2"	
12-inch diameter	0.013
18-inch diameter	0.015
24-inch diameter	0.017
36-inch diameter	0.021
48-inch diameter	0.023
60-inch diameter and larger	0.024
Corrugated high-density polyethylene: single wall	0.024
Corrugated high-density polyethylene: smooth wall	0.012
Spiral rib metal	0.011
PVC	0.011
High density polyethylene - butt fused	0.009

Note: These n values are the "normal" range hydraulic roughness coefficient values for use in the analysis of conduits. Refer to the most current version of the ODOT Hydraulics Manual for additional reference values.

Table 11. Normal Range Hydraulic Roughness Coefficient (Manning's n) for Channels

Type of Channel	
Constructed	**Natural**
A. Earth, straight and uniform	A. Minor streams (top width at flood stage less than 100 feet)
1. Clean, recently completed 0.018	1. Streams on plain
2. Clean, after weathering 0.022	a. Clean, straight, full stage, no rifts or deep pools 0.030
3. Gravel, uniform section, clean 0.025	b. Same as above, but more stones and weeds 0.035
4. With short grass, few weeds 0.027	c. Clean, winding, some pools and shoals 0.040
B. Earth, winding and sluggish	d. Same as above, but some weeds and stones 0.045
1. No vegetation 0.025	e. Same as above, lower stages, irregular slopes and sections with more ineffective flow area 0.048
2. Grass, some weeds 0.030	f. Same as d, but more stones 0.050
3. Dense weeds or aquatic plants in deep channels 0.035	g. Sluggish reaches, weedy, deep pools 0.070
4. Earth bottom and rubble sides 0.030	h. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush 0.100
5. Stony bottom and weedy banks 0.035	2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages
6. Cobble bottom and clean sides 0.040	a. Bottom: gravels, cobbles, and few boulders 0.040
C. Rock cuts	b. Bottom: cobbles with large boulders 0.050
1. Smooth and uniform 0.035	B. Floodplains
2. Jagged and irregular 0.040	1. Pasture, no brush
D. Channels not maintained, weeds and brush uncut	a. Short grass 0.030
1. Dense weeds, high as flow depth 0.080	b. High grass 0.035
2. Clean bottom, brush on sides 0.050	2. Cultivated areas
3. Clean bottom, brush on sides, highest stage of flow 0.070	a. No crop 0.030
4. Dense brush, high stage 0.100	b. Mature row crops 0.035
	3. Brush
	a. Scattered brush, heavy weeds 0.050
	b. Light brush and trees 0.050
	c. Medium to dense brush 0.070
	4. Trees
	a. Dense willows, straight 0.150
	b. Cleared land with tree stumps, no sprouts 0.040
	c. Cleared land with tree stumps, heavy growth of sprouts 0.060
	d. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches 0.100
	e. Same as above, but with flood stage reaching branches 0.120

Note: The n values listed above are the "normal" range hydraulic coefficient values for use in the analysis of open channels. For conservative design of channel capacity, the "maximum" values listed in the current version of the ODOT Hydraulics Manual should be considered. For channel bank stability calculations, the "minimum" values listed in the current version of the ODOT Hydraulics Manual should be considered.

7.3.6 Capacity Analysis: Pressure Flow

A backwater analysis shall be included in the stormwater report for the following circumstances:

A. Where uniform flow is not expected or where losses within the system may cause surcharging of water.

B. A discharge into a tailwater condition, such as a partially full stormwater detention pond or into a partially full channel.

C. Culvert entrances.

D. Ditch inlet location where backwater effect could cross a property line.

E. Other locations as determined by the District.

The backwater analysis shall be to a point where non-pressure flow at the design storm flow rate is re-established.

When a backwater condition exists, the storm drain system shall be designed to convey and contain at least the peak runoff from the 25-year Design Storm or the design storm identified in Section 7.3, whichever is larger.

Structures for proposed pipe systems must be designed to provide a minimum of 1 foot of freeboard between the HGL and the top of the stormwater structure and appurtenances or finish grade above the pipe during the design flow. Surcharge in pipe systems shall not be allowed if it will cause flooding in portions of a structure, including below-floor crawl spaces and basements.

7.3.7 Hydrologic and Hydraulic Calculation Reporting

Design hydrologic and hydraulic data for each reach of a proposed storm drain system shall be included in the stormwater report submittal. It is the responsibility of the Developer's Engineer to determine the best way to document the design analysis for presentation in the Stormwater Report.

Storm Drainage System calculations shall include the following items:

A. Description and sketch of the storm drainage system, including pipe size, slope, and material for each segment of the system.

B. Description and sketch of the contributing area (curve number value or equivalent, as well as the size).

C. Time of concentration calculations, including assumed coefficients, flow path lengths, and slope.

D. Capacity analysis calculations as outlined in Sections 7.3.5 and 7.3.6.

E. Design flow calculations, including assumed coefficients and design storm.

F. Design flow rate for each pipe and open channel segment of the onsite storm drainage system.

G. HGL and ground surface elevation at each structure and outlet location. It is preferable to show this information on a profile plot on an engineering scale, though spreadsheet tables are acceptable. When spreadsheet tables are used in place of a profile plot, include the distance between the ground surface and the HGL at each structure and outlet location.

H. Flow velocity at outlet structures and in open channels.

7.4 Open Channels

The following section describes accepted criteria and methods for designing open channel storm drainage systems, such as swales and ditches.

7.4.1 Geometry

Constructed open channels shall be sized to pass the design flows listed in **Table 9** without causing erosion.

Channel side slopes shall be no steeper than two-horizontal to one-vertical (2h:1v) for undisturbed ground (cuts), as well as for disturbed ground (embankments).

A low-flow channel, within the main channel, designed to carry 10 percent of the design storm, will be required for channels with a design flow of greater than 20 cubic feet per second (cfs). Side slopes for the low-flow channel shall not exceed 2h:1v and shall be stabilized to the satisfaction of the District. The minimum stabilization material shall be seeded matting or approved equivalent.

Channel design along curves shall be curvilinear with a 100-foot minimum radius. Tighter curves may be used if the District determines that sufficient erosion control has been incorporated into the design to maintain stable bank conditions following development.

Channels shall be designed to provide sufficient freeboard so as not to saturate any adjacent public road base with design storm peak flows. Channels shall have a minimum freeboard of 6 inches when the design discharge is 10 cfs or less and 1 foot when the design discharge is greater than 10 cfs. Extra freeboard may be required for curved segments of an open channel.

7.4.2 Channel Lining and Infiltration

Every opportunity should be taken to design open channels to provide infiltration throughout an entire storm drainage system. Engineers are also encouraged to consider innovative means of collecting and conveying runoff to incorporate infiltration into the storm drainage system design.

Vegetation-lined channels shall be used whenever practicable. Rock-lined channels shall be used only where a vegetative lining will not provide adequate protection from erosion.

If the channel has a flow line slope of 6 percent or greater or a peak design velocity that exceeds 4.0 feet per second (fps), the channel shall incorporate rock lining or riprap energy dissipation devices designed by a qualified PE. Channel protection shall be based on the minimum level of protection listed in **Table 12**.

Where riprap protection is specified, riprap shall be placed over a woven geo-textile fabric.

No protruding pipes, culverts, or other structures, which reduce or hinder the flow characteristics of the channel, will be allowed. Channel connections shall be designed to prevent scouring. All pipe connections shall match side slopes and incorporate a headwall.

All channel sides and bottoms shall be seeded, sodded, or rock-lined immediately following excavation, regardless of mean flow velocity.

Table 12. Protection for New Channel Construction

Velocity at design flow, fps		Required protection	Thickness, feet	Minimum height above design water surface, feet
Greater than	Less than or equal to			
0	5	Vegetation lining	Not applicable	0.5
5	8	Bioengineered lining	Not applicable	1
		ODOT Class 50 riprap❶	1.5	
8	12	ODOT Class 200 riprap	2.5	2
12	20	Slope mattress, etc.	Varies	2
20		Engineer-designed		

❶ *The District may require ODOT Class 100 Riprap on an as needed basis.*

7.4.3 Open Channel Location

New open channels in residential areas shall be in easements and recorded on plat maps with the following restrictions:

A. Owner shall not alter the drainageway without approval of the District.

B. Owner shall not place any structure or fence within the normal high-water area of the open channel.

C. Owner shall not introduce foreign material such as grass clippings within the high-water area of the open channel.

7.4.4 Check Dams

Check dams are not recommended for use in storm drainage system channels due to the problems they pose for routine maintenance operations. However, check dams are recommended for use in temporary channels as an EPSC device (see Chapter 8) and for stepping down swales being used for infiltration. Where check dams are proposed, they shall be spaced at maximum 2-foot elevation intervals.

7.5 Culverts

Culverts, for the purposes of this manual, are single runs of pipe that are open at each end and do not have structures such as catch basins or manholes. Culverts designed for fish passage are governed by the Oregon Department of Fish and Wildlife (ODFW) and often require additional design considerations such as depth of flow and velocity that may differ considerably from the design requirements included herein. When conflicts exist, the Applicant shall work with the District and the regulating agency to establish the appropriate design criteria.

Criteria for culverts designed for open channel flow in this section shall apply to culverts placed in drainageways and roadside ditches. Culverts which are part of a roadside ditch system or within the ROW shall be permitted by the local road authority.

Culverts within FEMA floodplains shall be reviewed and approved by the local FEMA-designated floodplain permitting authority.

Culverts placed in streams or drainageways determined to be Waters of the State require approval from the Oregon Division of State Lands (DSL) and the USACE.

For culverts which convey flows from or through water quality sensitive areas; a local representative of the ODFW or other applicable state or federal agency shall be contacted to determine if fish passage is required and to identify site specific design criteria.

7.5.1 Culvert Design Criteria

Culverts located within the structural street section shall be placed in accordance with local agency standard details for utility placement location.

For new culverts 18 inches in diameter or less, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter or three times the pipe diameter with a seepage collar unless an exception is approved by the District.

For new culverts larger than 18 inches in diameter the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter unless an exception is approved by the District.

The maximum headwater elevation of a design storm event for new culverts shall be at least 1 foot lower than the road or parking lot sub-grade.

Minimum diameters for cross culverts under public and private roadways are 18 inches. All other roadway culverts, including driveway culverts, are a minimum of 12 inches.

No bends shall be permitted in culvert pipes.

Minimum cover, as measured from the top of pipe to finished grade:

- Under roads classified as collectors or higher: 2 feet.
- If Class 52 Ductile Iron Pipe is used, the cover may be reduced to 1 foot.
- PVC and HDPE shall require a 2-foot minimum cover in any public roadway area.
- Pipe covers of less than the above stated minimums may be permitted on a case-by-case basis. These may require a designed reinforced concrete cover that will distribute roadway use (traffic) forces to a foundation area to the sides of the pipe.
- Reinforced concrete box culverts with no cover requirement may be permitted on a case-by-case basis. Signed and sealed structural design calculations shall be submitted for review (this requirement may be waived for pre-cast reinforced concrete box culverts with covers greater than 2 feet). In culverts with no cover, the clearance from the roadway surface to the reinforcing steel shall be no less than 3 inches and the 30-day concrete strength shall be no less than 4,500 pounds per square inch.

Maximum culvert length without access structures is 300 feet.

Minimum separation from other utility pipes and conduits (as measured from the outside edge of pipe) is 6 inches vertical, 3 feet horizontal, unless otherwise specified by the purveyor of the utility in question.

Controlled Density Fill or Controlled Low Strength Material (CLSM) shall be used for any pipes with less than 12 inch separation.

Pipe bedding and backfill shall conform to applicable roadway standards or the District's Standard Details.

The entrances and outlets to all culverts shall be stabilized with quarry rock or other energy dissipation methods to minimize scouring of the channel bottom and sides. These shall be designed by a PE using published references such as the current version of the Hydraulic Design of Energy Dissipaters for Culverts and Channels (U.S. Department of Transportation, Federal Highway Administration) and other references.

Rock protection at culvert entrances should extend upstream a minimum of 5 feet and shall have a minimum height of 1 foot above the design headwater elevation. Rock protection at the culvert outlet shall have the greater of:

- A minimum height of 1 foot above the design tailwater elevation
- 1 foot above the crown of the pipe

When two parallel pipes are installed, the minimum separation between the exterior pipe walls shall be 3 feet or half the diameter of the larger pipe, whichever is greater. Pipe separations less than the stated minimum may be permitted on a case-by-case basis.

7.5.2 Culvert Materials

The pipe materials listed in Section 7.6.2 are approved for use for culverts, subject to the limitations listed in Section 7.5.1.

7.5.3 Headwalls/Endwalls

Pipe headwalls, endwalls, or other approved end protection shall be required where pipe material other than concrete or ductile iron is exposed in the design of an outlet or inlet pipe or where required to provide slope stability. Headwalls and endwalls should be built high enough to support the full depth of pipe cover recommended by pipe manufacture. Headwalls and endwalls built to the proper height improve pipe capacity during extremely high flows and help prevent pipe blockage, road washouts, and compounding damage caused by pipe failure.

No plastic pipes shall be exposed, which may require pipe transitions from underground plastic to exposed ductile iron pipe or mitered pipe end matching the slope with a paved concrete endwall. Concrete endwalls shall extend a minimum of 18 inches out from the end of pipe.

For culverts 18 inches in diameter and larger, the embankment around the culvert inlet shall be protected from erosion by armoring around the inlet with rock or other protection. The armoring shall extend downstream from the culvert a minimum of 5 feet and shall be as high as the designed headwater elevation.

7.6 Pipe Systems

Pipe systems are comprised of more than one run of pipe and include at least one junction-type of structure such as a catch basin or manhole. The following section describes accepted criteria and methods for designing pipe systems.

7.6.1 General Pipe Design Criteria

Storm drainage pipe systems, sometimes referred to as storm sewers or lateral closed systems, are piped storm drainage systems used for transporting runoff from the roadway and other inlets to outfalls at structural SMFs and receiving waters. Pipe drain

systems are suitable mainly for medium to high-density residential and commercial/industrial development where the use of natural drainageways and/or vegetated open channels is not feasible.

Storm Drainage Systems shall be designed to accommodate flows identified under Chapter 7 and include the design considerations of this section.

Manning's Equation shall be used to calculate pipe capacity. Open channel (gravity) flow is required.

Storm management facilities shall be designed and constructed to accommodate all assumed future full build-out flows generated from upstream property within the basin.

Storm Drainage Systems within the ROW shall be not less than 12 inches in diameter.

Service Connections within the ROW shall not exceed half the diameter of the mainline and cannot exceed 8 inches in diameter. For larger Service Connections, a structure for maintenance access is required.

Mainlines to be publicly maintained shall be not less than 12 inches in diameter.

Private storm drains outside the Public ROW or public easement shall not be less than 6 inches in diameter and permitted and inspected in accordance with the OPSC.

Pipes from catch basins to the main line in the Public ROW shall be not less than 12 inches in diameter.

Storm pipes serving roof drain with no requirement to be extended shall be a minimum of 8 inches in diameter. Storm Sewer Service Connections serving a house or commercial property shall generally be 6 inches in diameter or as approved by the District.

The maximum pipe slope is 20 percent except as approved by the District. Pipes on slopes in excess of 20 percent shall be constructed with anchor walls per the standard details. Storm lines shall not decrease in size as they move downstream regardless of the slope provided on the pipe.

Storm sewers shall be designed with a minimum slope of 0.5 percent. Exceptions will be made for topographic constraints, but the minimum acceptable pipe design must have sufficient slope to maintain a minimum flow velocity of 3.0 fps for a pipe flowing half-full.

Any change in pipe size, alignment, grade, or material shall require a structure per the Standard Details.

IE in and IE out crown elevations shall be matched for any changes in pipe size diameter from upstream to downstream the pipe.

If trash racks or debris barriers are required by the District for pipe or culvert systems, the Developer's Engineer shall submit the trash-rack-debris barrier system design to the District for approval.

7.6.2 Pipe Material

Pipe materials shall conform to the District rules, regulations, and standards. Pipe material must also comply with the local road authority. Acceptable pipe materials and abbreviations are as follows:

- Concrete sewer pipe or reinforced concrete pipe
- Concrete lined ductile iron

- PVC
    - ASTM D3034 SDR 35, 4 to 24 inches
    - ASTM C-900 D-1784 DR, 4 to 24 inches (preferred by District)
    - ASTM C-905 D-1784 DR, 4 to 24 inches (preferred by District)
- HDPE, ASTM D-3035
- Polyethylene – Smoothed Wall

Where required for added strength, C905 or C900 PVC shall be used. Pipe with less than 3 feet of cover requires submittal of the manufacturer's specifications. The District may require pipe load analysis calculations in unusual situations, typically in areas where the depth of ground cover over the pipe is not within the limits specified by the District or the pipe manufacturer.

A minimum 75-year lifespan is required.

Alternate materials will be approved on a case-by-case basis. The Developer's Engineer shall provide manufacturer's specifications, design calculations, or other information as required by the District for review.

Trench backfill, compaction, and testing shall conform to the District's Sanitary Standards Chapter 6 and Standard Detail Drawings.

7.6.3 Alignment and Location

The following bullets provide the criteria for the alignment and location of the storm drainage system

Storm drainage systems within a Public ROW shall be located in the center of the street and a minimum of 5 feet from the curb, unless otherwise approved by the District and the local road authority.

Storm drainage systems shall be laid on a straight alignment and uniform grade between structures.

Utility crossings shall be constructed as near 90 degrees as practicable. Utility crossings have the minimum separation of 12 inches of vertical separation measured from the edge of each pipe. Any separation of less than 12 inches will be reviewed and approved on a case-by-case basis by the District.

Unless approved by the District, the minimum separation distance between parallel sanitary and storm sewers and utilities shall be 5 feet measured from the edge of each pipe, and vertical separation between utilities is a minimum of 3 feet. Additional horizontal spacing may be required to allow for maintenance and repair access.

If streets have curved alignments, whenever possible, the storm drain alignment shall be parallel with water and sanitary lines with a minimum separation of 10 feet with sanitary and 6 feet with water. The intent is to prevent conflict with sanitary and water lines while providing the fewest manholes required to traverse on curve and prevent a conflict with survey monuments.

Where storm drains are located parallel with other utility pipe or conduit lines, the vertical and horizontal alignment shall permit future side connections of main or lateral storm drains and avoid conflicts with the parallel utility without abrupt changes in vertical grade of main or lateral storm drains.

Storm drain alignments shall accommodate future planned projects such as street widening, changes in horizontal or vertical street alignment, and master plan water or sewer facilities.

Storm drain lines shall enter a creek or drainage channel at 90 degrees or less to the direction of the flow. The outlet shall have a headwall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of the pipe and channel being entered will govern which protective measures are required.

7.6.4 Junctions

Connections to the existing public storm systems that are 8 inches diameter and greater.

Manholes shall be provided at least every 500 feet, at every grade change, and at every change in alignment.

Manhole lids shall not be located in a wheel path of the motor vehicle travel way.

Manhole lids shall have a minimum of 12 inches clearance from the edge of a curb and gutter.

All manholes shall be a minimum of 48 inches in diameter and have a minimum 12-inch ledge in the base.

A detail shall be submitted with the plans where pipes into or out of a manhole are larger than 24 inches or where more than four mainline connections are made.

A minimum of 8 inches of un-perforated wall separating the cut-outs or breakouts for the individual pipe connections shall be provided in manholes.

Where a connection is proposed to an existing manhole, elevation of the existing ledge, location of steps, and elevations of existing inlets and outlets shall be submitted as a detail on the plans.

Manholes constructed on lines with 12-inch or smaller pipes shall have a minimum 0.2-foot fall through the manhole, unless otherwise approved by the District.

Where different size public storm drainage pipes enter a manhole, the crowns of the upstream pipes shall be no lower than the crown on the downstream pipe without District approval.

A lateral entering a manhole within a public storm drainage system shall be designed so that the invert of the lateral is 6 inches above the invert of the outlet pipe.

All manhole bases shall be properly channelized.

No more than three side laterals or side sewers are allowed to be connected to a manhole unless an exception is approved by the District.

Manhole lids shall be in conformance with the Standard Details.

A Curb Inlet Manhole or Modified Curb Inlet Manhole per Standard Details may be used in lieu of a manhole, when approved as part of a flow-through system.

Storm drainpipe junctions shall be manholes, or other approved junctions, which conform to Oregon UPC and District requirements. Oversized manholes and other specialized junctions shall be approved on a case-by-case basis by the District.

Public piped storm drain systems shall have junctions at not more than 500-foot intervals.

Junctions located outside the Public ROW shall generally be minimum 48-inch-diameter manhole structures except as approved by the District.

Catch basins may be used as junctions only with pipes not greater than 12 inches in diameter for depths up to 5 feet from rim to invert with prior approval of the District.

Cleanouts may only be used as junctions only with private pipes not greater than 6 inches in diameter for depths up to 5 feet from rim to invert with prior approval of the District.

Catch basin laterals must be connected to the mainline at a manhole.

Roof drain laterals may be tee connected into the mainline, manhole, or catch basin.

Pipes entering manholes may have a maximum free fall of 4 feet as measured to the invert of the manhole base. A sump may be required for energy dissipation at the discretion of the District.

7.6.5 Inlets and catch basins

Curb and gutter requirements will be regulated by the local road authority.

All inlets and catch basins shall be designed to accept a 25-year storm event. Grates shall, as far as practical, be designed to avoid failure due to accumulation of debris.

Inlets shall be designed to completely intercept the design storm gutter flow with no greater than 250 feet between inlets. Flow paths shall not cross intersections, so inlets shall be installed at intersections as needed. In addition, catch basins shall be provided just prior to curb returns.

Flow through catch basins are generally not allowed. The main storm line shall not pass through any catch basins.

Type GB-2 catch basins, or equal are required for all curbed street inlets and shall be generally located within the Public ROW, or an easement granted to the District.

All catch basins shall be constructed with an 18-inch minimum sump.

No more than three catch basins, with the maximum distance of 50 feet apart, may be connected in series before connecting to a main storm line.

A ditch inlet or field inlet may be connected to the end of the main storm line through a structure.

Inlets shall be located along the gutter line or open channel flowline. When streets are widened or otherwise modified, causing an inlet to be located outside a flowline, the inlet shall be removed entirely and reconstructed with a junction box, manhole, or other acceptable connection as specified by the District.

Dual GB-2 catch basins are required at all roadway sags and cul-de-sac low points. An emergency overflow pathway for the 100-year storm event shall be provided within the boundary of the plat as a tract of land, or onsite as a recorded easement.

Catch basins, except for CG-48 manholes shall be a maximum depth of 6½-feet from the top of grate to the lowest pipe IE, unless approved by the District.

Where design criteria and methodology are not specified in this section, design shall follow the current versions of the ODOT Hydraulics Manual or the Hydraulic Engineering Circular No. 12 (FHWA-TS-84-202) Drainage of Highway Pavements.

Ditch inlets and area drains in rear or side yards shall be equipped with an 18-inch sump.

A main storm line shall not pass through an area drain or ditch inlet.

Area drains or ditch inlets located at the upper terminus of a main storm line shall connect to the main storm line at a manhole.

The maximum acceptable intake flow rates for area drains and ditch inlets with a grate angle of 30 degrees are shown in **Table 13** where H is the hydraulic head measured in feet from the bottom of the grate to headwater and Q is the flow rate in cubic fps.

Table 13. Maximum Intake Flow Rates for Area Drains and Ditch Inlets with Grate Angle of 30 Degrees

H	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.0	10.0
Q	2.0	5.6	10.3	11.9	13.3	14.6	16.8	18.8	22.3	26.6

7.6.6 Pipe Cover Requirements

In paved areas or areas anticipated to receive vehicular traffic, pipe cover shall be measured from the top of the paved surface (finish grade) to the upper exterior surface of the pipe barrel. The pipe bell shall not intrude into the subbase. In areas without pavement or vehicular traffic, pipe cover shall be measured from finish grade to the upper exterior surface of the pipe barrel.

The minimum cover requirement for the mainline storm sewer shall be 36 inches unless an exception is approved by the District and roadway authority.

7.6.7 Storm Drainage Systems in Right-of-Way, Private Streets or Easements

All publicly maintained storm drainage systems shall be located within the ROW, or private street with public easements that provide access to all structures. If the storm drainage system cannot be located in a ROW or private street, then an easement granted to the District will be provided.

Public storm drainage systems in easements will be allowed only after all reasonable attempts to place the drains in the ROW have been exhausted. Provisions shall be made for vehicular access to manholes for preventive maintenance and emergency service.

See Section 6.4.1 for more discussion on easements.

7.7 Service Connections

The following subsections provide the requirements and responsibilities for Service Connections.

7.7.1 Responsibilities

A property shall be served by a single Service Connection designed, constructed, maintained, repaired and/or replaced in the following manner:

A. Operation and Maintenance of the Service Connection:

   a. The Owner(s) that benefits from the Service Connection is solely responsible to own, operate and maintain the Service Connection from the Building Sewer to the public mainline, including the connection to the mainline located within a Public ROW or easement.

b. The District is responsible for maintaining Public Stormwater Mainlines, and shall not be responsible for maintenance or repair of damage resulting from inadequate or improper operation of the Service Connection or of attached fixtures or appurtenances, such as cleanouts and traps, between the building and public mainline.

B. Property Owner Responsibilities for Repairs:

a. Inspections and investigations to determine the condition and functionality of the Service Connection from the building to the public mainline.

b. Repairs of structural and non-structural defects for any portion of the Service Connection that is on private property, including the area within easements granted to the District.

C. District Responsibilities for Repairs:

a. Repair of structural defects, as determined by the District, for the portion of the Service Connection that is within the Public ROW.

7.7.2 Diameter

Each residential single-family lot shall be served by a single 6-inch diameter Service Connection.

The diameter of the Service Connection for lots other than residential single family shall be served by a minimum 6-inch diameter pipe, or larger if deemed necessary by OPSC or permitted at the sole discretion of the District.

7.7.3 Materials

The Service Connection pipe, tee, cleanout, and joint materials shall be designed and constructed of the same material as the Public Stormwater Mainline.

All couplings, adapters, etc., used to connect dissimilar pipe materials together shall be approved by the District.

7.7.4 Installation

Service Connections shall be made by means of a manufactured tee. No Inserta Tees, wyes or grouted connections will be allowed in the extension of Public Stormwater Mainlines, unless otherwise approved by the District.

Service Connections may be installed into an existing Public Stormwater Mainline with an installation of an Inserta Tee at the sole discretion of the District. For further details see Section 7.7.9.

Manholes are required for Service Connections 8 inches or larger in diameter, and Service Connections shall be a minimum of one-half the diameter of the mainline. No Service Connection shall be larger in diameter than the mainline.

For additional information regarding Service Connection specifications see the Standard Detail drawings.

7.7.5 Location

Generally, the Service Connection shall be located within a Public ROW, or public easement as shown in Standard Detail drawings. Any other proposed location shall be at the sole discretion of the District on a case-by-case basis.

7.7.6 Direct Connection

All drain lines and/or stormwater facilities connected to the Public Storm System shall be connected in accordance with OPSC.

7.7.7 Separate Connection

A separate and independent Service Connection shall be provided for each tax lot, parcel of property, or lot of record. The District does not allow shared Service Connections.

A reduced number of connection points or a single point of connection may be utilized to serve parcels of properties for projects such as condominiums, multi-family, commercial, and industrial projects, whereas the parcels cannot be further divided. The Owner shall be responsible for the customer account and monthly service charges for all of the properties. The Owner shall not further divide the property, or sell a portion of the development, thus creating a shared Service Connection. If a portion of the property is either sold to another person, or divided to create a separate property, then the Owner shall provide a separate Service Connection connected to the Public Storm System to serve the property.

Any partition of land division that is required to install a Service Connection to serve the additional lot(s), shall construct said service connection prior to the recording of the plat, if the Service Connection traverses any part of an adjoining property, common area, private easement, or shared land. The Service Connection will not be required to be constructed to serve the additional lot(s), if the property has direct access to the Public Storm System, and no other jurisdiction is requiring any improvement to be constructed prior to the recording of the plat. Any existing building/residence not currently connected to the Public Storm System shall be required to construct the residence rain drains to the Public Storm System prior to the recording of the plat. Any existing Service Connections shall be used where feasible, as determined by WES.

Where a parcel requiring connection to a public storm drainage system cannot connect through a Service Connection meeting the requirements of this section, then extension of the public storm drainage system shall be required.

7.7.8 Restricted Connections

No person shall connect any Building Sewer or Building Drain that conveys domestic waste or a prohibited substance into the Public Storm System.

7.7.9 Tap-In Connections

For tap-in connections, the storm mainline must be at least a minimum of two (2) times the diameter of the Service Connection. Prior to starting any work the Contractor shall obtain approval by the District, and applicable local authorities. In order for the District to inspect the installation the Installer shall give the District 72 hours advance notice prior to starting the work. The Contractor will conduct the work during the District's regularly

scheduled business hours. If the Installer fails to comply with all local, state and federal safety codes applicable to the work, then District will not perform the inspection.

7.7.10 Slope and Alignment

The minimum slope for Service Connections shall be 2 percent (¼-inch per foot). In unusual conditions a slope of 1 percent (1/8-inch per foot) may be proposed by the Developer's Engineer and approved by the District. Maximum slope for Service Connections shall not be greater than 100 percent slope (45 degrees). All changes in alignment or slope of the pipe shall be made with manufactured fittings. No bends greater than 22.5 degrees, and a totaling 45 degrees shall be allowed. Any piping system constructed on private property shall be required to obtain a plumbing permit issued by the applicable jurisdictional plumbing authority, such as the City or County.

7.7.11 Minimum Depth

The minimum depth of the service connection shall be 3 feet deep at the edge of the ROW or Public Stormwater Easement. Service connections which cannot be laid at the required minimum depth shall be reviewed and approved by the District on case-by-case basis.

7.7.12 Buried Detectable Tape

White detectable metallic tape labeled "CAUTION BURIED STORM LINE BELOW" shall be installed 6 inches above the service connection pipe along its entire length from the tee connection at the mainline to the top of the white 2x4 stake.

Curbs shall be stamped with "ST" in a location of buried sanitary sewers and Service Connections.

7.7.13 Markings

Each Service Connection shall be marked with a white 2x4 stake extended from the end of the pipe to at least 1 foot above the ground.

The location of the Service Connections shall be indicated by a permanent marker, in one of the following manners:

A. Where the service connection is located in a street with curbs, the connection marker shall be a permanent stamp on the top of the curb: ST – Storm Sewer; SS – Sanitary Sewer.

B. Where the Service Connection is in a street without curbs, the marker shall be on the sidewalk.

C. Where the Service Connection is in a street without curbs or sidewalks, the Developer's Engineer shall present to the District for approval an alternative permanent marking method.

7.8 Structures

The following section provides design criteria for storm drainage system structures.

7.8.1 Manholes

Manholes or curb inlets with manhole-type access shall be installed at all pipe junctions where the depth from rim to invert exceeds 4 feet or where the pipe is 18 inches in diameter or greater.

Manholes shall conform to the District's applicable Standard Drawings.

Where minimum vertical distance is proposed between inlet and outlet pipes in a manhole (or inlet structure serving as a junction structure), pipes must be aligned vertically by one of the following criteria, in order of preference:

- Standard manhole channel shall have a minimum channel drop across the manhole of 0.20 foot with a maximum drop of 1 foot.
- Drops between the IE in and out exceeding 1 foot across the manhole will not be channeled.
- Drops exceeding 3 feet between the IE in and out will require an 18-inch sump to dissipate the energy.
- Drops exceeding 6 feet between the IE in and out will not be prohibited.
- Manholes shall be required at, but not limited to, the following locations:
- Changes in vertical grade or horizontal alignment of storm drainpipes
- Change in size of storm drainpipes
- Uppermost extent of storm pipe not opened (daylighted) to receive ditch or other open storm drainage system flows. Cleanouts are not allowed in this situation.

Manholes with pipe horizontal alignment changes of more than 30 degrees in angle shall have the outlet pipe invert at least 0.2 foot in elevation lower than all inflow pipe inverts. This is in addition to the normal grade crossing the manhole.

In addition, a minimum 3-foot elevation difference between the rim and the top of pipe at all manholes with more than 30 degrees of alignment change is required. This is to allow for containment of turbulence generated during high flows by such abrupt changes of alignment.

Standard depth manhole rim frames shall be installed in all paved street locations.

Manhole rims not in pavement areas, and not in the pavement section of a paved road, shall be set 6 inches above finished grade with a bolt down tamperproof lid.

7.8.2 Inlet Structures

Inlet structures are required at the ends of all dead-end streets with a descending grade and at all impervious surface sags and low points, but in no case shall they be spaced farther apart than 250 feet.

Inlet structures located in street sections where there is curb and gutter shall be a curb inlet catch basin per District standards, unless otherwise approved by the District.

Catch basins with connector storm drains shall connect to a receiving storm drainage system pipe into a manhole, unless otherwise approved by the District.

Ditch and/or area inlets shall be required to intercept existing flows and convey to the appropriate outlet.

Any low point structure shall provide an emergency overflow pathway.

7.9 Outfalls

Outfalls from drainage facilities shall be designed with adequate energy dissipaters to minimize downstream damage and erosion. All outfalls with exit velocities of more than 4 fps shall be examined with respect to soil type to ensure adequate erosion control. Unless otherwise approved, an outfall elevation shall be submerged by the receiving creek or channel during the peak storm event as specified in this chapter.

Storm drain lines shall enter a creek or drainage channel at 90 degrees or less to the direction of the flow. The outlet shall have a headwall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of the pipe and channel being entered will govern which protective measures are required.

Engineered energy dissipaters, including but not limited to, stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, shall be designed using published references such as the current version of the Hydraulic Design of Energy Dissipaters for Culverts and Channels published by the Federal Highway Administration of the U.S. Department of Transportation, the current version of the ODOT Hydraulics Manual and others. The design reference shall be cited in the stormwater report.

Rock protection at outfalls shall be designed in accordance with information listed in **Table 14**.

Table 14. Rock Protection at Outfalls

Discharge velocity at design flow, fps		**Minimum required protection dimensions**				
Greater than	**Less than or equal to**	**Type**	**Thickness, feet**	**Width**	**Length (use greater of)**	**Height over crown, feet**
0	5	ODOT Class 50 Riprap❶	1.5	Diameter + 6 feet	8 feet –OR– 4 x diameter	1
5	10	ODOT Class 200 Riprap	2.5	Diameter + 6 feet	12 feet –OR– 4 x diameter	1
10		Engineered energy dissipater required				

❶*The District may require ODOT Class 100 Riprap in areas with likelihood of vandalism.*

If the outfall is located in an environmental overlay zone, additional requirements may apply. A permit from the USACE and/or the DSL may be required. The Applicant is responsible for obtaining the proper permits from the regulating agencies.

7.10 Drains

The following requirements apply to drains installed with development activities.

7.10.1 Slope Intercept Drains

Slope intercept drains are allowed at the following locations:

Along the upper and lower boundaries of a development where surface and/or ground water can be expected to migrate and cause adverse impacts to the future, or adjacent Owners.

Along the upper and lower boundaries of a development where slope exceeds 10 percent to prevent drainage from the tributary area above the site.

Along the top of all cut slopes which exceed two-horizontal to one-vertical (2h:1v) where the tributary drainage area above the cut slope has a drainage path greater than 40 feet as measured horizontally from the hinge point of the cut.

7.10.2 Subsurface Drains/Cutoff Trenches

Subsurface drains (underdrains) shall be provided at the following locations:

- Along the upper and lower boundaries of a development where surface and/or ground water can be expected to migrate and cause adverse impacts to the future, or adjacent Owners.
- For stability on cut and fill slopes, when required by the District.
- For all existing springs or springs intercepted during construction activity for other facilities.
- Where high groundwater exists or when it is necessary to reduce the piezometric surface to an acceptable level to prevent land slippage or under floor flooding of buildings.
- Where recommended by a geotechnical engineer.
- Where possible, a minimum slope of 0.15 foot per 100 feet should be used. The subsurface drain must be installed below the water flow to function properly. The use of a geotextile fabric to line the trench is recommended.

7.10.3 Foundation Drains

The following drainage provisions shall be made for foundation drains in a development:

Foundation drains shall be piped directly to a storm drain system other than a street gutter. Provisions must be taken so that the design HGL of the receiving storm drainage system does not back up into the foundation drain.

Foundation drains are prohibited to be piped directly onto the street. If directing drain onto the street is the only possible solution, then the District and local road authority shall consider the circumstances to determine the acceptable solution on a case-by-case basis. Otherwise, foundation drains shall be piped directly to a storm drain system other than a street gutter.

Should site topography prevent connecting foundation drains directly to a public storm drain system, the drains for one or more lots shall be piped through a private system to the public storm drainage system. This private storm drainage system shall be located in a dedicated easement and the Owner shall be responsible for the private system maintenance. Any private storm drain piping shall be permitted and constructed in accordance with OPSC.

7.11 Private Pumping Systems

Private stormwater pumping systems are only allowed for private commercial/industrial development. These private stormwater pumps will be permitted only after approval by the District. It is the District experience that pumping systems are not reliable in order to prevent flooding or property damage without the Owner assuming significant liability and risk to itself,

and the surrounding properties. Therefore, it is the District policy not to allow the pumping of stormwater runoff, unless the Developer can meet all of the conditions listed below:

- The proposed pump system is not intended to circumvent any development that can provide a gravity storm drainage system, by means of obtaining an easement to provide the required gravity storm drainage system, and emergency overflow pathway. Not being able to acquire the necessary easement does not authorize the pumping of stormwater runoff.
- Due to topology a pumping system may be considered, if there is no other possible engineered solution to providing a gravity system, and pumping is the only possible solution to alleviate flooding. Without pumping the property would have no means to develop.
- Pumping stormwater will not be allowed for facilities that are publicly maintained or have multi-property Owners sharing the use of the pumping system, such as a partition, subdivision, or other similar development.
- Pumping will only be allowed if the use benefits a single property Owner who is the sole responsible person for the liability, risk, ownership, operation, maintenance, replacement, and repair of the private pumping system.
- The pump system must provide storage for a minimum of 25 percent of the runoff volume from a 2-year, 24-hour storm event. An emergency backup power source may be required, at the discretion of the District.
- The pump system must include dual pumps with an external audible and visual alarm system.
- The pump system must be capable of discharging a 100-year storm event.
- The topology of the property must provide an off-site emergency overflow pathway, to convey the stormwater runoff from 100-year storm event during a complete failure to an acceptable storm drainage system.
- Applicants will be required to provide assurance that no downstream impacts from the implementation of a stormwater pump system.
- Private storm drainage system for the pump system must transition to gravity and will only be allowed to discharge into an open storm drainage system.
- All pump systems must be privately operated and maintained by a single Owner. Prior to final approval of the project served by such a pump system, an agreement establishing responsibility for payment of costs resulting from the operation and maintenance of the pump system must be approved by the District and must be legally recorded.
- An O&M Plan and maintenance covenant, consistent with Chapter 9 shall be developed for all private stormwater pumps.

8. Construction Requirements

All development, regardless of permit status, shall keep sediment laden water and any other forms of stormwater pollution from entering natural drainage systems or the storm drainage system. The requirements for erosion prevention and sediment control shall be implemented in accordance the District's Rules, these Standards, and the most current version of the Erosion Prevention and Sediment Control Planning and Design Manual adopted by the District. The Applicant for a development permit shall submit an EPSC Plan as part of their application specifying appropriate BMPs. For site disturbances of 5 acres or larger, the Applicant must demonstrate that they also have an DEQ-approved 1200-C permit.

The Applicant for a development permit is ultimately responsible for retaining all soil on the project site and must recognize the potential for changing, or unexpected site and weather conditions. If at any time the District approved EPSC Plan is determined to be ineffective, District will require additional controls to be implemented until a site is stabilized. The Applicant is responsible for updating the EPSC Plan and resubmitting it to the District.

8.1 General Provisions

The following general erosion prevention and sediment control provisions apply to all properties within the District boundary, regardless of whether that property is involved in a construction or development activity.

A. The use of erosion prevention techniques, including proper site planning and construction phasing, shall be emphasized, rather than sediment control measures. Erosion and sediment control practices shall be designed and implemented to maintain water quality; protect fish and wildlife habitat; maintain natural vegetation; reduce the use of pesticides, fertilizers, chemicals; and manage dust.

B. Construction within waterways shall be pursuant to permits issued by State and Federal agencies having jurisdiction and shall apply their regulations. Pollutants such as, but not limited to, fuels, lubricants, asphalt, concrete, bitumens, raw sewage, and other harmful materials shall not be discharged into rivers, wetlands, streams, impoundments, undisturbed buffers, or any storm drainage system, or at such proximity that the pollutants flow to these watercourses.

C. The use of water from a stream or impoundment, wetland, or sensitive area, shall not result in altering the temperature or water quality of the water body in violation of OARs, and shall be subject to water rights laws. All sediment-laden water from construction operations shall be routed through sedimentation basins, filtered, or otherwise treated to remove the sediment load before release into the surface water system.

D. Construction shall be done in a manner to minimize adverse effects on wildlife and fishery resources pursuant to the requirements of local, state, and federal agencies charged with wildlife and fish protection.

E. Natural Vegetation

   a. As far as is practicable, natural native vegetation shall be protected and left in place. Disturbed Areas shall be carefully located and marked to reduce potential damage.

   b. Trees shall not be used as anchors for stabilizing working equipment.

c. During clearing operations, trees shall not be permitted to fall outside the Disturbed Area. In areas designated for selective cutting or clearing, care in falling and removing trees and brush shall be taken to avoid injuring trees and shrubs to be left in place.

d. Where natural vegetation has been removed, or the original land contours disturbed, vegetative ground cover shall be planted and established in accordance with the Wet Weather standards in Section 8.2.6.

F. The use of hazardous chemicals, including pesticides, insecticides, herbicides, defoliants, soil sterilant, and fertilizers, must strictly adhere to Federal, State, County, and local restrictions.

G. All pesticides, fertilizers, and chemicals delivered to the job site shall be covered and protected from the weather. None of the materials shall be exposed during storage. Waste materials, rinsing fluids, and other such material shall be disposed of in such a manner that pollution of groundwater, surface water, or the air does not occur. In no case shall toxic materials be dumped into drainageways.

H. Dust and other particulate matters caused by development activity containing pollutants may not settle on property and/or be carried to Waters of the State through rainfall or other means. Dust shall be minimized to the extent practicable as per Section 8.6.5.

8.2 Erosion Prevention and Source Control Required

This section provides criteria regarding erosion prevention and sediment control standards. The requirements of this section shall apply to all activities requiring an EPSC Permit. The Applicant for the EPSC Permit shall be responsible for meeting these requirements.

8.2.1 Erosion Prohibited

Visible or measurable erosion as defined in Section 7.6 of the District's Rules, which enters, or is likely to enter, the public or private storm and surface water system or other properties, is hereby prohibited, and is a violation of these standards, unless authorized by a state or federal permit or certification.

Unless authorized by a State or Federal permit or certification, no person shall create physical erosion by dragging, dropping, tracking, or otherwise placing or depositing, or permitting to be deposited, mud, dirt, rock, or other such debris upon a public street or into any part of the public storm and surface water system, or any part of a private storm and surface water system which drains or connects to the public storm and surface water system. Any such deposit of material shall be immediately removed using hand labor or mechanical means. No material shall be washed or flushed into any part of the storm and surface water system until all mechanical means to remove the debris have been exhausted and preventative sediment filtration is in place. The Applicant of the property, Permittee, under a site development permit, together with any person or persons, including but not limited to the Contractor or the Developer's Engineer who causes such erosion, shall be held responsible for violation of these standards.

8.2.2 Erosion Prevention and Sediment Control Plan

An EPSC Plan shall be prepared in accordance with the requirements of Section 8.4 of these standards for all sites where an EPSC Permit is required.

8.2.3 Erosion Prevention and Sediment Control Permits

The Applicant for a development permit shall submit an EPSC Plan as part of their application specifying appropriate BMPs.

An EPSC Permit is required under the following conditions:

A. Prior to placement of fill, site clearing, or land disturbances, including but not limited to grubbing, clearing or removal of ground vegetation, grading, excavation, or other activities, any of which results in the disturbance or exposure of soils covering an area of 800 sf or greater.

B. For Disturbed Areas or exposed soils of areas less than 800 sf, where the District has determined that site conditions may result in visible and measurable erosion and where the District has provided written notice of the requirement to obtain an erosion prevention and sediment control permit to the Owner. Upon notice by the District, all work shall cease pending receipt of an EPSC Permit and installation of approved EPSC measures.

C. For any lot that includes natural resources regulated by the District, an EPSC Permit may be required prior to placement of fill, site clearing, or land disturbances, including but not limited to grubbing, clearing or removal of ground vegetation, grading, excavation, or other activities, any of which has the potential for, or results in visible and measurable erosion, regardless of the area of disturbance.

An EPSC Permit shall not be issued for activities on lots that include natural resources, where the site activity has not been authorized, or is not exempt under the provisions of Natural Resources as determined by the District. This provision does not apply where the EPSC Permit is associated with correction of a violation of the District Rules or Standards or as necessary for public safety, or the protection of property or water quality.

8.2.4 NPDES 1200-CN and 1200-C Permit

In addition to the District EPSC Permit, a NPDES 1200-CN permit is required for projects disturbing one acre up to less than 5 acres of disturbance. The 1200-CN shall be issued by the District along with the local permit.

For disturbances of 5 acres or greater, a District EPSC Permit and an DEQ 1200-C permit is required. The local permit shall be issued by the District. The 1200-C permit shall be obtained directly from DEQ.

8.2.5 Maintenance and Removal of Stormwater Best Management Practices

The Permittee shall maintain the BMPs contained in the approved EPSC Plan to continue to be effective during the construction phase, post construction phase, establishment of permanent vegetation, or any other permitted activity. If the BMPs approved in an EPSC Plan are not effective or sufficient as determined by District site inspection, the Permittee shall submit a revised plan within three (3) working days of written notification by District. Upon approval of the revised plan by the District, the Permittee shall immediately implement the additional BMPs included in the revised plan. In cases where erosion is likely to occur, the District may require the Applicant to install interim control measures prior to submittal and/or approval of the revised EPSC Plan.

Temporary BMPs, such as sediment fences, shall be removed after permanent vegetation is established.

8.2.6 Wet Weather Stabilization

Where natural vegetation has been removed, or the original land contours disturbed, vegetative ground cover shall be planted and established by October 1 and continue to function through May 31 of the following year, or as approved by the District. If ground cover is not established by October 1, the open areas shall be protected through May 31 of the following year with straw mulch, erosion blankets, or other methods approved by the District. The site shall be revegetated per a submitted and approved seeding and maintenance plan as soon as practicable after construction has commenced, but not later than September 1. After that date, a stabilization plan approved by the District must be used.

8.2.7 Contaminated Soils

In the event the construction process reveals soils contaminated with hazardous materials or chemicals, all parties shall stop work immediately, ensure no contaminated material is hauled from the site, remove work forces from the immediate area of the contamination, leaving all machinery and equipment, and secure the area from access by the public until such time as a response team has evaluated the situation and identified an appropriate course of action. The Applicant and the Contractor shall notify OSHA and DEQ of the situation upon discovery. The Applicant and the Contractor must comply with OSHA and DEQ statutes and rules.

8.3 Establishing Protective Vegetative Cover Upon Completion of Final Grading

To prevent and minimize erosion, all development shall implement BMPs as required by the EPSC requirements in these Standards including, but not limited to, the following stages of a project:

A. Vegetation is to be established as soon as practicable after completion of final grading to minimize erosion.

B. Prior to final project acceptance, the site shall be permanently stabilized with approved cover or permanent landscaping.

C. In cases of a land division, temporary groundcover will be accepted on each lot where home construction will begin within 30 days of project completion.

D. To the extent practicable, all stormwater facilities and open channel storm drainage system shall be permanently stabilized prior to use.

E. Erosion control measures shall be continued after construction has been completed until the permanent stabilization measures and vegetative ground cover for the site is established and functioning such that erosion has ceased.

F. The Developer will be responsible for all erosion prevention and sediment control for individual lots until ownership has changed.

G. In cases with developments with 1200-C permits, the Permittee is responsible for erosion prevention and sediment control until the 1200-C permit is terminated by the state.

H. Temporary EPSC measures shall be removed by the Developer when permanent stabilization or landscaping has been installed and is functioning.

8.4 Plans Required

An EPSC Plan shall be prepared in accordance with the requirements of the most current version of the Erosion Prevention and Sediment Control Planning and Design Manual adopted by the District and these Standards for all sites where an EPSC Permit is required. See **Appendix A** for submittal requirements.

8.5 Supplemental Plans

This section provides criteria for supplemental plan submittals.

8.5.1 Mass Grading and Runoff Control

A phased mass grading and runoff control plan is required for projects where clearing and mass grading activities are proposed during Wet Weather. The runoff control plan shall identify BMPs from Section 8.6.3, **Table 15**, or approved alternatives, and be submitted with, or as a revision to, the EPSC Plan. All stormwater BMPs specified on the runoff control plan shall be in place and functional prior to commencement of mass grading.

8.5.2 Dewatering

A dewatering plan is required for projects with anticipated excavation activities at or below the ground water table, or if ground water is encountered during construction. The supplemental plan shall be submitted with, or as a revision to, the EPSC Plan and shall identify how dewatering discharges will be managed.

8.5.3 Cement Treatment

A cement treatment plan is required for projects where cement treatment is proposed as a soil amendment (including, but not limited to Portland cement-treated base [CTB], cement kiln dust [CKD], or fly ash). The supplemental plan shall indicate an application rate, work schedule, and limits of work areas proposed for cement treatment. If cement treatment will occur during Wet Weather, the following conditions will also apply:

A. The project shall be phased in small manageable areas to minimize the risk for erosion.

B. Contractor shall have sufficient erosion prevention stormwater BMPs on site to cover all exposed soil.

C. Each phase must be stabilized with temporary or permanent erosion prevention stormwater BMPs before disturbing additional phases.

D. The plan shall indicate how runoff from areas treated with cement will not cause or accelerate erosion of soils not treated with cement.

E. If the runoff has a high pH (8.5 standard units or higher) then the plan must include an engineered sediment basin or similar impoundment must be used for treatment before discharge. The operator is required to determine the acceptable pH water quality criteria range of site discharge based on criteria of the receiving waterbody according to OAR 340-041-0021. If necessary, the operator must adjust or neutralize the high pH water until it is in the range of pH Standard Units (SU) using an appropriate treatment BMP such as carbon dioxide (CO^2) sparging or dry ice. The operator must conduct and document pH monitoring of stormwater captured in the sediment impoundment as described below:

a. The operator must begin the pH monitoring period when the engineered soils are first exposed to precipitation and must continue every 7 calendar days and within 24 hours of the occurrence of discharge from the site, or the occurrence of a storm event of 0.10-inches or greater until final stabilization of the area of engineered soils is established.

b. Document date soil amendments were added and final stabilization achieved in the Inspection Reports.

c. The operator must monitor the pH of stormwater in the sediment basins/impoundments and at discharge point locations that receive stormwater runoff from the area of engineered soils before the stormwater discharges to surface waters. Testing shall be done by an approved method and protocol and be performed by an operator knowledgeable in the testing method.

d. The benchmark value for pH is defined in SU and determined by the river basin containing the receiving waterbody according to OAR 340-041-0021. Anytime monitoring indicates that the pH is the maximum allowed SU or greater, the operator must either:

i. Prevent the high pH water from entering storm sewer systems or surface waters; or

ii. If necessary, adjust or neutralize the high pH water until it is in the range of pH SU acceptable for discharge to the river basin containing the receiving waterbody by using an appropriate treatment BMP such as carbon dioxide (CO^2) sparging or dry ice. The operator must obtain written permission from District (and/or other authorities as applicable) before using any form of chemical treatment other than CO^2 sparging or dry ice.

F. If visible or measurable erosion is occurring, all cement treatment activities shall be suspended, and approved erosion prevention facilities shall be applied to all exposed soil.

8.5.4 Chitosan Treatment Systems

Chitosan treatment plan is required where chitosan is proposed as a BMP. The supplemental plan must include a statement of the intent to use chitosan, the reason for its use and the name, experience and training of the qualified operator who will be monitoring the use of chitosan. Additional requirements are dependent on the form of chitosan proposed, as detailed below:

A. If chitosan acetate is proposed, the system must be a chitosan enhanced sand filtration system. The supplemental plan must demonstrate that the system is consistent with the protocol outlined in Ecology's GULD for chitosan enhanced sand filtration.

B. If chitosan lactate (cartridge) is proposed, the system shall be designed by a registered PE to meet site specific conditions and comply with the manufacturer's recommendations. A supplemental plan must include the following:

a. Location and design schematic of treatment system, location of inlet and location of discharge and dispersion device design.

b. Method for ensuring filtration or settlement of treated stormwater to comply with the following discharge standards:

i. Residual chitosan must not exceed 1 mg/L,

ii. Turbidity must not exceed DEQ's Water Quality Standards, and

iii. pH must remain within a range of 6.5-8.5

C. Qualified operator inspection and certification of consistency with the design, prior to system operation and use.

D. Testing and monitoring protocol, including at minimum:

a. Qualified operator must field test discharge using a Residual Chitosan Lactate Field Screening Test Kit, or District approved equal.

b. Field tests shall be performed during the first discharge of treated water and weekly thereafter for as long as chitosan is being used.

E. Response protocol, if field testing demonstrates exceedance of discharge standards, including immediate notification to the District, modification to the treatment system, and implementation of additional erosion control facilities.

F. Notification protocol to the District if any modifications to the treatment system are made.

G. Maintenance protocol of treatment system

8.6 Best Management Practices

This section provides a list of approved stormwater BMPs. Each BMP shall be implemented consistent with additional information in the Standard Details and the most current Erosion Prevention and Sediment Control Planning and Design Manual adopted by the District.

Depending on site-specific conditions, the required base measures may be inadequate to prevent erosion and control sediment discharges. In these cases, additional stormwater BMPs shall be applied to the site to meet the EPSC standards.

8.6.1 Base Measures

The following stormwater BMPs, as described in **Table 15**, shall be implemented on all sites requiring an EPSC Permit:

A. Gravel construction entrance/exit.

B. Linear barrier or downslope perimeter control (e.g., sediment fence, straw wattles, or similar measure).

C. Storm drain inlet protection.

8.6.2 Erosion Prevention Stormwater BMPs

Erosion prevention is the highest priority in the overall EPSC Plan and shall be integrated into a project throughout the planning, design, scheduling, and construction phases. Erosion prevention stormwater BMPs shall be included in the approved EPSC Plan. **Table 15** lists approved erosion prevention facilities.

Table 15. Erosion Prevention Stormwater BMPs

Name	EPSC Manual Standard Detail	Description
Preserve Natural Vegetation	NA	Maintain existing vegetation or place vegetative buffer strips. This SMF is especially effective for sites with sensitive resources like wetlands, stream corridors, lakes, and steep slopes.
Buffer Zone	NA	An undisturbed area or strip of natural vegetation or an established suitable planting adjacent to a Disturbed Area that reduces erosion and runoff. A Vegetated Corridor shall not be used or considered a buffer zone under this section.
Temporary and Permanent Seeding	NA	Vegetative cover established on Disturbed Areas to reduce erosion by seeding (applied by hand or hydroseeding) with appropriate and rapidly growing grasses. Permanent seeding can be used in conjunction with erosion control blankets and mats to provide both temporary and permanent erosion prevention control.
Ground Cover	NA	A protective layer of straw or other suitable material applied to the soil surface. Various ground cover methods include straw mulch and compost blankets.
Hydraulic Application	NA	A mechanical method of applying erosion control materials, other than simply hydroseeding, to bare soil. This BMP is often called Bonded Fiber Matrix. Bonded Fiber Matrix can be used without seed in upland areas to stabilize and prevent erosion. This BMP cannot be used in areas of concentrated flow or water quality facilities. This BMP may be used in place of straw, mulch, compost, or matting depending on site and weather conditions.
Sod	NA	Permanent or temporary turf for immediate erosion protection and stabilization.
Matting	4-1 and 4-2	A class of products that includes manufactured mulch materials that are produced in a roll configuration that is placed on the ground and held in place by stakes, metal staples, geotextile pins, or other fastening system. Matting shall be 100% biodegradable fibers or approved equal. Refer to the Floodplain, Wetland and Stream Construction Strategies Handbook for a comparison of matting types for work in sensitive areas.
Soil Binders	NA	Materials that are applied to the soil surface for dust control and temporary erosion control. These are also known as hydraulic soil stabilizers.
Stockpile Management	4-3	Methods to reduce or eliminate loss of sediment from temporary stockpiles of soil.
Dust Control	NA	Water applied over susceptible areas, typically due to dry soil conditions, during high wind periods. (Also see Section 8.6.5).

8.6.3 Runoff Control Stormwater BMPs

The purpose of runoff control BMPs is to control stormwater runoff and drainage patterns at construction sites. Runoff control BMPs shall be included in the EPSC Plan. **Table 16** provides a list of approved runoff control BMPs.

Table 16. Runoff Control Stormwater BMPs for All Sites

Name	EPSC Manual Standard Detail	Description
Pipe Slope Drain	4-9	The pipe slope drain carries concentrated runoff down steep slopes without causing gullies, erosion, or saturation of slide-prone soils. It should be designed to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device, or stabilized area.
Outlet Protection	4-7 and 4-8	Outlet protections are physical structures that reduce the velocity and energy of concentrated flow to prevent scour at storm drainage system outlets. Outlet protection includes riprap-lined basins, concrete aprons, and stilling basins.
Surface Roughening	4-10 and 4-11	Soil surface is roughened by mechanical methods. All slopes prepared by surface roughening shall meet engineering compaction requirements. This BMP is intended to only affect the surface of soils and is not intended to compromise slope stability or overall compaction.
Check Dams	4-4 and 4-5	Small, temporary dams placed across a natural or man-made channel or drainage ditch and designed to reduce drainage ditch erosion caused by stormwater runoff by reducing the velocity of flow in the ditch. Check dams are often used as a temporary measure while a channel is being permanently lined with vegetation or other materials to prevent erosion.
Diversion Swale or Dike	4-6	A ridge of compacted soil or a vegetated lined swale located at the top, base or somewhere along a sloping Disturbed Area.

8.6.4 Sediment Control Stormwater BMPs

Sediment control BMPs include any practice that traps soil particles after they are dislodged and moved by wind, water, or mechanical means. These BMPs are usually passive systems that rely on filtering or settling particles out of the water or wind once they have become suspended. Soil that accumulates in or near sediment control BMPs is a waste product that must be removed and disposed of at an approved location. Uncontaminated sediment/soil can be placed back on site and protected with appropriate erosion control BMPs.

Sediment control BMPs are considered the last line of defense before stormwater runoff leaves a site and are not to be used as the primary methods for EPSC.

Table 17 lists approved sediment control BMPs. These BMPs are to be applied prior to and during earthwork. Sediment control BMPs shall be included in the approved EPSC Plan.

The perimeter sediment barrier identified in **Table 17** is not required where:

A. Flows are collected through the use of temporary or permanent grading or other means such that the flows are routed to an approved settling pond, filtering system, or sediment control BMP.

B. There are no concentrated flows, slopes are less than 10 percent, and runoff passes through a grass area which is either owned by the Applicant or such use is allowed, through written agreement, by the Applicant of the grass area. The grass area shall be at least equal in dimensions to the project area. The grass area shall not be located in a Vegetated Corridor or Sensitive Area.

C. The surface is protected by re-established permanent vegetation.

Table 17. Sediment Control Stormwater BMPs

Name	EPSC Manual Standard Detail	Description
Gravel Construction Entrance/Exit❶	4-13	Gravel construction entrances/exits shall be required at each entrance/exit to and from the site. If a property contains or is adjacent to a stream, watercourse, stormwater facility, wetlands, or other water quality sensitive area, BMPs in addition to a gravel construction entrance/exit shall be required to prevent physical erosion into the water quality sensitive area.
Tire Wash Facility	4-26	The wheel wash, which shall be incorporated with a stabilized construction entrance, shall be designed and constructed for anticipated traffic loads.
Linear Barrier or Perimeter Control❶	4-23	Linear barrier (sediment fence) shall be installed around the down-gradient perimeter of the site to control sheet flow from the site. Sediment fence shall not be placed in areas of concentrated flow or across stream channels.
Wattles	4-27	Wattles are small, cylindrical barriers composed of biodegradable fibers encased in photodegradable open-weave netting. Wattles are placed in shallow trenches and staked along the contour of newly constructed or disturbed slopes.
Storm Drain Inlet Protection❶	4-15 through 4-20	Temporary inlet protection shall be provided for all active inlets for the duration of construction to keep sediment, trash, and other construction-related pollutants out of the storm drain system.
Rock or Brush Filter Berm	4-14	Rock or brush filter berms are temporary barriers composed of brush, wrapped in filter cloth, and secured or rock anchored in place. These are designed for sheet flow, not concentrated flow, and shall not be placed across a stream or channel.
Sidewalk Subgrade Gravel Barrier	4-25	Undercut lots or sidewalk subgrades with rock base are linear drainage barriers that provide an effective sediment filtration and retention area behind the curb. If weep holes exist, they must be plugged when using this BMP.
Dewatering		Separation of sediment and water achieved through filtration, either by gravity or with pressure.
Sediment Trap	4-24	A sediment trap consists of a small, temporary ponding area with a rock weir or perforated riser pipe at the outlet. This BMP is not to be used for drainage areas greater than 5 acres.
Sediment Basin	4-22	A temporary sediment basin has one or more inflow points and baffles to spread the flow for wet and dry storage. The sediment basin is effective for about one year with a drainage area less than 10 acres.
Turbidity Curtains	NA	A turbidity curtain is a pre-manufactured floating geotextile structure which minimizes turbidity transport from a Disturbed Area adjacent to or within a body of water. This BMP can be used to minimize the mixing of turbid water with adjacent clean water and/or contain soil particles during construction and/or repair activities.
Sediment Entrapment Mats	4-21	This is a flat layered pad that provides filtration and settling of sediment. BMP may be incorporated into the permanent stabilization/revegetation process if used in conjunction with mulch and/or seed.

❶These measures are minimum requirements for all projects per Section Base Measures8.6.1.

8.6.5 Dust Control Stormwater BMPs

Dust shall be minimized to the extent practicable, using all measures necessary, including, but not limited to the following BMPs.

A. Sprinkling the haul and access roads and other exposed dust producing areas with water.

B. Application of dust palliatives on access and haul roads as approved by the District.

C. Establishing temporary vegetative cover.

D. Placing wood chips or other effective mulches on vehicle and pedestrian use areas.

E. Maintaining the proper moisture condition on all fill surfaces.

F. Pre-wetting cut and borrow area surfaces.

G. Use of covered haul equipment.

8.6.6 Non-Stormwater Pollution Control Stormwater BMPs

For the purposes of this section, non-stormwater pollution includes, but is not limited to, concrete truck wastewater, paint, fuel, hydraulic fluid, solvents, glues, and other waste materials characteristic of construction sites. Non-stormwater pollutants are prohibited from entering a public or private street or storm system or surface waters.

Non-stormwater pollution controls consist of general site and materials management measures that directly or indirectly aid in minimizing the discharge of sediment and other construction related pollutants from the construction site.

Approved non-stormwater pollution control BMPs include:

A. Concrete truck washout areas.

B. Written spill prevention and response procedures.

C. Employee training on spill prevention and proper disposal procedures.

D. Protected areas for equipment storage and maintenance where the risk of pollution is minimal.

E. Debris boxes to contain construction wastes.

8.7 Inspection Requirements

This section provides criteria for EPSC inspections during a project's construction.

8.7.1 Pre-Construction Conference

Prior to the initial EPSC inspection, the District may require, or the Permittee, Applicant, or Contractor may request, a pre-construction conference to review and discuss the EPSC Plan for the site.

A pre-construction conference shall be required when the risk of erosion is high due to one or more of the following factors:

A. Construction during Wet Weather.

B. Steep slopes with severe erosion potential.

C. Construction adjacent to a sensitive area or vegetated corridor.

D. Mass grading on a large site.

8.7.2 District's Initial EPSC Inspection

On all projects, except single family home construction sites, EPSC base measures shall be installed by the Permittee and then inspected and approved by the District's Inspector prior to the start of any permitted activity.

For single-family home construction sites, EPSC measures for each property shall be installed by the Permittee and then inspected and approved by the District's Inspector prior to the building foundation installation. Foundation approvals shall not be given until EPSC measures are approved.

8.7.3 Permittee Inspections

The Permittee or Applicant's authorized agent shall provide ongoing inspection of the site in accordance with approved plans to ensure compliance with the standards specified in this chapter. The Permittee or Applicant's authorized agent for inspections shall be knowledgeable in EPSC BMP selection, installation, and maintenance. They shall also possess the technical skills to assess conditions at the construction site that could impact stormwater quality, and to assess the effectiveness of EPSC BMPs selected. If the Permittee or representative determines the stormwater BMPs approved in the EPSC Plan are not effective or sufficient to ensure compliance, additional stormwater BMPs must be implemented and identified in a revised plan.

For single family developments that disturb 1 acre or greater and all non-single-family developments the Engineer's Inspector shall:

A. Meet the applicable DEQ qualifying inspection certifications.

B. Inspect the site once every 14 calendar days and within 24 hours of any storm event, including snowmelt, that results in discharge from the site.

C. Maintain records of their EPSC inspection and maintenance activities. Records shall be made no later than 48 hours after inspection by the Permittee or their authorized agent. Records shall be made available to the District Inspector upon request.

For single family developments that disturb less than 1 acre, the Permittee's or representative shall:

A. Inspect the EPSC measures and provide maintenance as required to maintain the functionality of the BMP measures.

B. Inspect site daily when stormwater runoff, including runoff from snow melt, is occurring, once per week on active sites when runoff not occurring or once every two weeks on inactive sites

C. Keep onsite documentation of their EPSC activities for reference during operations, maintenance activities, and inspections.

8.7.4 Final Inspection

A final erosion control inspection shall be required on all sites after they have been stabilized and prior to approval of the Certificate of Occupancy. All temporary BMPs shall be removed prior to final inspection.

For single family sites seeking final erosion control inspection between September 1 and May 31, groundcover, using approved techniques, shall be completed before the single-family site can be deemed complete.

9. Operations and Maintenance

The purpose of the District's O&M requirements is to assure long-term operations and maintenance of public and private SMFs.

The O&M requirements in this chapter apply to all SMFs constructed as a requirement of the District's Rules. Maintenance activities, such as routine maintenance, restorative maintenance, and rehabilitation are required to ensure the long-term function and effectiveness of SMFs and infrastructure. Initial site planning must incorporate provisions for adequate access and space to perform maintenance activities for all SMFs.

9.1 General Requirements

All SMF designs will be held to the same maintenance standards regardless of the organization or entity that has accepted responsibility for the maintenance. There are two categories of maintenance for SMFs, described below.

Privately maintained SMFs only convey Private Stormwater that generally benefit one owner or entity. They include residential, multi-family, commercial, and industrial types of developments. These SMFs require a maintenance covenant recorded with the title that describes the types of facilities and necessary maintenance.

Publicly maintained SMFs are regional and sub-regional SMFs which convey Public Stormwater, that benefit the public in general, and any facility located within the Public ROW. SMFs that serve multiple properties (e.g., facilities for residential subdivisions) shall be transferred to WES following the 2-year warranty period and formal acceptance.

9.2 Operations and Maintenance Plans Required

All SMF that are intended to be privately maintained require the Developer, Applicant, or Owner to execute and record an O&M Plan prior to final inspection approvals of the related development permits. The O&M Plan shall ensure that Owner maintains and operates the SMF to preserve and continue its function. O&M Plans require Owners of property with SMFs to properly maintain, repair, modify or reconstruct (if necessary) the facility, and provide a schedule for the maintenance frequency for the facility.

9.2.1 Operations and Maintenance Plan Development

O&M Plans shall be required for all permanent SMFs to ensure that they function as designed. The purpose of an O&M Plan is to provide guidance to those who are responsible for the long-term inspection and maintenance of the facility.

To ensure functionality of the SMFs, Owners are required to inspect facilities regularly per the approved O&M Plan to determine maintenance needs. Routine inspection and maintenance can help to keep overall maintenance costs low by detecting problems early and avoiding large repair or replacement costs.

The facility design and maintenance specifications in **Appendix B** can be used to create the O&M Plan. If the proposed facility types do not match the SMFs in **Appendix B**, the Applicant and Developer's Engineer will be responsible for creating any drawings, maintenance specifications, and an inspection checklist to be incorporated into the O&M Plan.

O&M Plans for privately owned/maintained facilities shall be recorded with the Recording Office of Clackamas County as an exhibit to the maintenance covenant referenced in Section 9.3 before issuance of a building permit or final plat approval.

9.2.2 Operations and Maintenance Plan Elements

The following outline can be used to prepare an O&M Plan.

Introduction and general information

Facility information, including type and identifying name or number, as applicable. Include the number of each type of structure including the manufacturer's model number where applicable.

Name and contact information for the organization or individual responsible for conducting maintenance and/or ensuring maintenance is conducted.

Written narrative overview describing the site, drainage areas, and intended function of the facility.

Operations and Maintenance

Normal operating procedures for facility function, including any seasonal modifications, adjustments, and manufacture's recommendations.

Required regular maintenance activities and schedule (e.g., landscape maintenance, sediment removal, pipe cleaning).

Required inspection frequency to verify facilities are being maintained and functioning as designed.

Minimum maintenance standards that are required for the SMF to produce desired results and maintenance actions when the minimum standards are not met (See **Appendix B**). Where applicable, the minimum maintenance standards should include manufacturer's recommendations.

Expected lifespan of the facility components (i.e., the time when Owners should expect to replace growing media, plantings, cartridges, and control structure elements). Proprietary facility lifespan information, if known.

List of interrelated or connected SMFs and description of how each facility works with the next one.

O&M Plan Responsibility

Identify the person(s) or organization(s) responsible for inspections of SMFs.

Identify the funding source for maintenance.

Attachments

Include a site plan to identify the location of the facility/facilities, sources of runoff entering each facility, and ultimate stormwater disposal point.

Include the SMF detail sheet(s) and O&M Plan and checklist(s) (when applicable, use details in **Appendix C** for reference).

Include a copy of the public maintenance agreement and/or private maintenance covenant that will be used to assign maintenance responsibility and/or to allow access for maintenance or inspection of the SMFs.

9.2.3 Operations and Maintenance Plan Review and Approval Process

The O&M Plan and associated agreements, covenants, and easements will be reviewed as part of the District's overall plan review and approval process.

9.3 Privately Owned and Maintained Facilities

Generally, SMFs that convey Private Stormwater that benefit a single Owner or entity shall be privately-owned and maintained. All privately owned and maintained SMFs require an O&M Plan that is reviewed and approved as part of the overall plan review process.

9.3.1 Maintenance Covenant for Private Stormwater Facilities

Maintenance of all privately-owned SMFs shall be ensured through the creation of a formal maintenance covenant that must be approved by the District and recorded into the land record prior to final plan and/or plat approval. The O&M Plan, including scheduled inspections and regular maintenance activities, shall be referenced in the maintenance covenant.

9.3.2 Access Easement

Prior to the issuance of any permit that includes a SMF, the Applicant or Owner of the site must execute a maintenance covenant that includes public access rights, to inspect the facility and ensure that it is maintained in proper working condition. This includes the right to enter a property when the District has a reasonable basis to believe that a violation of District standards and/or rules and regulations is occurring or has occurred, and to enter when necessary for abatement of a public nuisance or correction of a District violation. The access easement shall be included in the maintenance covenant, as approved by the District and recorded at the Recording Office of Clackamas County.

9.3.3 Annual SMF Inspection and Maintenance

The Responsible Party identified within the O&M Plan shall complete and keep records of annual inspections of their SMF. The annual inspection records may be reviewed by the District upon request. All SMFs must undergo an annual inspection to document maintenance and repair needs and ensure compliance with the requirements of these standards. Maintenance needs may include, but not limited to the following: removal of silt, litter and other debris from all stormwater structures and facilities; grass cutting and invasive vegetation removal; and necessary replacement of water quality vegetation. Any maintenance needs identified must be addressed by the Responsible Party in a timely manner. The inspection and maintenance frequency may be increased as deemed necessary to ensure proper functioning of the SMF.

9.3.4 Records of Maintenance Activity

Owners shall keep records of all SMF maintenance and repairs and shall retain the records for at least three (3) years. These records shall be made available to the District staff during inspection of the facility and at other reasonable times upon request. The Owner shall submit a copy of the SMF maintenance and inspection records to the District annually.

9.3.5 District Inspection of Stormwater Management Facilities

Inspections may be conducted by the District at any time, including but not limited to, routine inspections, random inspections, inspections based on complaints or other notice of possible violations, inspections related to the District's NPDES MS4 Permit, and joint inspections with other agencies done under environmental or safety laws. Inspections may include, but are not limited to, review of maintenance and repair records; sampling discharges, surface water, groundwater, or material/water in SMFs; and facility condition evaluations.

9.3.6 Failure to Comply with the O&M Plan

If a SMF becomes a danger to public safety or public health, the District shall notify in writing the party responsible for maintenance of the SMF. Upon receipt of the written notice, the responsible person shall have 30 days, unless otherwise specified by the District, to complete the necessary maintenance and repair of the facility in an approved manner. If a responsible party fails or refuses to meet the requirements of the maintenance covenant, the District, after reasonable notice, may correct a violation of the design standards or maintenance needs by performing all necessary work to return the facility to proper working condition. If the Owner does not comply with their O&M Plan, after proper notice, the District shall assess the Owner of the facility for the cost of repair work and any penalties.

9.3.7 Modifications to the Operations and Maintenance Plan

If it is determined that the O&M Plan requires modification to maintain the functionality of the facility, then modifications to the O&M Plan shall be submitted to the District for review and approval. Written approval from the District is required prior to modifying the O&M Plan. The approved modified plan shall be recorded at the Recording Office of Clackamas County.

9.4 Publicly Owned and Maintained Facilities

Generally, publicly owned and maintained SMFs convey Public Stormwater, serve multiple properties, or provide drainage for the general public. Publicly owned SMFs can serve any type of development (residential, multi-family, commercial, industrial). Publicly owned facilities may be constructed by the District, or they may be constructed by private parties, with maintenance responsibilities transferred to the District following acceptance after completion of the 2-year warranty period.

9.4.1 Location

All publicly owned SMFs shall be located in the Public ROW or separate tract with adequate maintenance access with an easement granting rights to the District.

9.4.2 Operations and Maintenance Plan

All SMFs to be maintained by the District require an O&M Plan that is reviewed and approved as part of the overall plan review process. The O&M Plan is prepared by the Applicant, identifying the District as the responsible party for inspection and maintenance following acceptance after completion of a successful 2-year warranty period.

During the 2-year warranty period, the Applicant is responsible for all maintenance and documentation requirements outlined within the O&M Plan. Prior to the completion of the

warranty period, the District will require all maintenance records and documents be reviewed and deficiencies addressed prior to the transfer of maintenance responsibilities.

The Applicant shall enter into a maintenance agreement with the District establishing bonding, surety, or payment for maintenance of the facility during the 2-year warranty period.

9.4.3 Maintenance Fees

The District may establish maintenance fees for publicly maintained SMFs that serve multiple privately owned properties. When separate maintenance fees are established, they will be distributed proportionally among the Owners that use the facility for stormwater management.

APPENDIX A. Permitting And Submittal Requirements

Appendix A outlines the planning, plan review, and project completion requirements for both sanitary and storm sewer projects and is included in both the Sanitary Standards and the Stormwater Standards. This section is intended to standardize the submittals and clearly outline the minimum requirements. The requirement for a complete submittal package is intended to reduce the overall plan approval processing time.

1. Review and Permitting Requirements

The following is a generalized overview of the District development review and permitting processes. This process may vary from one application, submittal and/or building permit to another and is only shown as a general outline of procedures and processes involved in the review and approval of projects located within the District. To obtain further information on a specific plan review or permit process contact a Development Review staff member. The Developer shall have ultimate responsibility for compliance with all requirements specified in these Sanitary Standards and the District's Regulations. The Developer shall be directly responsible for all administrative requirements including application for service, submittal of all required Plans, bonds and insurance, and payment of fees.

General Plan Review and Approval Process

This subsection describes the most common elements of the general development review process for a typical partition, subdivision, multi-family, commercial or industrial project. Applicants should discuss their project with the District and local planning authority early to understand the review and approval process required for a specific project.

1. **Pre-Application Conference** – The Applicant may elect to meet with the local planning authority, District, and other related departments to discuss the proposed project to better understand the potential requirements. It is best if the Applicant submits a preliminary concept or plan, so the District is better prepared to discuss the proposed development. Contact the local planning authority to schedule the pre-application meeting. The planning authority will invite the District to the meeting.
2. **Service Provider Letter** – Applicants proposing to develop or redevelop property shall obtain a Service Provider Letter from the District prior to submitting the land-use or design review application to the local planning authority.
3. **Water Quality Resource Area Boundary Verification** – If applicable, prior to the District issuing a Service Provider Letter, the local planning authority must approve a WQRA Boundary Verification for vegetated buffer requirements (see the Buffer Standards).
4. **Conditions of Approval** – The local planning authority will process the land use/design review application and route a copy of the application for District review. The District will review the application and submit comments to the local planning authority to be included as conditions.
5. **Jurisdictional Authority**– If the proposed project is outside the service area boundaries of the District, the Developer must petition for annexation to the District. The annexation must be approved by the Board before final occupancy or plat approval. The Applicant shall submit a complete annexation packet to WES prior to any plan approvals by WES.

6. **Pre-Design Meeting** – The Applicant may elect to coordinate a meeting with the local planning authority and/or the District to discuss the project and requirements outlined in the conditions.
7. **Plan Submittal** – Upon land use approval, the Applicant must submit required fees, civil plans and supporting documentation as specified in these standards for plan review and approval.
8. **Other approvals** – Other permits and approvals may be required prior to the District approving the plans (i.e., County, City, State or Federal).
9. **Approved Plan(s)** – Plans and applicable building permit applications will be reviewed, approved, and then signed by an authorized representative of the District. If applicable, it may be necessary to hold a Pre-Construction Meeting with the Developer's Engineer, Contractor, Applicant, District, and other related agency representatives to discuss project requirements, including processes to complete the project as specified in the Sanitary and Stormwater Engineering Agreements.
10. **Construction** – The public sanitary and stormwater management infrastructure shall be constructed under the supervision of the Developer's Engineer as specified in the Sanitary and Stormwater Engineering Agreements.
11. **Construction Completed** – Upon final completion of the construction, the Developer's Engineer will certify the project was constructed in accordance with the approved plans, and the as-built plans are an actual record of what was constructed.

    The following items will be completed and submitted prior to requesting the final inspection of the public sanitary and/or stormwater infrastructure:

    i. All sanitary and/or stormwater infrastructure shall be cleaned of sediment and debris.
    ii. A *Certification of Completion* shall be submitted – Certifies the project was constructed in accordance with the approved plans and District Standards.
    iii. Two paper copies of the as-built drawings shall be submitted.
    iv. If applicable, submit the video testing of the public sanitary and stormwater conveyance piping systems, along with the Contractor's reports for review and approval. The Developer's Engineer shall review the video and reports, and note any deficiencies discovered in the system(s) prior to submitting the items to the District.
    v. Submit a copy of the Developer's Engineer inspection reports.
    vi. Submit Service Connection drawings prepared by the Developer's Engineer (if required).
12. **Final Inspection** – The District will review the required as-built submittals and, if acceptable, will schedule the final field inspection. All repairs and corrections shall be made prior to the District deeming the project complete.
13. **Final As-built Drawings** – When requested by the District, the Developer's Engineer shall submit the corrected final as-built drawings on paper, electronic CAD, and PDF files of the as-built civil construction plan set.
14. **Warranty Surety** – Upon completion of the public sanitary and stormwater final inspection, the Applicant will submit a sanitary and/or stormwater warranty surety in the amount of 25 percent of the actual cost to construct the public infrastructure. The warranty surety will be held for a minimum period of 2 years from the date of completion, or until all the requested system repairs are completed.

15. **Letter of Completion and Acceptance –** Upon final approval of the construction of the public sanitary and stormwater infrastructure, and all of the above noted items have been reviewed and approved by the District, then the District will issue a letter of completion of the stormwater infrastructure, and letter of acceptance of the public sanitary sewer system and/or Public Stormwater System.
16. **Warranty Surety Inspection** – Between 20 and 24 months after issuance of the letter of completion and acceptance, the District will inspect the public facilities at the request of the Owner. The inspection will include all public sanitary and stormwater infrastructure, included the plantings and other related improvements. Once all deficiencies are corrected, the District will issue a warranty surety release letter.

Service Provider Letter Submittal Requirements

The intent of the Service Provider Letter is that, prior to applying for Land Use/Design Review, the Applicant must demonstrate the proposed development is viable in accordance with District Rules and applicable Standards. The Service Provider Letter will only be issued once the Applicant has provided sufficient plans, reports, studies, and agency approvals needed for preliminary review by the District. Based on the preliminary review, the District may require additional information prior to issuance of the letter or as part of the forthcoming land use application. Receipt of the Service Provider Letter does not imply that all District requirements have been met or guarantee that land use approval for the development will be granted.

Applicants must submit the following to the District for review:

- Preliminary plat (if applicable)
- Preliminary proposal for public and private sanitary infrastructure
- Proposed sanitary system layout, including compliance with minimum design standards
- Points of connection to public sanitary sewer system
- Service proposal for upstream properties
- Preliminary Stormwater Management Plan and Drainage Report
- Site assessment and maps
- Proposed storm drainage system and stormwater facilities:
    - Infiltration, detention, and water quality facilities
    - Conveyance System design
    - Point of discharge
    - Emergency overflow pathway
    - Service proposal for upstream properties
- Soils report and analysis
- Drainage area maps
- Infiltration testing results
- Drainage system analysis (upstream and downstream)
- Sizing and conveyance calculations
- Other supporting reports and information (as deemed necessary by the District)

- BMP Sizing Tool calculations
- WQRA Boundary Verification or Natural Resource Assessment
- Preliminary approval for off-site easements
- Offsite mitigation measures for downstream conveyance

Land Use Submittal Requirements

As part of the land use/design review application process, the local planning agency will route applicable sanitary and stormwater plans and reports to District for comment. The Applicant must provide sufficient plans, reports, studies, and agency approvals needed for preliminary review by the District, as including, but not limited to the Service Plan Submittal Requirements, above. The Applicant's materials shall include any additional information or revisions requested by the District with issuance of the Service Provider Letter.

The land use review stage includes WES issuance of 1) a Service Provider Letter, prior to land use application submittal, and 2) land use conditions of approval, following receipt of a complete land use application from the local planning agency.

Plan Review Submittal Requirements

The Developer's Engineer shall submit sufficient supporting information to indicate that the proposed plan design meets all the provisions within these Standards, including the land-use conditions. The submittal information shall include, but not be limited to, the items listed within this section.

Initial/First submittal requirements:

The following is a list of application submittals required by the District for a typical development:

- Water Quality Resource Area (WQRA) Boundary Verification and WQRA Development Permit, submit to the local planning authority as required (see Buffer Standards)
- Complete set of drawings for the Stormwater Management Plan
- Existing conditions
- Infiltration testing
- Proposed on-site storm drainage system and stormwater facilities
- Proposed grading plan
- Existing and proposed off-site improvements
- EPSC Plan
- Details and notes
- Stormwater Management Report that includes:
    - The engineered or BMP Sizing Tool method used to size the stormwater facilities.
    - A Storm Drainage System/Hydrologic and Hydraulic Calculations Report
    - Hydrology and hydraulic calculations with drainage area maps
    - Tributary drainage areas shall be calculated in table form and identified on maps submitted with the report

  - Geotechnical/Geologist Report
    - Infiltration Testing
    - Soils Report
    - Geology Report

Other submittal requirements required by the District as applicable prior to final plan approval.

- Standard Forms
  - Storm System Engineering Agreement
  - Storm System Construction and Engineering Costs Data Sheet
  - Sanitary Sewer Engineering Agreement
  - Sanitary Sewer Construction and Engineering Costs Data Sheet
- Non-Residential Questionnaire Easements/Agreements as applicable
  - Public/Private Sanitary and Stormwater Easements
  - Public/Private Storm Facility Operation and Maintenance Plan/Agreements

Periodically, the District may require additional information to support design assumptions used for sanitary sewer design. When required, the information shall be included on the Plans or submitted in memorandum form to the District. The following may be required:

- Potential size of drainage basin
- Number of potential EDUs

Sanitary Sewer Extension Submittal

The Public Sanitary Sewer Extension submittal shall include all required information along with any other information requested by the District. The required information includes, but is not limited to the following:

- Two sets of complete civil construction Plans.
- Sanitary Sewer Engineering Agreement (form can be found online).
- Construction and Engineering Cost Estimate (form can be found online).
- Sanitary Plan review fees.

All submittals will be reviewed for completeness and the Developer's Engineer will be notified if required information is missing. Upon acceptance of a complete submittal, subsequent project review and approval steps shall be undertaken.

Partition/Subdivision Plat Review and Approval

The Applicant shall submit a preliminary plat to the local planning authority, who will coordinate plat review with the District. The District will only perform an official review of plats received from the local planning authority. The District will review the plat in accordance with the approved Sanitary Plans and Stormwater Management Plans and return comments to the local planning authority. Prior to final plat approval by the District, the Developer shall address the following:

- All associated agreements and easements shall be reviewed and approved by the District. The District will deliver the signed documents to the County Surveyor's Office at the time of plat approval.

- Sanitary and Stormwater Improvements shall be:
  - Fully constructed in accordance with the approved plans, or
  - The Applicant shall obtain a performance surety for all proposed sanitary and stormwater improvements on the approved plan. If the construction work is partially completed, the surety will be based on a status report submitted by the Developer's Engineer.
- Public easement documents shall include a site plan and specify the entitlements within the boundary of the easement.
- Deferred Improvements – In some situations, the responsibility to construct improvements may be deferred to the future Owner of a specific lot. Deferrals are at the discretion of the District and will be reviewed on a case-by-case basis. All deferred improvement(s) shall be fully constructed and completed in accordance with the Rules and applicable Standards, prior to any future occupancy permit approvals by the District. All responsibilities of the future Owner to construct the deferred improvements shall be stipulated in a separate document recorded as a covenant with the plat.
  - Subdivision Plats – Any deferred improvements must be part of a District-approved subdivision improvement plan.
  - Partition Plats – Eligible improvements are limited to Service Connections, Conveyance System, pervious surfaces, and stormwater facilities that either benefit one lot, or are shared facilities. In the case of shared facilities, the deferred improvements will be the responsibility of the first future lot Owner to submit a building permit application.
  - Other related agreements and documents (i.e., Homeowner's Association covenants, conditions and restrictions; maintenance agreements, etc.)

Plan Submittals

This section contains specific information and drawing specifications for submittals made to the District. This section is intended to standardize the submittals and clearly outline the minimum requirements. The requirement for a complete submittal package is intended to reduce the overall plan approval processing time. Plans will not be reviewed until a complete plan has been submitted. A complete plan shall include at a minimum all requirements listed in this section.

a. Specific Sheet Submittal Requirements and Specifications

The following sheets are required as part of a complete plan submittal:

- Title Sheet
- Composite Utility Plan
- Composite Stormwater Management Plan Cover Sheet
- Stormwater and Sanitary Sewer Plans and Profiles
- Grading Plan
- EPSC Plan
- Vegetated Buffer Planting Plan
- Stormwater Management Facility Planting Plan
- Standard and Non-Standard Drawings/Detail Sheets

- Standard and Non-Standard Construction Notes
- All applicable Standard Drawings shall be included on a separate sheet in a clear and legible size.

b. Title Sheet

As a minimum the following information shall be found on the title sheet:

- Index of Sheets.
- Complete legend of symbols used.
- Vicinity Map to a scale of not less than 1 inch = 800 feet showing the project location.
- Site Plan of the entire project showing street ROW and/or subdivision layout.
- Temporary and permanent benchmarks including their descriptions. Total acreage including streets directly served.

c. Composite Utility Plan

The Composite Utility plan shall be scaled to show the entire site on one sheet unless otherwise approved by the District and shall show:

- All proposed sanitary and storm improvements
- All other proposed improvements
- All existing utilities and utilities adjacent to and within 100 feet of the project
- Existing natural or artificial drainage features
- Tract names and numbers
- Property lines with tax lot numbers and addresses
- Street names at a minimum shall be shown

d. Composite Plan Cover Sheet (separate sanitary and storm)

The following information shall be included on the Composite Plan cover sheet:

- The scale shall be scale-appropriate to fit the entire site on one sheet, unless otherwise approved by the District
- Show the appropriate contour lines to demonstrate the overall site topography. Generally, these are 1-, 2-, 5-, or 10-foot contour lines. The topography must extend a minimum of 50 to 100 feet beyond the proposed limits of development
- Show the entire system
- Show the SMFs
- Shade all other utilities not related to sanitary sewer or stormwater drainage systems.
- Show drainageway(s) as existing and/or proposed.
- Show emergency overflow pathway(s) to an acceptable point of discharge.
- Show existing and/or proposed storm drainage and conservation easements.
- Show vegetated buffers and associated sensitive areas.
- Show all site and roadway improvements.

- Show the subdivision, phase lines or plat boundaries.

e. Plan and Profile Views

Plan and profile views shall include the following information:

Plan View

Plan views shall contain as a minimum the following information:

- The scale shall be 1 inch = 50 feet horizontal. Alternative scales may be approved by the District on a case-by-case basis. The scale shall be shown for each plan and profile view.
- Entire sanitary and storm sewers clearly shown and labeled.
- Plan views showing north predominantly to the top or left of each sheet.
- Plan views showing accurate 1- or 2-foot contour lines and extending a minimum of 50 feet to 100 feet beyond the limits of the development. Alternative contour spacing may be approved by the District on a case-by-case basis.
- All proposed extensions of the Conveyance Systems showing mainlines, manholes and Service Connections.
- Manholes identified and stationed to facilitate comparison of the plan view and the profile view.
- Manhole callouts in District format.
- District stationing formats for new lines and manholes.
- Size and type of pipe, backfill material, and location.
- Sanitary/Storm Service Connection tees off the mainline. For each lot being served, show the mainline stationing, pipe size, length, and depth of lateral at end of pipe.
- Public ROW, property, and easement lines.
- Location of water courses, stream and railroad crossings, culverts and storm drains that cross the alignment.
- Subdivision names, roadway names and lot/parcel numbers or tax lot numbers.
- Existing and proposed Sensitive Areas and the required Vegetated Buffer.
- Existing utilities, all manholes, water mains, services, gas mains, underground power, and other utilities and structures, including hydrants, pedestals, signs, mailboxes, light poles, wells, water mains, valves, pumps stations, and blowoff structures, manholes, valves, meter boxes, power poles, handicap ramps, striping, and trees.
- Existing and proposed edge of pavement on both sides of the street, including shoulders, curb, sidewalk, ditch line, culverts, and driveways.
- Plan view including the above items for a minimum distance of 50 feet to a maximum of 500 feet may be required beyond the proposed improvement in order to prevent future improvement conflicts.
- Location and dimensions of all SMFs, including the following:
    - Setbacks from property lines and structures,
    - Facility wall material, if required, and geotextile/waterproofing membrane specifications,

  - Growing medium specifications,
  - Drain rock and filter fabric specifications,
  - All stormwater piping associated with each facility including pipe materials, sizes, slopes, IEs at bends and connections,
  - Ground elevations at catchment locations, channel inverts, top and toe of slope surrounding detention/retention areas,
  - Ground slopes of channel inverts and sides, parking lots, bottoms and sides of facilities and adjacent surroundings,
  - Invert and top or bottom elevations (if applicable) of pipes, catch basins, overflows, manholes or other similar structures.
  - Location of construction fencing used to protect proposed SMFs from compaction and other construction disturbance.
- Location of all drainageways and the 100-year flood plain.
- Show the location and direction of any surface stormwater conveyance path(s).
- Location and detail of all existing facilities on which work is to be performed, i.e., installation, repair, or removal.
- Location and description of all known existing property monuments, including, but not limited to, section corners, quarter corners, donation land claim corners and any other county control monuments.
- Street stationing may be shown on the construction plans, but later removed on the final as-built plans.
- Roof drain connection points shall be shown using the ® symbol.
- Sanitary and storm structures should be easily visible and shown drawn at least 2x the size of the line width and in proportion to the line weight.

Profile View

Profile views shall contain as a minimum the following information:

- Plan and profiles on each sheet shall match and line up on at least one edge of the drawing (i.e., profile to show pipe in same direction as the plan view and lined up plan view over profile).
- The scale shall be 1 inch = 50 feet horizontal and 1 inch = 10 feet vertical. Alternative scales may be approved by the District on a case-by-case basis. The scale shall be shown for each plan and profile view.
- Location of existing and proposed manholes and other appurtenances with each manhole numbered and stationed. Manhole numbers to be provided by District, if applicable. Manhole callouts shall be in the District format. The benchmark used as a basis for vertical control in the design shall be referenced on the plans.
- The location and elevation of an approved benchmark shall be shown on the plans or, if not within the proposed area of work, shall be referenced by number and location. Elevations shall be based on the NGVD88 datum if the project is within ½-mile of a County benchmark. A conversion factor to relate the existing connection point elevations to the plan elevations and benchmark.

- Grid lines using the horizontal and vertical scale.
- Existing and proposed ground and/or pavement surface with elevations noted at critical points.
- Sanitary/Storm lines shall be labeled with the name of the mainline centered under the profile view in large bold letters.
- Sanitary/Storm lines shall be labeled with the pipe size, material, slope (as a %), length and type of backfill between manholes.
- Nonstandard manholes must be labeled with the type (i.e., tamperproof, drop, flat top, etc.).
- Railroad, culvert, ditch, or stream crossings with elevations of the ditch or streambed and casing details.
- All existing and proposed storm, water, and any other crossing utility lines greater than 6 inches in diameter.
- Non-standard SMFs and appurtenances shall show a typical cross-section with dimensions.

f. Grading Plan

Projects requiring grading and/or fill activities will require the submittal and approval of grading plans prior to the beginning of such operations. The District will review the grading plan in the context of the overall Stormwater Management Plan. Generally, an additional grading permit and/or approval are required by the local authority or State agency governing such activities. It is the responsibility of the Applicant to obtain all necessary permits and approvals prior to beginning any grading activity.

Grading plan views shall contain as a minimum the following information:

- Total land area and proposed Disturbed Area,
- Existing topography and impervious area,
- Proposed topography and impervious area,
- 1-, 2-, or 10-foot contour intervals (as applicable),
- Elevations of all existing and proposed streets, alleys, utilities, sanitary and stormwater sewers, and existing buildings and structures,
- Natural or artificial drainageways,
- Limits of flood plains (as applicable),
- Existing and proposed slopes, terraces, or retaining walls,
- All existing and proposed SMFs, drainage structures and/or features, and devices used to protect these areas during construction,
- All stormwater structures/features on-site, upstream, and downstream of the site,
- EPSC Plan (as applicable),
- Drainage calculations when required,
- Drainage easements when required,
- Geotechnical report (if applicable),

- Any other supporting documentation necessary to evaluate the existing and/or proposed site conditions for stormwater management.

g. Erosion Prevention and Sedimentation Control Plan

The general process and requirements for EPSC Plans is outlined in the Stormwater Standards. For specific details on erosion control BMP measures and applications see the **Erosion Prevention and Sediment Control Planning and Design Manual** adopted by the District. A link to this manual can be found on the District website.

If a 1200-C or 1200-CN Permit is required, the EPSC Plan shall meet the requirements of the 1200-C Program, in addition to the following list:

- The total acreage of the site and the total acreage of the proposed Disturbed Area.
- Adjacent offsite drainage patterns indicated by arrows.
- Contours at 2-foot intervals. Where slopes exceed 15 percent, contours may be shown at 5-foot intervals.
- North arrow.
- Existing and proposed structures for the project site.
- Existing and proposed access location for the project site.
- Existing project boundaries, rights-of-way, easements, and jurisdictional boundaries clearly identified by note, symbol, or key.
- Adjacent streets with street names and ROW boundaries.
- Capacity and condition of existing drainage facilities, including roadside or other drainage ditches, that transport surface water onto, across, or from the project site.
- Existing Sensitive Areas, vegetated corridors, and water quality and quantity facilities. For natural drainage features, show direction of flow, drainage hazard areas, and the 100-year floodplain.
- Clearing and grubbing limits.
- Proposed ground contours.
- For multi-phase projects, phasing of any EPSC work clearly indicated on the plan.
- Details of proposed EPSC BMPs.
- EPSC Plan to include a key signifying BMP measure used and placement on EPSC Plan.
- When sedimentation ponds are proposed, at least one cross section detail shall be shown.
- Vegetation/permanent site stabilization measures.
- If submitted independently of the full project plans, a cover sheet with the proposed name of the development, the name and address of the Applicant and Developer, the name and address of the Developer's Engineer, and the land use case file number from the local planning authority.

h. Vegetated Buffer Planting Plan

If restoration of a Water Quality Resource Area or vegetated buffer is required in the **Stormwater Standards**, a plan addressing the requirements shall be submitted.

The construction plans and specifications shall include:

- Water Quality Resource Area and required vegetated buffer boundaries.
- The limits of any approved, temporary construction encroachment.
- Orange construction fencing noted at vegetated buffers as well as at encroachment limits during construction.
- Permanent type fencing and signage at the development and the vegetated buffer boundary noted and details shown.
- Conservation easement documents prepared and easement area shown on the plan.
- Site preparation plan and specifications, including limits of clearing, existing plants, and trees to be preserved, and methods for removal and control of invasive, non-native species, and location and depth of topsoil and or compost to be added to re-vegetation area.

Planting plans and specifications shall include the following information:

- Planting table that documents the common name, scientific name, distribution (planting zone, spacing, and quantity), condition and size of plantings, and installation methods for plant materials listed.
- Mulching rates.
- Plant tagging for identification noted.
- Plant protection methods.
- Seeding mix, methods, rates, and areas delineated.
- Irrigation plan and specifications, including identification of water source, watering timing and frequency, and maintenance of the system.
- Maintenance schedule, including responsible party and contact information; dates of inspection (minimum three per growing season and one prior to onset of growing season); and estimated maintenance schedule (as necessary) over the two-year monitoring period.
- “Good” rated corridor notes (i.e., invasive species removal shall be replanted with native vegetation).
- Access points for installation and maintenance, including vehicle access if available.
- Standard drawing details (north arrow, scale bar, property boundaries, project name, drawing date, Developer’s Engineer and Owner).

i. **Stormwater Management Facility Planting Plan**

The Stormwater Management Facility Planting Plan shall include planting information for each SMF based on requirements of the **Stormwater Standards**.

Planting plan specifications and plans must address all elements that ensure plant survival and overall SMF functional success. At a minimum, landscape specifications and plans must include:

- A planting plan that indicates existing vegetation to be preserved; protective construction fencing; the location of all landscape elements; and the size, species, and location of all proposed plantings. The plant species should be selected and placed in accordance with proper delineation and location of moisture zones where appropriate.

- A plant list or table that includes botanic and common names; size at time of planting; quantity; spacing; type of container; evergreen or deciduous; and other information related to the facility-specific planting in accordance with landscape industry standards. Also include the square footage of each plant zone and the numbers and types of each plant required and provided in each zone.
- A soil analysis for the SMF growing medium (required for all public facilities and may be required for private facilities. A soil analysis is not required for single-family residential sites). The source of the growing medium must be provided. The location of all stockpiles must be indicated on plans, and erosion protection measures included on the EPSC Plan.
- The method of temporary irrigation to be used for the plant establishment period.
- Stormwater Management Facility Planting Plan shall also include all areas requiring protective construction fencing to shield the area from construction traffic and compaction.

j. Landscape Plan

Landscape plans for publicly maintained SMFs shall be prepared, stamped with the seal of, and signed by, a Landscape Architect, registered in the State of Oregon. Plans for privately maintained SMFs do not require the involvement of a Landscape Architect. Landscape Plans shall include the following a detailed landscape plan, at a scale of 1 inch equals 20 feet shall be provided for each landscaped SMF. This plan may be combined with the grading plan. The landscape plan shall include the following:

- Existing vegetation to be preserved and protective construction fencing.
- Areas of SMFs to be designated with construction fencing to protect from construction traffic and compaction.
- Final ground contours at a minimum of a 2-foot contour interval.
- Location of top and toe of slope.
- Limits of embankment designed to impound water.
- Location of all drainage structures as well as any other piped utilities in the vicinity.
- Limits of areas to receive amended topsoil and growing medium.
- A plant list or table, including botanic and common names, size at time of planting, quantity, spacing, type of container, evergreen or deciduous, and other information related to the facility-specific planting, in accordance with landscape industry standards.
- Location of stockpiles (erosion protection measures must be shown on the EPSC Plan).
- Method of temporary irrigation to be used for the establishment period.
- Location of maintenance access, as applicable.

k. Standard Drawings/Detail Sheets

The construction plans shall include a sheet containing all the standard details applicable to a specific project.

The purpose of the District Standard Drawings and Details is to provide basic information as a convenience to those who use them in their designs. These drawings and details are also intended to communicate design standards and practices to the Developer’s Engineer.

Detailed drawings shall be included with all construction plans where Standard Drawings do not apply. If a standard drawing, such as a manhole, must be modified to fit existing, or unique conditions, the modified detailed drawing shall be shown on the plan and profile sheet. When appropriate, due to required detail complexity, a separate detail sheet shall be used.

Standard Drawings are available for use on development projects and cannot be modified by designers on a project-by-project basis. It is the responsibility of the Developer's Engineer to incorporate these drawings as originally intended.

Non-standard detail drawings shall be the responsibility of the Developer's Engineer to demonstrate that site conditions require a non-typical device or structure and submit the specifications and supporting documentation to the District for approval. All non-standard details shall be shown on the Stormwater Management Plan.

Stormwater Management Facility Detail sheets are included in the **Stormwater Standards**. A link to additional Standard Details can be found on the District website.

l. General Sanitary/Stormwater Construction Notes

General construction notes required on the plans can be found on the District website or provided upon request. These general construction notes shall be included on the sanitary and Stormwater Management Plans. These notes are required, and the design professional may include other applicable notes they deem necessary.

m. General Sheet Submittal Specifications and As-built Requirements

The following subsections outline general submittal specifications for sheet size, scales, north arrow, text, labeling callout, and title block specification requirements.

Sheet Dimension Requirements

Construction plans shall be clear and legible and submitted on blue-line paper 22 by 34 inches or 24 by 36 inches in size with a 1½-inch clear margin on the left edge and ½-inch margins on all other edges.

Title Block

Located on the bottom edge or at the right side of the drawing, showing the project name, drawing name/type, completed modification date table, the submittal date, drawing number, Developer's Engineer's name, address and official stamp, the Developer/Owner's name and address and where applicable, the name of the plat of subdivision and/or name of development.

Drawing Scale Requirements

The following general layout guideline shall be used:

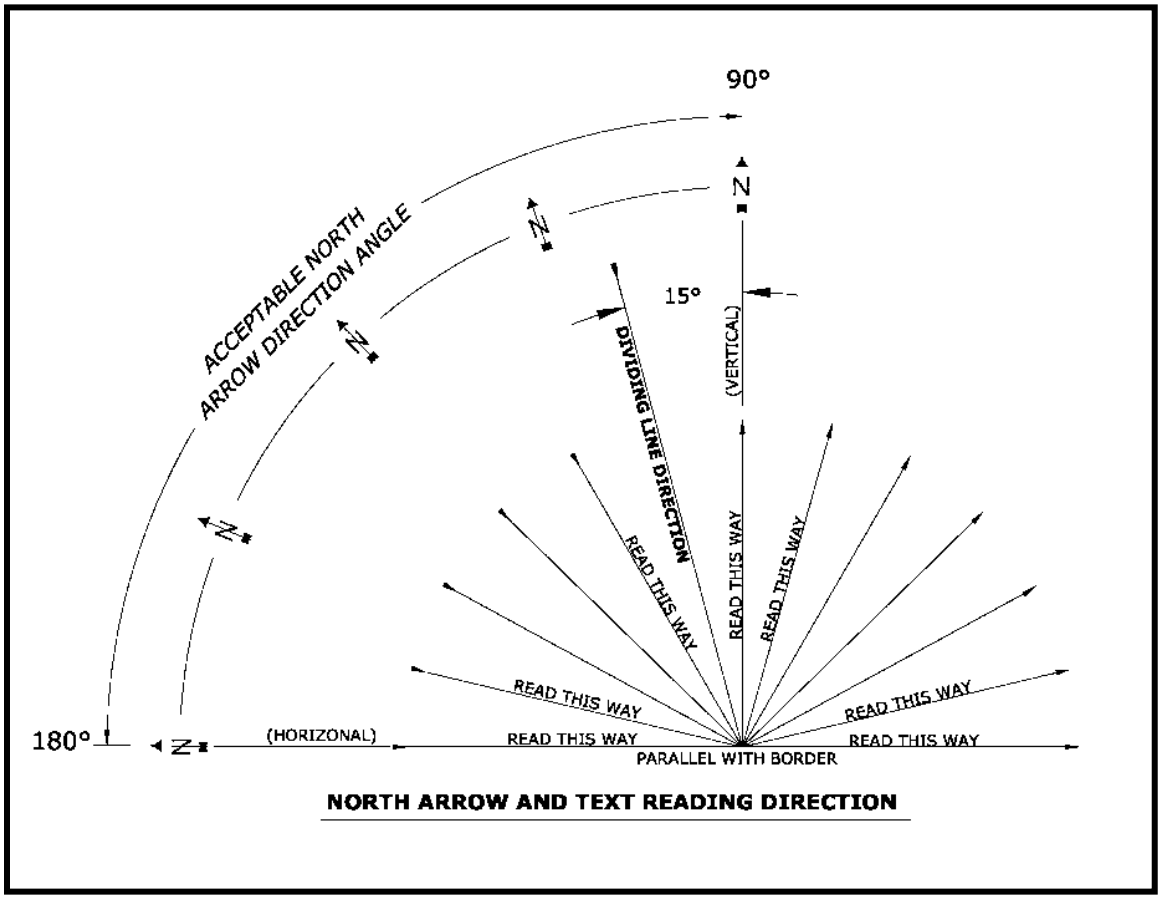
- Plan and Profile sheets shall be 1 inch = 50 feet horizontal and 1 inch = 10 feet vertical. The District may approve alternative scales on a case-by-case basis.
- Each sheet shall include a bar scale with text.

North Arrow Requirements

Each sheet shall include a north arrow. Each separate view on each sheet shall have its own north arrow. The north arrow in each view should face the top (VERTICAL) on the sheet if possible. It is acceptable to align the north arrow off vertical if the project does not fit vertically facing north; it can be rotated counterclockwise as much as 90 degrees.

For acceptable north arrow angle directions see **Figure 5**.

Figure 5. North Arrow and Text Reading



Lettering/Text Requirements

- Text Rotation
  - Text should be readable from either the bottom or right edge of the sheet. For acceptable text reading direction, see **Figure 5**.
- Lettering Size and Style
  - Lettering Size
    - The minimum lettering size shall be eight-hundredths (0.08) of an inch high for existing items and a minimum lettering size shall be ten-hundredths (0.10) of an inch high for new items. Items shall be legible and reproducible.
  - Lettering Style

- Standard text styles should be used. All lettering should be upper case.

Labeling Requirements

- Sanitary and storm structures, proposed and existing, shall be labeled on each sheet.
- All street names are to be labeled in each model space window.
- All tax lots and easements within the development and surrounding area pertaining to the project shall be clearly labeled.
- Non-standard storm structures (e.g., Flat Top Manhole) shall be labeled with the unique structure type after the structure name.

Plan and Profile Views-Structure and Pipe Callouts

Plan View Leader Line Requirements (see **Figure 6** and

Figure 7)

- Leader lines must angle off horizontal and vertical planes from the center point of the structure in plan view. Horizontal and vertical leader lines are acceptable in profile view.
- Leader lines should have an arrow.
- The leader line arrow should touch the edge of the symbol and point to the center of the structure.

Figure 6. Accepted Leader Practice

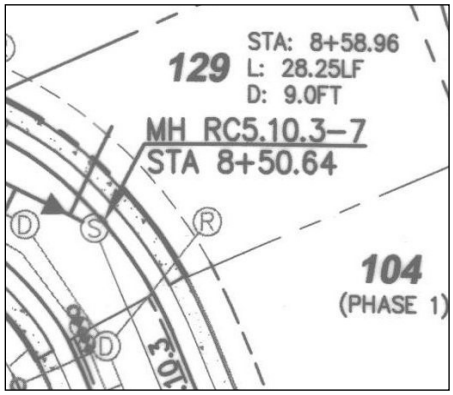
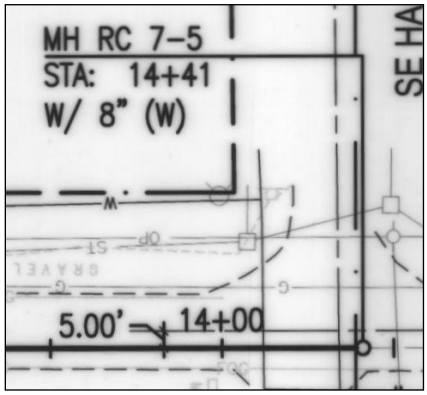


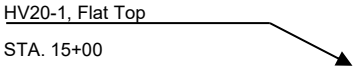
Figure 7. Not Accepted Leader Practice



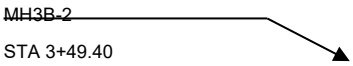
General Sanitary/Storm Structure Callouts in Plan and Profile Views

Street stationing and other related information is allowed on the construction plans; however, this must be removed on the accepted as-built plans.

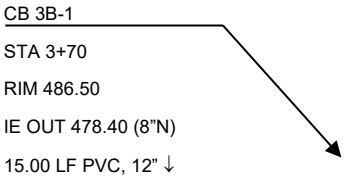
Plan View–Non-Typical Manhole Callout:



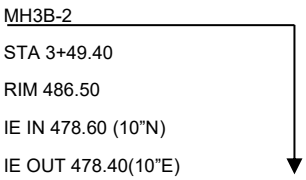
Plan View–Manhole Callout:



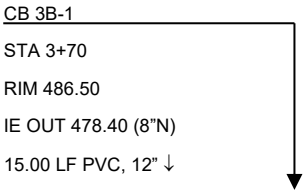
Plan View–Catch Basin and Other Structures:



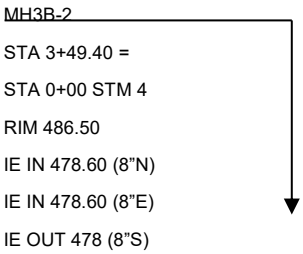
Profile View–Manhole Callout:



Profile View–Catch Basin and Other Structures:



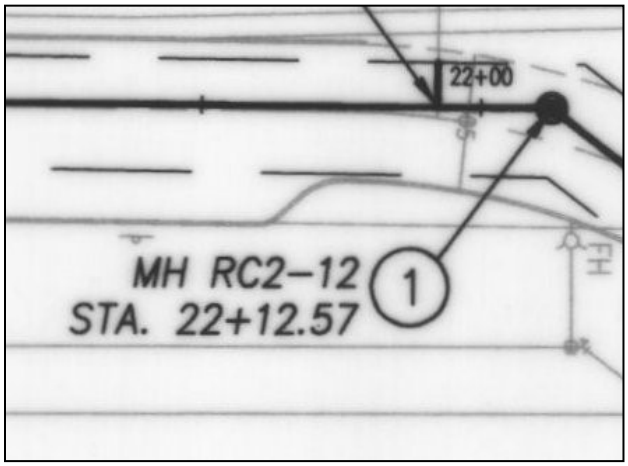
Profile View–Manhole Callout with Multi IE IN:



Reference Balloons

In general, note reference balloons are not allowed. The District will determine the type and format of all callouts on the final as-built drawings if notes are included. If reference balloons are used on construction drawings then the structure name callout must precede the number as shown below in **Figure 8**.

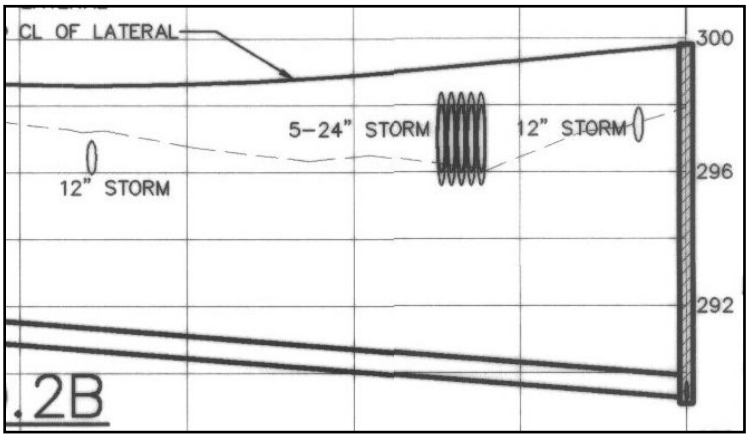
Figure 8. Reference Balloon



Utility Crossings

Show and label all storm, sanitary, waterline, gas and all other utilities that are 6 inches or larger that cross the pipeline alignment in the profile view. Utility invert and crown elevations may be required if they are in close proximity to a proposed storm line. See **Figure 9**.

Figure 9. Utility Profile



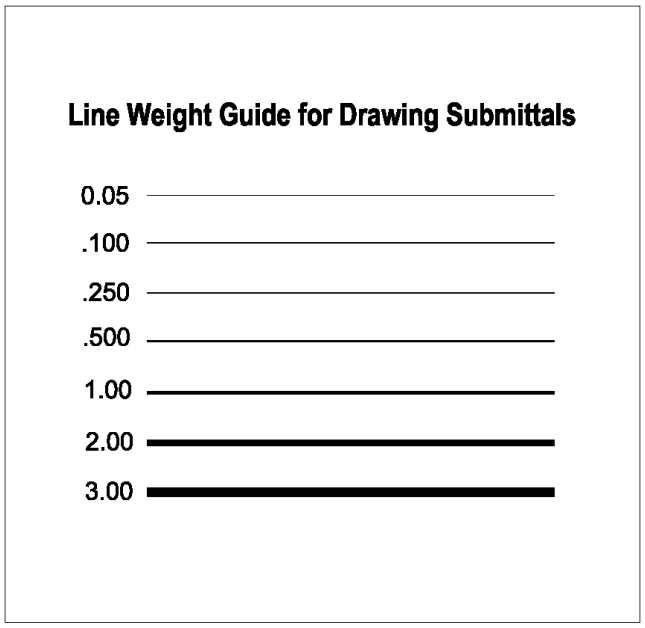
n. Plan and Profile View Sheet Specifications

Plan and Profile Views shall contain the following information:

- Follow the Line Weight Guide for Drawing Submittals, **Figure 10**
- Screening layers during plotting will not be permitted for any line types on plots except for widely spaced hatching. Screening lines are not allowed on as-built record drawings.

- The primary structures and pipes (storm) shall appear **BOLD** and stand out against all other background features in both the plan and profile views, i.e., only the applicable conveyance lines and appurtenances should appear bold on submittals.

Figure 10. Line Weight Guide



Plotted Line Widths:

Lines shall be plotted in millimeters and widths and plotted at 1 inch = 50 feet in model space and 1:1 in paper space. The line widths should be plotted the thickness of the lines as illustrated in Figure 10.

Screening of line weights is prohibited for illustration of line weights. Solid gray lines may be used in place of screening lines.

Plan View:

The plan and profile showing the proposed mainline extensions and Service Connections shall have a line weight of 3.00 millimeter (mm) (black). The sanitary or storm in the background shall have a width of 1.00 mm.

Existing contour lines in the plan view may be drawn as a dashed or solid line type; black or gray; between 0.250-0.500 mm in weight.

Profile View:

Profile view of the proposed system mainline shall be drawn at a line weight of 2.00 mm. Other utilities shown in the background shall be drawn at a line weight of 0.500 mm in either black or gray.

Existing sanitary/storm lines shall be shown in the profile view as a dashed black or a gray line in a line weight of 1.00 mm.

Other associated line specifications for plan and profile views:

Profile view gridlines:

- Primary – 0.250 mm/black
- Secondary – 0.050 mm/black
- Tax lots, parcels, property, and easement lines – 1.00 mm/black
- Roadway improvements – 0.500 mm/black
- All other utilities – 0.250 mm/black or gray
- Subdivision or plat boundary – 2.00 mm/black or gray

As-Built Submittal Requirements

The District requires the sanitary and storm plans shall be as-built prior to the acceptance of the project. As-built drawings are necessary to assure the project was constructed per the approved plans and/or meet the requirements of these Standards. The Developer's Engineer of record is responsible for record keeping, inspection, and preparation of the as-built drawings. Final as-built drawings will be submitted in the following manner, paper(s), CAD files and PDF files.

a) Survey requirements

The following Public Sanitary System structures shall be surveyed, and the as-built elevation and location shall be noted on the final as-built drawings:

i. I.E. ins, outs and rim elevations of the:

- Point of connection, existing downstream manholes, and structures,
- Dead end manholes, cleanouts, and structures,
- Any manhole or structure that may be extended in the future,
- Any substantial change in the approved plans that deviate more than 0.250-feet in elevation or alignment.
    - A table listing the Service Connections for each building lot noting the mainline stationing, the measurement in linear feet of the location of the Service Connection from the center of the upstream and downstream manholes, pipe size, pipe length, and pipe depth at the property line crossing.
    - Show alignment changes, slope changes, IE changes, pipe size changes and changes in construction materials.
    - Measured depth from existing ground surface of all storm, sanitary, waterline and utilities that cross the pipeline alignment in profile.
    - Type of pipe, backfill material and location.

b) Paper As-built Drawing Requirements

As-built drawings shall contain, at a minimum, the following information:

- For all publicly maintained systems and all public and private detention and SMFs, the Developer's Engineer shall submit certified as-built plans and profile drawings.
- Each page shall be stamped by the Developer's Engineer and stated in writing that it is an as-built drawing.

- Show final pipe alignment, slope, pipe size, and pipe material type in the appropriate view.
- Indicate areas of rock removal not completed by standard backhoe, i.e., splitter or blasting.
- As-built drawings and electronic drawings shall become the unencumbered property of the District and are public records that may be distributed as the District deems necessary.
- Two (2) sets of full sized “Draft” as-built drawings on blue-line shall be submitted to the District for review and redline mark-up prior to final paper, electronic file format submittal, and PDF files.
- The final as-built drawings shall be black-line drawings on paper. High quality plotting preferences must be used so the paper, when photocopied and/or scanned, is capable of being reproduced with all details legible at an archival quality.
- On the applicable Plan View sheet show a table listing the following information for each sanitary and/or storm Service Connection; mainline stationing, measurement in linear feet of the location of the Service Connection from the center of the upstream and downstream manholes, pipe size, pipe length, and pipe depth of the service lateral at the property line.
- Street stationing and information not related to the storm system construction is not allowed on the as-built plans; however, this information is acceptable on the construction plans.
- Remove all hatching associated with material type.
- The subdivision name shown in the title block shall match the name shown on the plat.

c) CAD Requirements for As-Built Drawings

General Requirements:

- AutoCAD electronic files must be compatible with the AutoCAD version the District is currently running.
- Standard fonts, shapes and line types are required.
- All drawings are to be plotted in paper space at a scale of 1:1.
- For specific line weight requirements see **Figure 10**.
- Show the project boundary in **BOLD** type.
- All manholes, catch basins, fire hydrants, valves, meters, etc. are to be inserted as blocks. All blocks are to be created on layer 0.
- Not allowed are blocked x-refs and preferences or permissions set, so that the District cannot access each layer individually.
- All drawings are to be seamless and drawn in model space.
- Drawings are NOT to be rotated off of world coordinate bases.
- Drawings are to be delivered purged of all unused layers, blocks, line types, and styles.
- The drawing files saved to disk shall be ready to plot when opened and be the same dated file used to plot the paper as-built.
- SoftDesk point files are not requested and should not be transmitted. Combination files are acceptable.
- The final as-built drawing files are to be saved under one file folder. All drawings, x-refs, plot files, images, text, and shape files are to be in this one file folder.

- Only pertinent files are to be submitted in this project folder. NO revisions, SoftDesk files, log times, or miscellaneous DWGs are to be submitted.
- Before approval will be given, the digital file and hard copy will be evaluated to verify that they are the identical drawings and to make sure all required and only necessary files are included.
- The electronic as-built drawings shall be submitted along with a completed "As-built Release of Liability Form" and all contents shall become the property of the District.
- Provide the CAD as-built project drawings in digital data and saved to compact disk or flash drive for transmittal to the District.
- Use of a self-extracting PKZIP file format is acceptable. Use of compressed file(s) is allowed only if the decompression program is included.

Disks Labeling Requirements:

- Title of project
- The District (WES Log#) project file number
- Specify contents of the disk (DWGs)
- Name of the Developer's engineering firm submitting the files
- The project completion date.

d) PDF File Requirements for As-Built Drawings

AutoCAD electronic files must be compatible with AutoCAD version the District is currently running.

As-built drawings and electronic drawings shall become the unencumbered property of the District and are public records that may be distributed as the District deems necessary.

The PDF files shall represent an exact copy of the paper as-built drawings.

General Conditions for Performance And Warranty Surety

The District may require the Applicant to submit a surety, cashier's check, or irrevocable letter of credit from an acceptable financial institution to guarantee performance or warranty in completion of the improvements required by these standards. Upon default, the District may draw upon the surety or available funds to complete the remaining work or remedy violations. The different types of acceptable surety are listed below.

a) Surety – Types of Acceptable Guarantees

Surety shall be provided only through State regulated surety companies while assignment or commitment of savings or loan proceeds shall be through State regulated financial institutions. Cash Acknowledgment is a cash surety held directly by the District.

b) Surety Forms

All sureties shall be submitted with forms provided by the District or other authority having jurisdiction to permit or regulate the activity. All sureties are subject to review and approval by the District's legal department.

c) Performance Surety

The Applicant shall provide a Performance Surety acceptable to the District prior to recording of the plat for residential developments or the issuance of building permits for commercial or industrial developments, if the required public improvements are not completed and/or accepted by the District.

The following conditions shall be met prior to acceptance of the Performance Surety:

- The Performance Surety shall be in the amount of 125 percent of the Developer's Engineer's cost estimate for all approved but uncompleted sanitary and stormwater improvements, including landscaping requirements. The Developer's Engineer's cost estimate for the required improvements will be approved by the District.
- Nothing herein shall limit the Owner's responsibility for repair and maintenance to the amount of the surety.

The following conditions shall be met prior to release of the Performance Surety:

- All improvements must be completed as shown on the approved plans and accepted by the District in accordance with the Rules, Regulations, and Standards.
- A warranty surety shall be provided to the District prior to release of the Performance Surety.

If the Applicant fails to comply with the conditions of approval and the approved plans, the District may call upon the Performance Surety to complete the improvements according to the approved plans.

At the end of the surety period when all conditions are satisfied, the residual surety amount shall be released.

d) Warranty Surety

In general, the Warranty Surety is posted by the surety principal to the District to ensure the principal will maintain, repair, replace and be responsible for damage to the improvements for a period of 2 years following the date the District deems the improvements complete and a letter of completion and/or acceptance is issued.

The following conditions shall be met prior to acceptance of the Warranty Surety:

- The Warranty Surety shall be in the amount of 25 percent of the actual constructed cost for all constructed sanitary, stormwater, and vegetated buffer vegetated buffers are covered in the warranty bond improvements. The Developer's Engineer's cost data sheet will be approved by the District.
- The Warranty Surety shall be in favor of the District and be issued for a minimum two-year period from the date of completion of the sanitary or storm system.
- Nothing herein shall limit the Owner's responsibility for repair and maintenance to the amount of the surety.
- Upon notification from the District, the principal shall, within 30 days complete corrective measures to the satisfaction of the District.
- The District may perform emergency work without notice to the principal or surety.
- All work performed by the District due to the nonperformance of the principal or in response to an emergency shall be reimbursed to the District within 30 days of invoice.

- If the principal fails to reimburse the District in 30 days, the District may demand payment from the Surety.
- The warranty period may be extended, if the required improvements show any signs of failure during a final warranty release inspection.

The following conditions shall be met prior to release of the Warranty Surety:

- The Owner or Developer shall perform a thorough cleaning of all sanitary and stormwater improvements.
- The District shall make a determination of final completion in conformance with the approved plans, specifications, and District standards as well as conduct a final warranty surety inspection of all sanitary and stormwater improvements, including landscaping in any SMF and vegetated buffer. If more than 20 percent of the total area within a SMF or Vegetated Buffer is not in compliance with the approved plans, then the vegetated plantings will be replanted and/or repaired to meet the requirements of the approved plans. If replanting of the SMF or Vegetated Buffer is required, then an additional 1-year warranty surety in the amount of 25% of the cost of replanting all of the effected vegetated planting areas shall be required. The additional 1-year warranty surety will be renewed annually until the vegetated plantings are acceptable to the District.
- Any deficiencies resulting in non-acceptance of the work permitted shall be identified in writing on a final punch list and presented to the Developer's Engineer and/or Permittee with a date named for correction and completion. Upon correction of the noted deficiencies and the determination that all work is in conformance with District Standards, the work will be deemed complete and all sureties shall be released.

2. Infiltration Testing Requirements

To properly size and locate SMFs, it is necessary to characterize the soil infiltration conditions at the location of the proposed facility. All projects that require a SMF shall evaluate existing site conditions and determine if the site's infiltration rate is adequate to support the proposed SMF. The following sections provide the approved methods for testing infiltration and setting the design infiltration rate. District staff may require additional testing on a case-by-case basis.

Basic Method – Open Pit Test

The Basic Method – Open Pit Test (Basic Method) is applicable only to projects on private property with less than 10,000 sf of new or redeveloped impervious area. The results of infiltration testing shall be documented on the Basic Method Form. The Basic Method cannot be used for projects that have known downstream conveyance problems.

The intent of the Basic Method is to determine whether or not the local infiltration rate is adequate (0.5-inches/hour) to support a SMF that infiltrates. It is recommended but not required that the Basic Method infiltration test is conducted by a licensed professional.

1. Conduct one test for each proposed SMF. The test should be where the facility is proposed or within the direct vicinity.

2. Excavate a test hole to the depth of the bottom of the infiltration system, or otherwise to 4 feet. The test hole can be excavated with small excavation equipment or by hand using a shovel, auger, or posthole digger.

3. If a layer hard enough to prevent further excavation is encountered, or if noticeable moisture/water is encountered in the soil, stop, measure, and record this depth from the surface. Proceed with the test at this depth.

4. Fill the hole with water to a height of about 6 inches from the bottom of the hole (or to one-half the maximum depth of the proposed facility) and record the exact time. Check the water level at regular intervals (every 1 minute for fast-draining soils to every 10 minutes for slower-draining soils) for a minimum of 1 hour or until all of the water has infiltrated. Record the distance the water has dropped from the top edge of the hole.

5. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to portray the soil's ability to infiltrate at different levels of saturation accurately. The third test provides the best measure of the saturated infiltration rate.

6. For each test pit required, submit all three testing results with the date, duration, drop in water height, and conversion into inches per hour.

If the results of the Basic Method show an infiltration rate greater than 0.5-inches per hour, the Applicant can proceed with SMF design that uses infiltration. If the Applicant would like to use an infiltration rate for design purposes, a Professional Method Infiltration Test shall be conducted.

Professional Method

The Professional Method shall be used for all public and private developments with more than 10,000 sf of new or redeveloped impervious area. The Professional Method may be required by the District a public and private development of any size with known downstream conveyance problems. The qualified professional shall exercise judgment in the selection of the infiltration test method.

Testing Criteria

Testing shall be conducted or observed by a qualified professional. This professional shall be a PE, Registered Geologist, or Certified Engineering Geologist licensed in the State of Oregon.

The location and depth of the test shall correspond to the facility location and depth.

Infiltration testing should not be conducted in engineered or undocumented fill.

Boring logs shall be provided as supporting information with infiltration and depth to groundwater tests.

All testing data shall be documented in the project submittals. The submittals shall demonstrate that the proposed facilities are sized appropriately for the tested infiltration rates.

Depth and Location of Required Tests

Infiltration tests shall be performed at the base of the proposed facility.

If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within 4 feet of the bottom of the planned infiltration system, the testing shall be conducted within that confining layer.

Tests shall be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location.

For relatively deep stormwater facilities, a hollow stem auger with an electronic measuring tape can be used, provided there is an adequate seal between the auger and the native soil.

Factors of Safety

Table 18 lists the recommended factors of safety to be applied to field-obtained infiltration rates for use in stormwater system design. To obtain the infiltration rate used in design, divide the infiltration rate measured in the field by the factor of safety. The factor of safety used in design should be chosen by collaboration between the geotechnical engineer or geologist overseeing the infiltration testing and the civil engineer designing the stormwater management system.

Determination of the factor of safety shall include consideration of project specific conditions such as soil variability, testing methods, consequences of system failure, complexity of proposed construction, and other pertinent conditions. The design infiltration rate after applying the safety factor shall not exceed 100 in/hr for non-vegetative facilities, such as drywells or infiltration chambers. Vegetated facilities with growing media shall be designed at a maximum infiltration rate of 6.0 in/hr through the growing media.

Table 18. Infiltration Rate Safety Factors

Test Method	Recommended Correction Factors
Encased Falling head	3
Open Pit Falling Head	2
Double-Ring Infiltrometer	Public Facilities: 1 Private Facilities: 2

Open Pit Falling Head Procedure

The open pit falling head procedure is based on the EPA Falling Head Percolation Test Procedure (Onsite Wastewater Treatment and Disposal Systems Design Manual, EPA/625/1-80-012, 1980). The test is performed in an open excavation and therefore is a test of the combination of vertical and lateral infiltration.

1. Excavate an approximately 2-foot by 2-foot-wide hole into the native soil to the elevation of the proposed facility bottom. The test can be conducted in a machine-excavated pit or a hand-dug pit using a shovel, posthole digger, or hand auger. If smooth auguring tools or a smooth excavation bucket is used, scratch the sides and bottom of the hole with a sharp-pointed instrument, and remove the loose material from the bottom of the test hole.
2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.
3. Fill the hole with clean water a minimum of 1 foot above the soil to be tested and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to presoak the native material.
4. Percolation rate measurements shall be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period shall be

removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

5. In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.
6. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit are convenient reference points. The tester and excavator should conduct all testing in accordance with OSHA regulations.
7. Measure the water level to the nearest 0.01-foot (1/8-inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. At no time during the test is the water level allowed to rise more than 6 inches above the gravel.
8. Successive trials shall be run until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials shall be conducted. After each trial, the water level is readjusted to the 12-inch level. Enter results into the **Infiltration Test Data Table** provided at the end of this section as **Table 19**.
9. The results of the last water level drop are used to calculate the tested infiltration rate. The final rate shall be reported in inches per hour. See the calculation following the **Infiltration Test Data Table** provided at the end of this section.
10. For very rapidly draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, conduct the test in the following manner:
    a. Approximate the area over which the water is infiltrating.
    b. Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.
    c. Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches).
11. Upon completion of the testing, the excavation shall be backfilled

Encased Falling Head Test Procedure

The encased falling head procedure is based on a modification of the EPA Falling Head Percolation Test Procedure (Onsite Wastewater Treatment and Disposal Systems Design Manual, EPA/625/1-80-012, 1980). The most significant modification is that this test is performed with a 6-inch casing that is embedded approximately 6 inches into the native soil. The goal of this field test is to evaluate the vertical infiltration rate through a 6-inch plug of soil, without allowing any lateral infiltration. The test is not appropriate in gravelly soils or in other soils where a good seal with the casing cannot be established.

1. Embed a solid 6-inch-diameter casing into the native soil at the elevation of the proposed facility bottom (see **Figure 11**). Ensure that the embedment provides a good seal around the pipe casing so that percolation will be limited to the 6-inch plug of the material within the casing. This method can also be applied to testing within hollow stem augers, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger.

2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.

3. Fill the pipe with clean water a minimum of 1 foot above the soil to be tested and maintain this depth for at least 4 hours (or overnight if clay soils are present) to presoak the native material.

Percolation rate measurements shall be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period shall be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

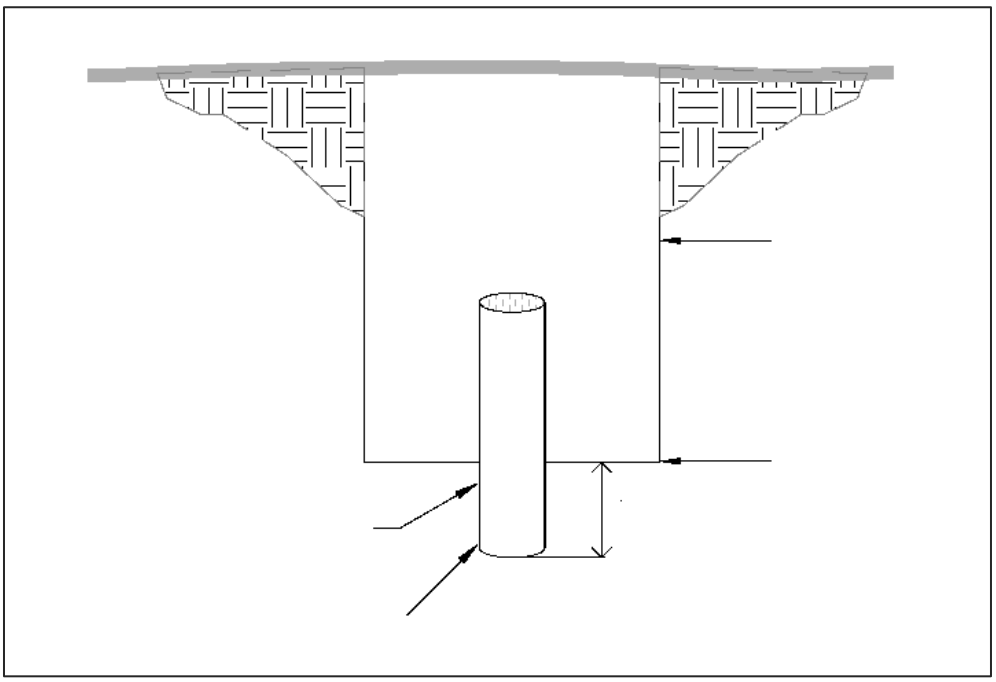
4. To conduct the first trial of the test, fill the pipe to approximately 6 inches above the soil and measure the water level to the nearest 0.01-foot (1/8-inch). The level should be measured with a tape or other device with reference to a fixed point. The top of the pipe is often a convenient reference point. Record the exact time.

5. Measure the water level to the nearest 0.01-foot (1/8-inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. The infiltration test is continued until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials shall be conducted. After each trial, the water level is readjusted to the 6-inch level. Enter results into the **Infiltration Test Data Table** provided at the end of this section. At no time during the test is the water level allowed to rise more than 6 inches above the gravel.

6. The result of the last water level drop is used to calculate the tested infiltration rate. The final rate shall be reported in inches per hour.

7. Upon completion of the testing, the casings shall be immediately pulled, and the test pit shall be backfilled.

Figure 11. Encased Falling Head



Double Ring Infiltrometer Test

The double-ring infiltrometer test procedure shall conform with ASTM 3385-94. The test is performed within two concentric casings embedded and sealed to the native soils. The outer ring maintains a volume of water to diminish the potential of lateral infiltration through the center casing. The volume of water added to the center ring to maintain a static water level is used to calculate the infiltration rate. The double-ring infiltrometer is appropriate only in soils where an adequate seal can be established.

This test may be difficult to perform where the tested soil strata are in a pit since careful regulation of the static volumes is necessary.

Reporting Requirements

In addition to the information required by the state for a signed and stamped Geotechnical Engineering Report, the following information shall be included in the project's submittals.

1. Infiltration results in inches per hour.

2. Location and depth of excavation. The excavation should be deep enough to verify that there is a 5-foot separation between the final depth of the facility (rock gallery) and the seasonal high groundwater or soil layer that could reduce the infiltration rate.

3. Summary and discussion of infiltration testing, including number of tests, amounts of water used in each test (inches, gallons, etc.), and time of each test. Testing is required to show that an accurate rate was achieved.

4. Discussion of how the test was performed:

- Open pit (size of area)
- Encased falling head

    - Pipe type and size
    - Embedment depth
- Double-ring infiltrometer
    - Pipe type and size
    - Embedment depth

5. **Table 19**. Infiltration Test Data Table provided at the end of this appendix.
6. Soil types with depth.
7. Groundwater observations: seasonal high groundwater level estimation.

Table 19. Infiltration Test Data Table

Location:	**Date:**	**Test Hole Number:**
Depth to bottom of hole:	**Diameter of hole:**	**Test Method:**
Tester's Name: **Tester's Company:**		**Tester's Contact Number:**

Depth, feet	**Soil Texture**

Time	**Time interval, minutes**	**Measurement, feet**	**Drop in water level, feet**	**Percolation rate, inches per hour**	**Remarks**

Figure 12. Infiltration Test Data Table Example

Infiltration Test Data Table Example

Location: Lot 105, Low Point Heights Subdivision	**Date:** 6/28/2010	**Test Hole Number:** 3
Depth to bottom of hole: 57 inches	**Diameter of hole:** 0.5 feet	**Test Method:** Encased falling head
Tester's Name: C.J. Tester **Tester's Company:** Tester Company		**Tester's Contact Number:** 555-1212

Depth, feet	Soil Texture
0-0.5	Black Topsoil
0.5-1.0	Brown SM
1.0-2.2	Brown ML
2.2-5.1	Brown CL

Time	Time interval, minutes	Measurement, feet	Drop in water level, feet	Percolation rate, inches per hour	Remarks
9:00	0	3.75	-		Filled with 6"
9:20	20	3.83	0.08		
9:40	20	3.91	0.08	2.88	
10:00	20	3.98	0.07	2.52	
10:20	20	4.04	0.06	2.16	
10:40	20	4.11	0.07	2.52	
11:00	20	4.17	0.06	2.16	
11:20	20	4.225	0.055	1.98	
					Adjusted to 6" level for Trial #2

Appendix B: Stormwater Facility Guidance

1. Planting Guide for Vegetated Stormwater Facilities

This appendix provides planting matrices categorized by SMF type. The matrices provide important information on plants approved for installation in each facility type and are intended to guide plant selection for planting plans.

All plants included in these matrices are intended to be drought tolerant but require irrigation temporarily during their establishment period. Even after the establishment period, native plants may require supplemental irrigation during periods of high heat or extended drought. The species listed are representative examples and are not to be considered exclusive or exhaustive for these facility types.

The City of Portland maintains a comprehensive Native Plant List for planting within the Portland metropolitan region that can be found on the City's website.

When a conflict exists between the representative species outlined within this publication and the Native Plant List, the Native Plant List will prevail.

An alternate plant selection may be proposed for review and approval by the District. No species adopted within the Portland Nuisance Plants List will be permitted.

Plant Type Information

A description of the type of information provided for each plant table is provided below.

Plant Name: Plants are listed by their botanical name first, in italics, followed by a generally accepted common name. Note that common names vary, so use of the botanical name is recommended to ensure proper plant selection

Zone: As noted in the zone section of the compiled plant lists, zone denotes the planting moisture zone in which it is appropriate to locate each respective plant. Zone A refers to the highest point on the slope (dry/upland), Zone B refers to the mid-section of the slope (moist/dry) and Zone S refers to the lowest part of the slope (saturated/wet). Refer to the Standard Detail Drawings for zones by facility type. Some plants work in multiple moisture zones, and others only in a particular dry, moist, or wet condition.

Origin: Plants approved for stormwater facilities can be grouped into three categories: NW Natives, NW Native Cultivars, and Non-Native Adaptive plants.

> NW Native: These are plants that are indigenous to the Willamette Valley. They typically require minimal care once they are planted because they have evolved and adapted to the growing conditions and climate of the region. Because of their place in the local ecology, native plants also provide habitat value for birds and other local species. For these reasons, native plants are strongly recommended for stormwater facilities and should be used to the maximum extent practical. In designated vegetated buffers and sensitive areas only native plants are allowed in SMFs.
>
> NW Native Cultivar: These species are cultivated varieties of native plants produced by horticultural techniques and are not normally found in wild populations. Cultivars are bred for certain desired characteristics that make them different from their native counterparts. Native cultivars may be selected over a native plant if it is more suitable for certain conditions, such as densely urbanized applications. For example, Kelsey

dogwood (Cornus sericea ‘Kelseyi) is a cultivar of the native red twig dogwood (Cornus sericea). Kelsey dogwood has been selectively bred to be much smaller at maturity than red twig dogwood, which can be advantageous in small scaled urban stormwater planters. In such instances, the native cultivar is preferred because it will not outgrow the facility or require frequent pruning maintenance, while still offering the same vegetative advantages as its native counterpart.

Non-Native Adaptive: These plants are not native to the Willamette Valley but have certain characteristics that make them very useful and well adapted to stormwater facilities. The non-native adapted plants included on the stormwater facility plant lists are considered non-invasive. The District prefers that native and native cultivars be used whenever practical but will allow non-native adapted plants where appropriate

Type/Size: The following factors provide guidance on individual plant characteristics:

(E)vergreen/(D)ecidious: Identifies the characteristic of a plant to keep or lose foliage during winter months. Evergreen plant materials are often preferred at the understory level for stormwater treatment through winter.

Potential Height: Identifies maximum size at maturity to use as a design guideline.

Typical On-Center Spacing: Identifies the optimum spacing for new plantings. This is to be used as a guideline and may vary slightly depending on site conditions.

Context Factors

The following factors should be considered when selecting vegetation. Consult the appropriate Plant List for guidance.

Sun/Shade: When developing planting plans, solar orientation is important to consider. This column identifies which plants are appropriate for full to part sun or shade.

Facility with underdrain: In facilities with underdrains, it is important to select plants appropriate for faster draining soils.

Facility less than 3 feet wide: Narrow conditions require plants that are not too large and will outgrow or have the potential for roots to be damaged in narrow planters. This column identifies which plants are appropriate for narrow planter widths.

Lined facility/on top of utilities: In lined facilities it is important to limit larger material or plants with aggressive and deep roots. This column identifies which plants are appropriate for this application.

Parking areas: This column identifies plants that are appropriate for facilities in most parking areas. Large shrubs selected for parking areas should have form and habit that are open and transparent. For portions of parking areas that have line of sight requirements, plants should be selected from the “Streets/Line of Sight” column.

Streets/line of sight: For street-side facilities and in parking areas where line of sight visibility is required, use plant materials that do not limit necessary lines of sight visibility. This column identifies which plants are appropriate for this application.

Adjacent to buildings: When planting adjacent to buildings, limit plant sizes for compatibility with building footings, windows, or other systems. This column identifies which plants are appropriate to use adjacent to buildings.

In Natural Resource Overlay District: If the stormwater facility is within the Natural Resource Overlay District, all plants shall be indigenous to the Willamette Valley.

Public Maintenance: For facilities that will be publicly maintained, plant palette shall be more limited and focused on lower maintenance plants. These facilities should also emphasize more hardy plants that can adapt to higher summer temperatures and extended drought.

Maintenance Legacy: The designer should carefully consider the long-term vegetation management strategy for the stormwater facility, with an emphasis on the anticipated maintenance requirements for the future Owners.

Native vs Blended Soils: Designers should select plants after a careful analysis of the facility's growing medium matrix. Plant material selection should take into account the site-specific characteristics of both blended and underlying native soils, including infiltration rates.

Planting Requirements

While planting sizes, densities, and irrigation requirements are not specified here, vegetation must be installed such that 100 percent vegetative cover is achieved through a mix of herbaceous, groundcover, and shrubs at the end of the warranty period, prior to acceptance. A dense vegetative cover at the ground level must be achieved for maximum water quality treatment.

Planter plant matrices and facility layout figures are provided in the following tables:

- Table 20. Stormwater Planter Plant List
- Table 22. Swale Plant List
- Table 23. Wetland Plant List
- Table 24. Pond Plant List
- Table 25. Green Roof Plant List

Table 20. Stormwater Planter Plant List

Plant Name	Zone	Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Fully-lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Herbaceous Plants														
Carex densa Dense sedge	x	x			E	24"	12"	Sun to Part Shade	x	x	x	x	x	x
Eleocharis ovata Ovate spike rush	x	x			E	30"	12"	Sun to Part Shade	x	x	x	x	x	x
Juncus ensifolius Dagger-leaf rush	x			x	D	10"	12"	Sun to Part Shade	x	x	x	x	x	
Juncus patens Spreading rush	x	x			E	36"	12"	Sun, Part Shade, Shade	x	x	x	x	x	x
Small Shrubs/Groundcover														
Cornus sericea 'Kelseyi' Kelsey dogwood	x		x		D	24"	24"	Sun to Part Shade	x	x	x	x	x	
Mahonia repens Creeping Oregon Grape	x	x			E	2'	3'	Sun, Part Shade, Shade		x	x	x	x	x
Fragaria chiloensis Coastal strawberry	x	x			E	6"	12"	Sun to Part Shade	x	x	x	x	x	x
Polystichum munitum Sword fern	x	x			E	2'	2'	Sun, Part Shade, Shade	x	x	x	x	x	x

Table 21. Rain Garden Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants																
Carex obnupta Slough sedge	x		x	x			E	48"	12"	Part to Full Shade		x	x	x	x	x
Carex stipata Sawbeak sedge	x	x	x	x			D	36"	12"	Sun to Part Shade	x	x	x	x	x	x
Deschampsia cespitosa Tufted hair grass	x			x			D	36"	12"	Part Shade	x		x	x	x	x
Elymus glaucus Blue wild rye	x	x		x			E	24"	12"	Part Shade	x		x	x	x	x
Juncus balticus Baltic rush		x	x	x			E	24"	12"	Sun	x	x	x	x	x	x
Juncus patens Spreading rush	x	x	x			x	E	36"	12"	Sun to Part Shade	x	x	x	x	x	x
Scirpus microcarpus Small Fruited Bulrush	x		x	x			E	24"	12"	Sun	x		x	x	x	x
Small Shrubs/Groundcover																
Athyrium filix-femina *Lady fern*	x	x		x			E	3'	2'	Part Shade to Shade	x		x	x	x	x
Arctostaphylos uva-ursi Kinnickinnick	x	x		x			E	5"	3'	Sun to Part Shade	x	x	x	x	x	x
Mahonia repens Creeping Oregon Grape	x	x		x			E	2'	3'	Part Shade to Shade	x	x	x	x	x	x
Philadelphus lewisii Mock orange	x		x	x			D	6'	4'	Sun to Part Shade			x	x	x	x
Polystichum munitum Sword fern	x	x		x			E	2'	2'	Part Shade to Shade	x		x	x	x	x
Symphoricarpos albus Snowberry	x	x		x			D	3'	3'	Sun, Part Shade, Shade	x	x	x	x	x	x

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Large Shrubs/Small Trees																
Cornus sericea Red twig dogwood	x	x	x	x			D	6'	4'	Part Shade						
Physocarpus capitatus Pacific ninebark	x		x	x			D	9'	3'	Sun to Part Shade			x	x	x	x
Rosa nutkana Nootka rose	x	x		x			D	8'	4'	Sun, Part Shade, Shade			x		x	
Ribes sanguineum Red flowering currant	x	x		x			D	8'	4'	Sun, Part Shade, Shade		x	x	x	x	x
Salix sitchensis Sitka willow	x		x	x			D	15'	5'	Sun, Part Shade, Shade						
Trees*																
Cornus nuttalii Pacific dogwood	x	x		x			D	20'	10'	Sun, Part Shade, Shade	x		x	x	x	x
Rhanmus purshiana Cascara	x	x		x			D	30'	20'	Part Sun to Shade						
Calocedrus decurrens Incense cedar	x	x	x	x			E	90'	15'	Part Shade to Shade				x		

** Trees are not required but are allowed with adequate soil volume and root space for healthy growth and maturity. Provide minimum 2 cubic feet of soil volume per square foot of mature canopy size.*

Table 22. Swale Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants																
Carex obnupta Slough sedge	x		x	x			E	48"	12"	Part Shade		x	x	x	x	x
Carex stipata Sawbeak sedge	x		x	x			D	36"	12"	Sun to Part Shade	x	x	x	x	x	x
Deschampsia cespitosa Tufted hair grass	x			x			D	36"	12"	Part Shade	x		x	x	x	x
Elymus glaucus Blue wild rye	x	x		x			E	24"	12"	Part Shade	x		x	x	x	x
Juncus balticus Baltic rush		x	x	x			E	24"	12"	Sun	x		x	x	x	x
Juncus patens Spreading rush	x	x	x			x	E	36"	12"	Sun to Part Shade	x	x	x	x	x	x
Scirpus microcarpus Small fruited bulrush	x		x	x			E	24"	12"	Sun	x	x	x	x	x	x
Small Shrubs/Groundcover																
Athyrium filix-femina Lady fern	x	x		x			E	3'	2'	Sun to Part Shade	x		x	x	x	x
Arctostaphylos uva-ursi Kinnickinnick	x	x		x			E	5"	3'	Sun to Part Shade	x		x	x	x	x
Fragaria chiloenis Coastal strawberry	x	x		x			E	6"	12"	Sun to Part Shade	x	x	x	x	x	x
Mahonia repens Creeping Oregon grape	x	x		x			E	2'	3'	Part Shade to Shade	x	x	x	x	x	x
Philadelphus lewisii Mock orange	x	x		x			D	6'	4'	Sun to Part Shade			x	x	x	x
Polystichum munitum Sword fern	x	x		x			E	2'	2'	Part Shade to Shade	x		x	x	x	x
Symphoricarpos alba Snowberry	x	x		x			D	3'	3'	Sun, Part Shade, Shade	x	x	x	x	x	x
Large Shrubs/Small Trees																
Cornus sericea Red twig dogwood	x	x	x	x			D	8'	4'	Part Shade						
Physocarpus capitatus Pacific ninebark	x		x	x			D	6'	3'	Sun to Part Shade			x	x	x	x
Rosa nutkana Nootka rose	x	x		x			D	8'	4'	Sun, Part Shade, Shade			x		x	

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Ribes sanguineum Red flowering currant	x	x		x			D	8'	4'	Sun, Part Shade, Shade			x	x	x	x
Salix sitchensis Sitka willow	x		x	x			D	15'	5'	Sun, Part Shade, Shade						
Trees*																
Cornus nuttalii Pacific dogwood	x	x		x			D	20'	10'	Sun, Part Shade, Shade	x		x	x	x	x
Rhamnus purshiana Cascara	x	x		x			D	30'	20'	Part Shade to Shade				x		
Calocedrus decurrens Incense cedar	x	x	x	x			E	90'	15'	Part Shade to Shade				x		

**Trees are not required but are allowed with adequate soil volume and root space for healthy growth and maturity. Provide minimum 2 cubic feet of soil volume per square foot of mature canopy size.*

Table 23. Wetland Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors					
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants															
Alisma plantago-aquatica Water plantain			x	x			D	24"	12"	Sun	x	x			
Carex obnupta Slough sedge	x		x	x			E	48"	12"	Part Shade		x	x	x	x
Deschampsia cespitosa Tufted hair grass	x			x			D	36"	12"	Part Shade	x	x	x	x	x
Elymus glaucus Blue wild rye	x	x		x			E	24"	12"	Part Shade	x	x	x	x	x
Juncus ensifolius Dagger-leaf rush	x		x			X	D	10"	12"	Sun to Part Shade	x	x	x	x	x
Juncus patens Spreading rush	x	x	x			X	E	36"	12"	Sun to Part Shade	x	x	x	x	x
Scirpus microcarpus Small fruited bulrush	x		x	x			E	24"	12"	Sun	x	x	x	x	x
Small Shrubs/Groundcover															
Mahonia repens Creeping Oregon grape	x	x		x			E	2'	3'	Part Shade to Shade	x	x	x	x	x
Rosa pisocarpa Swamp rose		x	x	x			D	6'	3'	Sun to Part Shade		x	x	x	x
Polystichum munitum Sword fern	x	x		x			E	2'	2'	Part Shade to Shade	x	x	x	x	x
Symphoricarpos albus Snowberry	x	x		x			D	3'	3'	Sun, Part Shade, Shade	x	x	x	x	x
Large Shrubs/Small Trees															
Cornus sericea Red twig dogwood	x	x	x	x			D	8'	4'	Part Shade					
Physocarpus capitatus Pacific ninebark	x		x	x			D	6'	3'	Sun to Part Shade		x	x	x	x
Rosa nutkana Nootka rose	x	x		x			D	8'	4'	Sun, Part Shade, Shade		x		x	
Ribes sanguineum Red flowering currant	x	x		x			D	8'	4'	Sun, Part Shade, Shade		x	x	x	x
Salix sitchensis Sitka willow	x		x	x			D	15'	5'	Sun, Part Shade, Shade					
Ceanothus velutinus Snowbrush	x	x		x			E	6'	3'	Sun, Part Shade, Shade		x	x	x	x

Plant Name	Zone			Origin			Type/Size			Context Factors					
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Trees															
Acer circinatum Vine maple	x	x		x			D	15'	8'	Part Shade to Shade	x	x	x	x	x
Cornus nuttalii Pacific dogwood	x	x		x			D	20'	10'	Sun, Part Shade, Shade	x	x	x	x	x
Fraxinus latifolia Oregon ash	x		x	x			D	30'	25'	Sun					
Calocedrus decurrens Incense cedar	x	x	x	x			E	90'	16'	Part Shade to Shade			x		

Table 24. Pond Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Facility width	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants																
Alisma plantago-aquatica Water plantain	S		x	x			D	24"	12"	Sun	x		x			
Carex obnupta Slough sedge	x		x	x			E	48"	12"	Part Shade		x	x	x	x	x
Deschampsia cespitosa Tufted hair grass	x			x			D	36"	12"	Part Shade	x	x	x	x	x	x
Elymus glaucus Blue wild rye	x	x		x			E	24"	12"	Part Shade	x		x	x	x	x
Juncus ensifolius Dagger-leaf rush	x		x			x	D	10"	12"	Sun to Part Shade	x	x	x	x	x	x
Juncus patens Spreading rush	x	x	x			x	E	36"	12"	Sun to Part Shade	x	x	x	x	x	x
Scirpus microcarpus Small fruited bulrush	x		x	x			E	24"	12"	Sun	x	x	x	x	x	x
Small Shrubs/Groundcover																
Athyrium filix-femina Lady fern	x	x		x			E	3'	2'	Part Shade to Shade	x		x	x	x	x
Mahonia repens Creeping Oregon grape	x	x		x			E	2'	3'	Part Shade to Shade	x		x	x	x	x
Polystichum munitum Sword fern	x	x		x			E	2'	2'	Part Shade to Shade	x		x	x	x	x
Symphoricarpos albus Snowberry	x	x		x			D	3'	3'	Sun, Part Shade, Shade	x	x	x	x	x	x
Large Shrubs/Small Trees																
Cornus sericea Red twig dogwood	x	x	x	x			D	8'	4'	Part Shade		x				
Physocarpus capitatus Pacific ninebark	x		x	x			D	6'	3'	Sun to Part Shade		x	x	x	x	x
Philadelphus lewisii Mock Orange	x	x		x			D	6'	4'	Sun to Part Shade		x	x	x	x	x

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Facility width	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Rosa Nutkana Nootka rose	x	x		x			D	8'	4'	Sun, Part Shade, Shade			x		x	
Ribes sanguimeum Red flowering currant	x	x		x			D	8'	4'	Sun, Part Shade, Shade		x	x	x	x	x
Salix sitchensis Sitka willow	x		x	x			D	15'	5'	Sun, Part Shade, Shade						
Ceanothus velutinus Snowbrush	x	x		x			E	6'	3'	Sun, Part Shade, Shade		x	x	x	x	x
Trees																
Acer circinatum Vine maple	x	x		x			D	15'	8'	Part Shade to Shade	x		x	x	x	x
Cornus nuttalii Pacific dogwood	x	x		x			D	20'	10'	Sun, Part Shade, Shade	x		x	x	x	x
Rhamnus purshiana Cascara	x	x		x			D	30'	20'	Part Sun to Shade						
Calocedrus Incense cedar	x	x	x	x			E	90'	15'	Part Shade to Shade				x		

Table 25. Green Roof Plant List

Plant Name	Zone		Origin			Type/Size			Context
Botanical Name Common Name	C	D	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade
Sedums and Succulents									
Delosperma ssp. Ice plant	x	x			x	E	4"	6"-12"	Sun
Malephora crocea v. purpurea Coppery mesemb	x	x			x	E	10"	6"-12"	Sun to Part Shade
Sedum album White stonecrop	x				x	E	3"	6"-12"	Sun
Sedum oreganum Oregon stonecrop	x	x	x			E	4"	6"-12"	Sun to Part Shade
Sedum spathufolium Stonecrop	x	x			x	E	4"	6"-12"	Sun to Part Shade
Sedum spurium Two-row stonecrop	x	x			x	E	6"	6"-12"	Sun
Sempervivum tectorum Hens and chicks	x				x	E	3"	6"-12"	Sun to Part Shade
Herbaceous Plants									
Achillea millefolium Common yarrow	x	x			x	D	24"	24"	Sun to Part Shade
Artemesia 'Silver Mound' Silver mound artemesia	x	x			x	D	12"	12"	Sun to Part Shade
Castilleja foliosa Indian paintbrush	x	x	x			D	10"	12"	Sun
Festuca glauca 'Elijah's Blue' Elijah's blue fescue	x	x			x	E	12"	12"	Sun
Fragaria chiloensis Coastal strawberry	x	x	x			E	6"	12"	Sun to Part Shade
Polystichum munitum Sword fern	x	x	x			E	24"	24"	Sun, Part Shade, Shade
Thymus serpyllum Creeping thyme	x				x	D	3"	6"	Sun, Part Shade, Shade

2. Stormwater Facility Operations and Maintenance Guidance

Stormwater Planter
Rain Garden
Vegetated Swale
Filter Strip
Drywell
Infiltration Trench
Detention Pond
Constructed Wetlands
Structural Detention
Pervious Pavement
Green Roof

Stormwater Facility inspection and Maintenance Log

Stormwater Planters

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Check overflow caps and replace if cracked or missing.	X		X		X
Check flow spreader, if present, and repair as necessary. Check inlet protection and replace or replenish rock, as necessary.	X		X		
Check liner, if present, and repair tears or holes, as necessary. Replace liner, as necessary.	X		X		
Patch concrete.		X	X		

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area, forebays, and inlets.	X		X		X
Repair any erosion around edges of concrete forebay if erosion is occurring.		X	X		X
Check trench drains discharging to the facility and remove any soil or debris.	X	X	X	X	X
Check for channeled flow in facility; fill in channels with soil and add plants to disperse flow.		X	X		X
Add 3 inches of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage at maturity. Do not add bark dust or bark chips; they will float and then clog the outlet or create bare spots.	X				
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth.	X				
Prune shrubs.	X			X	
If facility drains slowly, rake soil to stop crusting. Replace or amend soil if ponding occurs more than 24 hours	X		X	X	X
Ponding should not occur for more than 48 hours.	X		X	X	X

Rain Gardens

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Repairs	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Check overflow caps and replace if cracked or missing.	X		X		X
Check flow spreader, if present, and repair, as necessary. Check inlet protection and replace or replenish rock, as necessary.	X		X		

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area, forebays, and inlets.	X		X		X
Repair any erosion around edges of concrete forebay if erosion is occurring.		X	X		X
Check trench drains discharging to the facility and remove any soil or debris.	X	X	X	X	X
Check for channeled flow in facility; fill in channels with soil and add plants to disperse flow.		X	X		X
Add 3 inches of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage at maturity. Do not add bark dust or bark chips; they will float and then clog the outlet or create bare spots.	X				
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth.	X				
Prune shrubs and trees.	X			X	
If facility drains slowly, rake soil to stop crusting. Replace or amend soil if ponding occurs more than 24 hours.	X		X	X	X
Ponding should not occur for more than 48 hours.	X		X	X	X

Vegetated Swales

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Repairs	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Check overflow caps or grates and repair, as necessary. Replace if they are missing.	X		X		X
Check flow spreader, if present, and repair, as necessary. Check inlet protection and replace or replenish rock, as necessary.	X		X		

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area, forebays, and inlets.	X		X		X
Repair any erosion around edges of concrete forebay if erosion is occurring.		X	X		X
Check trench drains discharging to the facility and remove any soil or debris.	X	X	X	X	X
Check for channeled flow in facility; fill in channels with soil and add plants to disperse flow.		X	X		X
Add 3 inches of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage at maturity. Do not add bark dust or bark chips; they will float and then clog the outlet or create bare spots.	X				
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth.	X				
Prune shrubs and trees.	X			X	
If facility drains slowly, rake soil to stop crusting. Replace or amend soil if ponding occurs more than 24 hours.	X		X	X	X
Ponding should not occur for more than 48 hours.	X		X	X	X

Filter Strips or Landscaped Areas Receiving Sheetflow from Impervious Areas

NO pesticide, herbicide, or fungicide use is allowed.

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Maintenance Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove accumulated sediment.	X		X		X
Replace or replenish rock bordering filter strip or sheet flow area, as necessary.		X	X		X
Check flow spreader, if present, and repair, as necessary. Check inlet protection and replace or replenish rock, as necessary.	X			X	X
Check trench drains leading to the facility and remove any soil or debris.	X	X	X	X	X
Check for channeled flow; fill in channels with soil and add plants to disperse flow.	X		X		X
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth.	X				
Prune shrubs and trees.	X			X	
If moss is present, aerate the area or add 1/2-inch of 3/4-inch clean (no fines) rock.	X		X		
If facility drains slowly, aerate grasses or rake soil to stop crusting. Replace or amend soil if ponding occurs more than 24 hours.	X		X	X	X
Ponding should not occur for more than 48 hours.	X		X	X	X

Dry Wells

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Have drywell professionally cleaned and notify DEQ. Record the date and spill response measures in the inspection log.

Maintenance Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.		X	X		
Remove sediment from catch basin.	X		X		X
Remove leaf litter/debris from gutters.	X		X		
Check trench drains leading to the facility and remove any soil or debris.	X	X	X	X	X
Remove inspection portal lid and check for spalling or cracking of walls and for root intrusions. Repair, as necessary.		X	X		
Remove inspection portal lid and check sediment depth. Have professionally cleaned when depth of sediment or debris is 6 inches or greater.		X	X		
Ponding should not occur for more than 48 hours.	X		X	X	X

Infiltration Trenches

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Have drywell professionally cleaned and notify DEQ. Record the date and spill response measures in the inspection log.

Maintenance Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.		X	X		
Remove sediment from catch basin.	X		X		X
Remove leaf litter/debris from gutters.	X		X		
Check trench drains leading to the facility and remove any soil or debris.	X	X	X	X	X
Remove inspection portal lid. Check for cracking of walls and root intrusion. Remove roots and repair walls, as necessary. Have professionally cleaned when depth of sediment or debris is 3 inches or greater.		X	X		X
Ponding should not occur for more than 48 hours.	X		X	X	X

Detention Pond

NO pesticide, herbicide, or fungicide use is allowed.

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Repairs	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Remove sediment in catch basins discharging to pond.	X		X		
Inspect outlet structure. Clean clogged orifices. Repair cracked or broken shear gate and handles.		X	X		
Check spillway and berms. Add erosion control matting to areas of slight or moderate erosion.		X	X		X
Check spillway and berms. Contact WES at 503.742.4567 if the erosion is severe or there is evidence of concrete cracking or spalling.		X	X		X

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area and inlets.		X	X		X
Replace or replenish rock at inlets if erosion is occurring.		X	X		X
Check flow dissipaters. Repair or replace diffuser, as necessary. Replace or replenish rock, as necessary.		X	X		
Add 3 inches of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage. Do not add bark dust or bark chips; they will float as the wetland refills and either clog the outlet or create bare spots in the ponding area.	X	X	X		
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth if desired.	X				
Prune shrubs and trees.	X			X	
Check depth or high-water mark in several areas. If depth is less than 50% of design depth, dredge area and replant. If depth is more than 150% of the design depth, add soil and replant in channeled area.	X		X		

Constructed Wetlands

NO pesticide, herbicide, or fungicide use is allowed.

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Repairs	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Remove sediment in catch basins discharging to wetlands.	X		X		
Inspect outlet structure. Clean clogged orifices. Repair cracked or broken shear gate and handles.		X	X		
Check spillway and berms. Add erosion control matting to areas of slight or moderate erosion.		X	X		X
Check spillway and berms. Contact WES at 503.742.4567 if the erosion is severe or there is evidence of concrete cracking or spalling.		X	X		X

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area and inlets.		X	X		X
Replace or replenish rock at inlets if erosion is occurring.		X	X		X
Check flow dissipaters. Repair or replace diffuser, as necessary. Replace or replenish rock, as necessary.		X	X		
Add 3 inches of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage. Do not add bark dust or bark chips; they will float as the wetland refills and either clog the outlet or create bare spots in the ponding area.	X	X	X		
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth if desired.	X				
Prune shrubs and trees.	X			X	
Check depth or high-water mark in several areas. If depth is less than 50% of design depth, dredge area and replant. If depth is more than 150% of the design depth, add soil and replant in channeled area.	X		X		

Structural Detention

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Call Metro to determine proper disposal requirements of spill response materials. Record the date and spill response measures in the inspection log.

Structural Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Remove sediment in catch basins discharging to tank or vault.	X		X		X
Remove inspection portal lid, check for root intrusion, and remove roots and repair facility, as necessary. Check sediment depth and have professionally cleaned when depth of sediment and debris is > 15 percent of diameter at any point or > 6 inches below pipe invert.		X	X		X

Pavers and Pervious Pavement

***NO** pesticide, herbicide, fungicide, or moss inhibitor use is allowed.*

NO sand or deicer should be used on paver area.

Clean up spills immediately. Call Metro to determine proper disposal requirements of spill response materials. Record the date and spill response measures in the inspection log.

Maintenance Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Check for moss growth. Use baking soda to kill moss and then scrape dead moss off and throw in yard waste bin.	X			X	
Sweep leaf litter and debris off pavement. Use a professional pavement sweeper or wet/dry vacuum, as necessary. **NO** pressure washing; it clogs the pavement.	X		X		X
Remove overhanging plants or grass near pavers.		X	X		
During rainstorms, check for water running onto surface and divert water away from pavement.			X	X	X
Repair cracks and settling, as necessary.	X	X			
No ponding or runoff should occur on the pavement.	X		X	X	X

Green Roofs

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Call Metro to determine proper disposal requirements of spill response materials. Record the date and spill response measures in the inspection log.

Maintain system per manufacturer's requirements

Stormwater Facilities Inspection and Maintenance Log	CLACKAMAS WATER ENVIRONMENT SERVICES

OWNER:	**CONTACT INFO:**

FACILITY LOCATION/ADDRESS:

FACILITY TYPE:

ACCESS NOTES:

Refer to the facility's quarterly inspection requirements in the O&M Plan before conducting inspections and maintenance actions.

INSPECTION YEAR:

WINTER INSPECTION LOG	*SPRING INSPECTION LOG*	*SUMMER INSPECTION LOG*	*FALL INSPECTION LOG*
DATE:	**DATE:**	**DATE:**	**DATE:**
INSPECTOR NAME:	**INSPECTOR NAME:**	**INSPECTOR NAME:**	**INSPECTOR NAME:**
COMPONENTS INSPECTED*:	**COMPONENTS INSPECTED*:**	**COMPONENTS INSPECTED*:**	**COMPONENTS INSPECTED*:**
STRUCTURAL: ☐	**STRUCTURAL:** ☐	**STRUCTURAL:** ☐	**STRUCTURAL:** ☐
PONDING AREA: ☐	**PONDING AREA:** ☐	**PONDING AREA:** ☐	**PONDING AREA:** ☐
VEGETATION: ☐	**VEGETATION:** ☐	**VEGETATION:** ☐	**VEGETATION:** ☐
MAINTENANCE ACTIONS PERFORMED:	**MAINTENANCE ACTIONS PERFORMED:**	**MAINTENANCE ACTIONS PERFORMED:**	**MAINTENANCE ACTIONS PERFORMED:**

* ***Structural Components*** *include all 'hard' elements of the facility (inlets, flow spreaders, liners, overflow caps, etc.).*

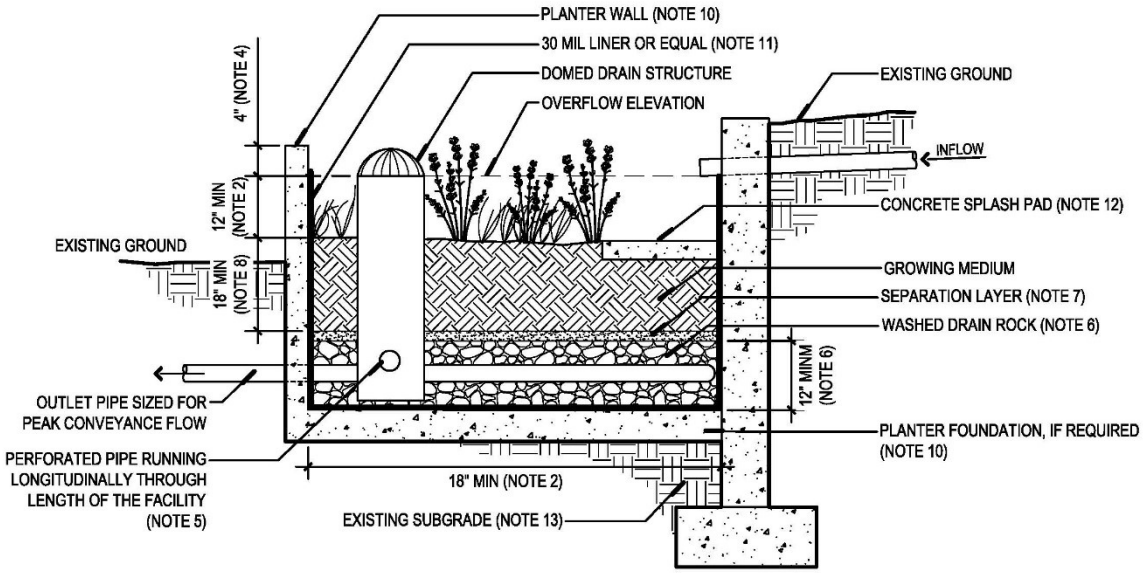
Ponding Area *includes areas on the surface or underground where stormwater accumulates. Inspect for blockages, sediment, and trash.*

Vegetation *includes maintaining vegetation, so the facility can function as designed (i.e., tree pruning, weed removal, mowing, grass management).*

Appendix C: Stormwater Typical Drawings and Standard Details

Dwg #	Drawing Description
BMP SIZING TOOL FACILITY DRAWINGS	
SWM-01	PLANTER FILTRATION
SWM-02	PLANTER INFILTRATION
SWM-03	RAIN GARDEN FILTRATION
SWM-04	RAIN GARDEN INFILTRATION
SWM-05	VEGETATED SWALE FILTRATION
SWM-06	VEGETATED SWALE INFILTRATION
SWM-07	FILTER STRIP
SWM-08	SIMPLIFIED DESIGN APPROACH DRYWELL
SWM-09	SIMPLIFIED DESIGN APPROACH INFILTRATION TRENCH
SWM-10	DETENTION POND
SWM-11	DETENTION POND FLOW CONTROL STRUCTURE
SWM-12	PERVIOUS PAVEMENT
SWM-13	GREEN ROOF
STANDARD DETAILS	
SWM-14	CB CURB AND GUTTER DETAIL
SWM-15	CB CURB INLET
SWM-16	CB DITCH INLET
SWM-17	CB FRAME AND GRATE
SWM-18	CB STANDARD GB2
SWM-19	DETENTION TANK DIAGRAM
SWM-20	POND DIAGRAM
SWM-21	SHEAR GATE AND ORIFICE
SWM-22	FLOW STRUCTURE TYPE 1
SWM-23	FLOW STRUCTURE TYPE 2

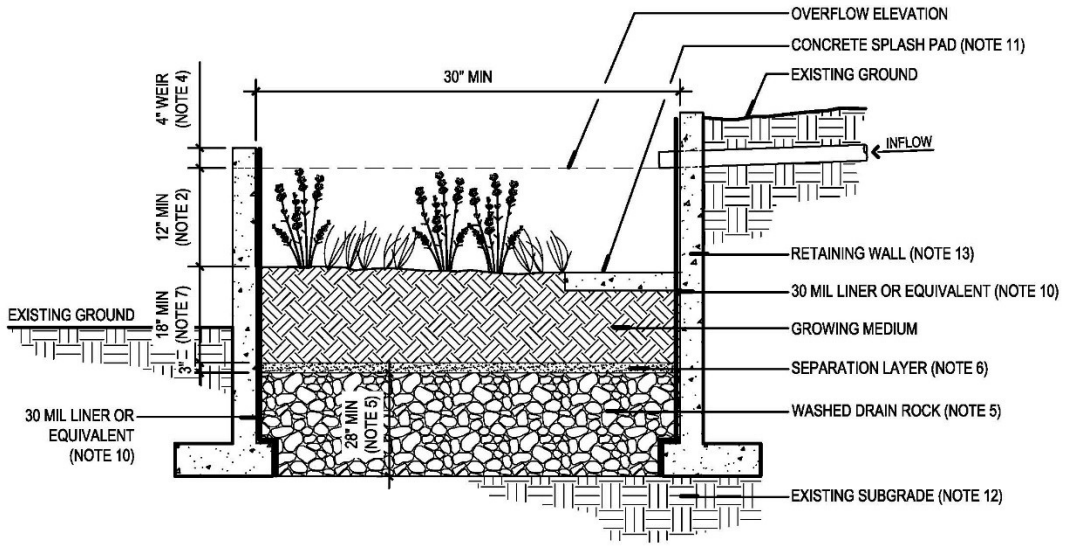
Dwg #	Drawing Description
STANDARD DETAILS (cont.)	
SWM-24	FLOW STRUCTURE TYPE 3
SWM-25	MANHOLE BASE
SWM-26	MH CHANNEL AND RING EXTENSION
SWM-27	MH DRYWELL
SWM-28	MH ENERGY DISSIPATOR
SWM-29	MH FLEXIBLE CONNECTION
SWM-30	MH FLOW CONTROL
SWM-31	MH OVAL GRATE DETAIL
SWM-32	MH SHALLOW PRECAST
SWM-33	MH STANDARD
SWM-34	MH STEP
SWM-35	MH STANDARD FRAME & COVER
SWM-36	MH SUBURBAN FRAME & COVER
SWM-37	ANCHOR WALL
SWM-38	TRENCH RESTORATION
SWM-39	TRENCH RESTORATION WITH CDF
SWM-40	COLLECTION SYSTEM DIAGRAM
SWM-41	MH LOCATION DIAGRAM
SWM-42	CURB CUT OPENING
SWM-43	CURB STAMP DETAIL
SWM-44	INSERTA TEE
SWM-45	OUTFALL RIP RAP
SWM-46	OUTFALL RIP RAP SIZING
SWM-47	REMOVABLE BOLLARD
SWM-48	ROOF DOWNSPOUT SYSTEM
SWM-49	SERVICE CONNECTION



GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   - WIDTH: 18" MINIMUM
   - DEPTH OF PLANTER (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   - SLOPE OF PLANTER: 0.5% OR LESS
3. SETBACKS:
   - PLANTERS MUST BE MINIMUM OF 5 FEET FROM PROPERTY LINE.
4. OVERFLOW:
   - INLET ELEVATION MUST ALLOW FOR 4" OF FREEBOARD, MINIMUM.
   - PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
5. PIPING:
   - PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40, 6" MINIMUM DIAMETER. PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
   - OVERFLOW PIPING: SHALL BE ABS SCH.40, DUCTILE IRON, OR PVC SCH.40 AND SHALL NOT BE PERFORATED. MIMIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
6. DRAIN ROCK:
   - SIZE FOR FLOW-THROUGH PLANTER: 1 1/2" - 3/4" WASHED
   - DEPTH: 12" MINIMUM
7. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
8. GROWING MEDIUM:
   - DEPTH: 18" MINIMUM
   - FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX F.
10. PLANTER FOUNDATION AND WALLS:
    - MATERIALS SHALL BE 4" REINFORCED CONCRETE, STONE, BRICK, OR OTHER DURABLE MATERIAL.
    - CONCRETE, BRICK, OR STONE WALLS SHALL BE INCLUDED ON FOUNDATION PLANS.
    - INSTALL INVERTED CURB AS NEEDED BETWEEN PLANTER AND ROAD SUBGRADE.
    - WALL HEIGHTS GREATER THAN 24" ABOVE GRADE REQUIRE HANDRAIL.
11. WATERPROOF LINER (IF REQUIRED):
    - LINER SHALL BE 30 MIL PVC OR EQUIVALENT, FOR FLOW THROUGH FACILITIES.
    - A WATERPROOF LINER IS NOT REQUIRED IF THE FOUNDATION OR WALL MATERIAL IS WATERPROOF REINFORCED CONCRETE OR APPROVED EQUAL.
12. INSTALL CONCRETE SPLASH PAD TO TRANSITION FROM INLET TO GROWING MEDIUM. SIZE OF PAD SHALL BE 1 FT. x 1 FT.
13. SEASONAL HIGH GROUNDWATER SEPARATION:
    - SEPARATION DISTANCE AS REQUIRED BY THE WES.
14. SUBMIT RETAINING WALL DESIGN IN ACCORDANCE WITH APPLICABLE STRUCTURAL CODES FOR REVIEW AND APPROVAL.
15. SEE WES STANDARD DRAWINGS FOR LOCATING PLANTERS IN THE PUBLIC RIGHT-OF-WAY.

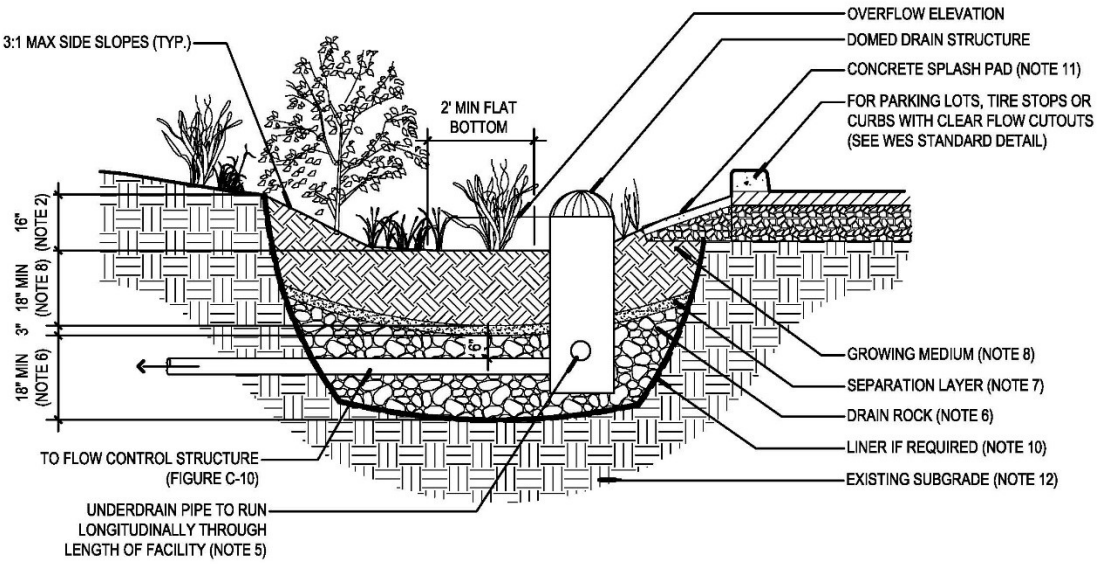
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS PLANTER FILTRATION	STANDARD DRAWING SWM -01



GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   - WIDTH: 30" MINIMUM
   - DEPTH OF PLANTER (FROM TOP OF GROWING MEDIUM TO OVERFLOW WEIR ELEVATION): 12"
   - SLOPE OF PLANTER: 0.5% OR LESS
3. SETBACKS:
   - PLANTERS MUST BE MINIMUM OF 5 FEET FROM PROPERTY LINE.
4. OVERFLOW:
   - WEIR ELEVATION MUST ALLOW FOR 4" OF FREEBOARD, MINIMUM.
   - SIZE OVERFLOW WEIR FOR THE 100 YEAR DESIGN STORM. IDENTIFY EMERGENCY OVERFLOW ROUTE ON THE STORMWATER MANAGEMENT PLAN.
5. DRAIN ROCK:
   - SIZE: 1 1/2" - 3/4" WASHED
   - DEPTH: 28" MINIMUM
6. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. GROWING MEDIUM:
   - DEPTH: 18" MIMIMUM
   - FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
8. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX F.
9. PLANTER WALLS:
   - MATERIALS SHALL BE STONE, BRICK, CONCRETE OR OTHER DURABLE MATERIAL.
   - CONCRETE, BRICK, OR STONE WALLS SHALL BE INCLUDED ON FOUNDATION PLANS.
   - INSTALL INVERTED CURB AS NEEDED BETWEEN PLANTERS AND ROAD SUBGRADE.
   - WALL HEIGHTS GREATER THAN 24" ABOVE GRADE REQUIRE HANDRAIL.
10. WATERPROOF LINER:
    - LINER SHALL BE 30 MIL PVC OR EQUIVALENT.
    - A WATERPROOF LINER IS NOT REQUIRED IF THE WALL MATERIAL IS WATERPROOF REINFORCED CONCRETE OR APPROVED EQUAL.
11. INSTALL CONCRETE SPLASH PAD TO TRANSITION FROM INLET TO GROWING MEDIUM. SIZE OF PAD SHALL BE 1 FT. x 1 FT.
12. SEASONAL HIGH GROUNDWATER SEPARATION:
    - SEPARATION DISTANCE AS REQUIRED BY WES.
13. SUBMIT RETAINING WALL DESIGN IN ACCORDANCE WITH APPLICABLE STRUCTURAL CODES FOR REVIEW AND APPROVAL.
14. SEE WES STANDARD DRAWINGS FOR LOCATING PLANTERS IN THE PUBLIC RIGHT-OF-WAY.

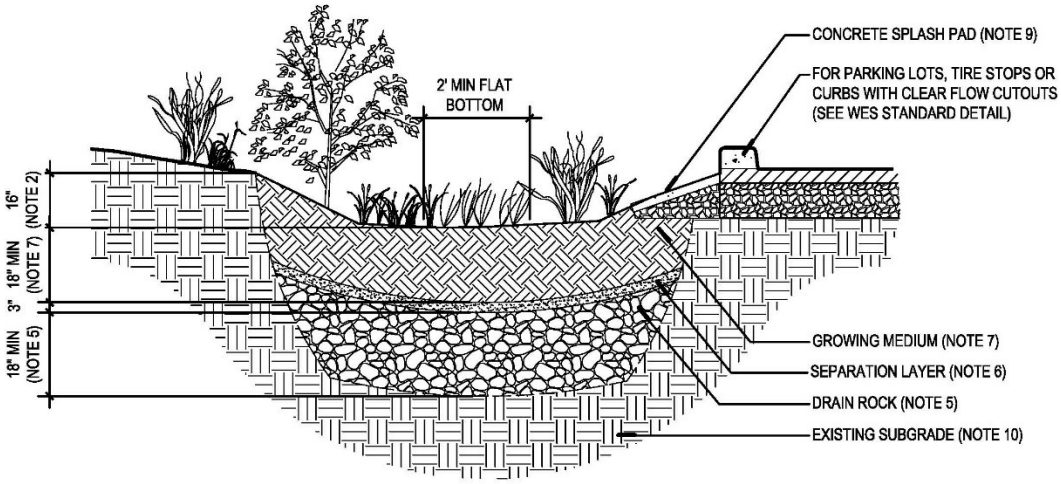
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS PLANTER INFILTRATION	STANDARD DRAWING SWM -02



GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED RAIN GARDENS ARE PREFERRED TO MAXIMIZE ONSITE INFILTRATION.
2. DIMENSIONS:
   - DEPTH OF BASIN (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   - FLAT BOTTOM WIDTH: 2' MINIMUM
   - SIDE SLOPES OF BASIN: 3:1 MAXIMUM
   - SLOPE OF RAIN GARDEN: 0.5% OR LESS
3. SETBACKS:
   - FILTRATION RAIN GARDEN MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. OVERFLOW:
   - OVERFLOW REQUIRED. INLET ELEVATION MUST ALLOW FOR 4" OF FREEBOARD, MINIMUM.
   - PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
5. PIPING:
   - PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40. MINIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
   - OVERFLOW PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
6. DRAIN ROCK:
   - SIZE: 1 1/2" to 3/4"-0 WASHED
   - DEPTH: 18" MINIMUM
7. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
8. GROWING MEDIUM:
   - DEPTH: 18" MINIMUM
   - FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
10. WATERPROOF LINER (IF REQUIRED): SHALL BE 30 MIL PVC OR EQUIVALENT.
11. SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM.
12. SEASONAL HIGH GROUNDWATER SEPARATION:
    - SEPARATION DISTANCE AS REQUIRED BY WES.
13. SEE WES STANDARD DRAWINGS FOR LOCATING PLANTERS IN THE PUBLIC RIGHT-OF-WAY.

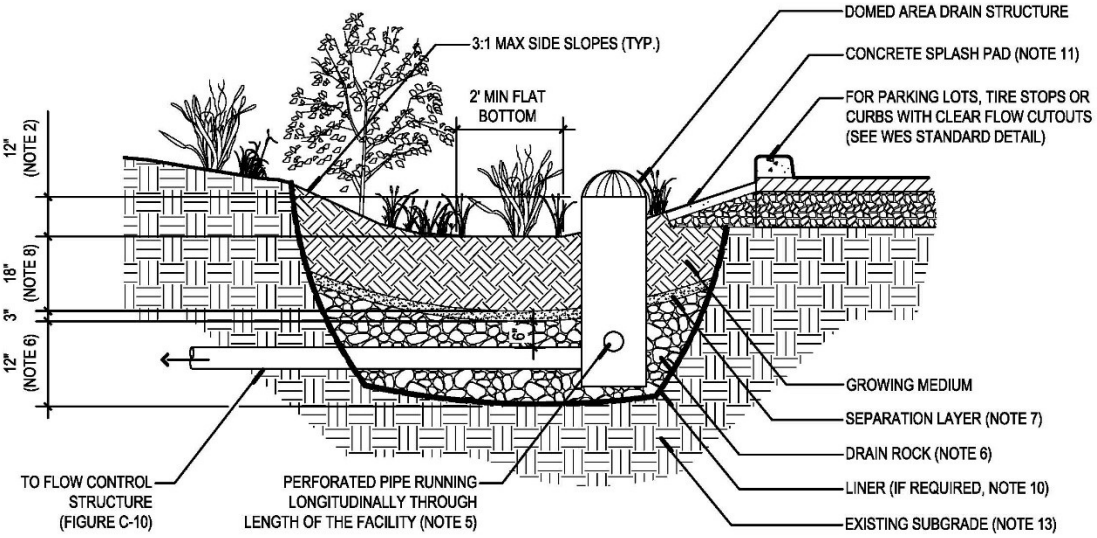
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS RAIN GARDEN FILTRATION	STANDARD DRAWING SWM -03



GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   - DEPTH OF BASIN (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 16"
   - FLAT BOTTOM WIDTH: 2' MINIMUM
   - SIDE SLOPES OF BASIN: 3:1 MAXIMUM
   - SLOPE OF RAIN GARDEN: 0.5% OR LESS
3. SETBACKS:
   - INFILTRATION RAIN GARDEN MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES.
4. OVERFLOW:
   - EMERGENCY OVERFLOW PATH FOR THE 100 YEAR DESIGN STORM SHALL BE IDENTIFIED IN THE STORMWATER MANAGEMENT PLAN.
5. DRAIN ROCK:
   - SIZE: 1 1/2" TO 3/4"- WASHED
   - DEPTH: 18"
6. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. GROWING MEDIUM:
   - DEPTH: 18" MINIMUM
   - FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
8. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
9. SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM.
10. SEASONAL HIGH GROUNDWATER SEPARATION:
    - SEPARATION DISTANCE AS REQUIRED BY WES.
11. SEE WES STANDARD DRAWINGS FOR LOCATING RAIN GARDENS IN THE PUBLIC RIGHT-OF-WAY.

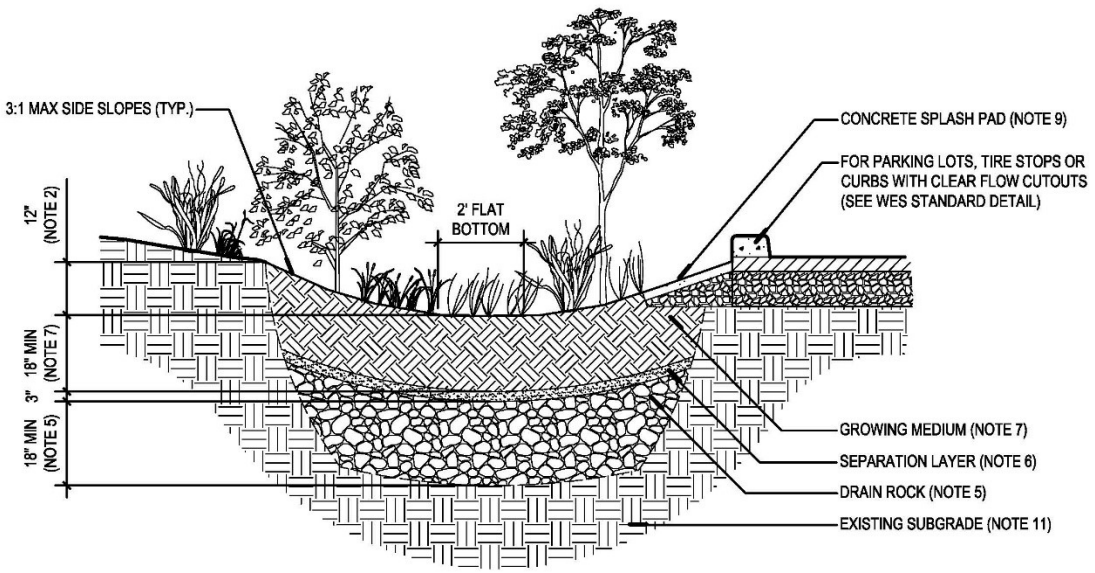
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS RAIN GARDEN INFILTRATION	STANDARD DRAWING SWM -04



GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED SWALES ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. DIMENSIONS:
   - DEPTH OF SWALE (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   - LONGITUDINAL SLOPE OF SWALE: 6.0% OR LESS. INSTALL CHECK DAM IF OVER 4.0%. SEE NOTE 12.
   - FLAT BOTTOM WIDTH: 2' MINIMUM
   - SIDE SLOPES OF SWALE: 3:1 MAXIMUM
3. SETBACKS:
   - FILTRATION SWALES MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. OVERFLOW:
   - INLET ELEVATION MUST ALLOW FOR 4" OF FREEBOARD, MINIMUM.
   - PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
5. PIPING:
   - PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40. MINIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
   - OVERFLOW PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
6. DRAIN ROCK:
   - SIZE: 1 1/2" - 3/4" WASHED
   - DEPTH: 12"
7. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
8. GROWING MEDIUM:
   - 18" MINIMUM
   - FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX F.
10. WATERPROOF LINER (IF REQUIRED): SHALL BE 30 MIL PVC OR EQUIVALENT.
11. SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM.
12. CHECK DAMS: SHALL BE REQUIRED FOR OVER 4% SLOPE, SHALL BE SPACED AT A MAXIMUM 2-FOOT ELEVATION INTERVALS. MAINTAIN 4 - 10 INCH DEEP ROCK CHECK DAMS AT DESIGN INTERVALS.
13. SEASONAL HIGH GROUNDWATER SEPARATION:
   - SEPARATION DISTANCE AS REQUIRED BY WES.
14. SEE WES STANDARD DRAWINGS FOR LOCATING SWALES IN THE PUBLIC RIGHT-OF-WAY

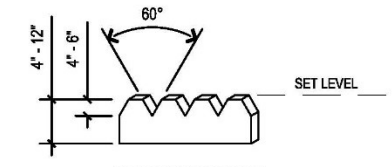
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS VEGETATED SWALE FILTRATION	STANDARD DRAWING SWM -05



GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   - DEPTH OF SWALE (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   - LONGITUDINAL SLOPE OF SWALE: 6.0% OR LESS
   - FLAT BOTTOM WIDTH: 2'
   - SIDE SLOPES OF SWALE: 3:1 MAXIMUM
3. SETBACKS:
   - INFILTRATION VEGETATED SWALES MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES.
4. OVERFLOW:
   - EMERGENCY OVERFLOW PATH FOR THE 100 YEAR DESIGN STORM SHALL BE IDENTIFIED ON THE STORMWATER MANAGEMENT PLAN.
5. DRAIN ROCK:
   - SIZE: 1 1/2" - 3/4"- WASHED
   - DEPTH: 18"
6. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. GROWING MEDIUM:
   - 18" MINIMUM
   - FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
8. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX F.
9. SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM.
10. CHECK DAMS: REQUIRED FOR OVER 4% SLOPE, SHALL BE SPACED AT A MAXIMUM 2-FOOT ELEVATION INTERVALS. MAINTAIN 4 - 10 INCH DEEP ROCK CHECK DAMS AT DESIGN INTERVALS.
11. SEASONAL HIGH GROUNDWATER SEPARATION:
    - SEPARATION DISTANCE AS REQUIRED BY WES.
12. SEE WES STANDARD DRAWINGS FOR LOCATING PLANTERS IN THE PUBLIC RIGHT-OF-WAY.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS VEGETATED SWALE INFILTRATION	STANDARD DRAWING SWM -06

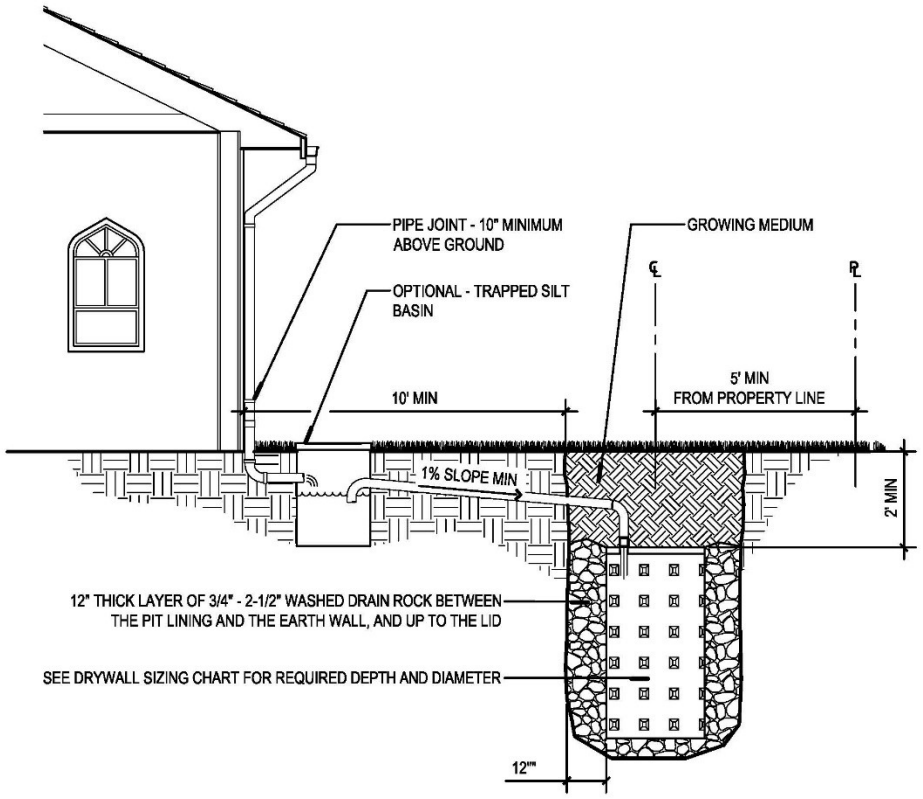


FLOW SPREADER DETAIL

GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   - LENGTH: 5' MINIMUM
   - SLOPE OF PLANTER: 0.5% -10%
3. SETBACKS:
   - FILTER STRIP MUST BE MINIMUM OF 5 FEET FROM PROPERTY LINE, 10 FT FROM BUILDINGS, 50 FT FROM WETLANDS, RIVERS, STREAMS, AND CREEKS.
4. OVERFLOW:
   - COLLECTION AND CONVEYANCE TO APPROVED DISCHARGE POINT MAY BE REQUIRED DEPENDING ON DESIGN.
   - WHERE REQUIRED, COLLECTION FROM FILTER STRIP SHALL BE SPECIFIED ON PLANS TO APPROVED DISCHARGE POINT ACCORDING TO WES STANDARDS.
5. GROWING MEDIUM:
   - UNLESS EXISTING VEGETATED AREAS ARE USED FOR THE FILTER STRIP, GROWING MEDIUM SHALL BE USED WITHIN THE TOP 18".
   - USE SAND/LOAM/COMPOST 3-WAY MIX OR APPROVED MIX THAT WILL SUPPORT HEALTHY PLANTS.
6. VEGETATION:
   - THE ENTIRE FILTER STRIP MUST HAVE 100% COVERAGE BY NATIVE GRASSES, NATIVE WILDFLOWER BLENDS, NATIVE GROUND COVERS, OR ANY COMBINATION THEREOF.
12. FLOW SPREADERS: A GRADE BOARD OR SAND/GRAVEL TRENCH MAY BE REQUIRED TO DISPERSE THE RUNOFF EVENLY ACROSS THE FILTER STRIP TO PREVENT A POINT OF DISCHARGE. THE TOP OF THE LEVEL SPREADER MUST BE HORIZONTAL AND AT AN APPROPRIATE HEIGHT TO PROVIDE SHEETFLOW DIRECTLY TO THE SOIL WITHOUT SCOUR. LEVEL SPREADERS SHALL NOT HOLD A PERMANENT VOLUME OF RUNOFF. GRADE BOARDS CAN BE MADE OF ANY MATERIAL THAT WILL WITHSTAND WEATHER AND SOLAR DEGRADATION. TRENCHES USED AS LEVEL SPREADERS CAN BE FILLED WITH WASHED CRUSHED ROCK, PEA GRAVEL, OR SAND.
13. CHECK DAMS: REQUIRED FOR OVER 4% SLOPE, SHALL BE SPACED AT A MAXIMUM 2-FOOT ELEVATION INTERVALS. MAINTAIN 4 TO 10 INCH DEEP ROCK CHECK DAMS AT DESIGN INTERVALS.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS FILTER STRIP	STANDARD DRAWING SWM -07



GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. SITING CRITERIA: GRAVELLY SAND, GRAVELLY LOAMY SAND OR OTHER EQUALLY POROUS MATERIAL MUST OCCUR IN A CONTINUOUS 5' DEEP STRATUM WITHIN 12' OF THE GROUND SURFACE. DRYWELL SHALL NOT BE PLACED WHERE BASE OF FACILITY HAS LESS THAN 5' OF SEPARATION TO WATER TABLE.
3. SIZING: DRYWELL SIZING CHART IS USED TO SIZE THE DRYWELL(S) BASED ON IMPERVIOUS AREA.
4. TOP OF DRYWELL MUST BE BELOW LOWEST FINISHED FLOOR.
5. SETBACKS: DRYWELL MUST BE 10' FROM FOUNDATIONS, 5' FROM PROPERTY LINES, AND 20' FROM CESSPOOLS.
6. PIPING MUST BE CAST IRON, ABS OR PVC. 3" PIPE REQUIRED FOR FACILITIES DRAINING UP TO 1500 SF, OTHERWISE 4" MINIMUM PIPE. UNIFORM PLUMBING CODE ALSO APPLIES.
7. TRAPPED SILT BASIN: OPTIONAL FOR ROOF RUNOFF OR PEDESTRIAN ONLY PAVED AREAS.

DRYWELL SIZING CHART

ONCE APPROVAL HAS BEEN GIVEN FOR ON-SITE INFILTRATION OF STORMWATER, THE FOLLOWING CHART SHALL BE USED TO SELECT THE NUMBER AND SIZE OF DRYWELLS. GRAY BOXES ARE ACCEPTABLE.

IMPERVIOUS AREA (SQ-FT)	28" DIAMETER DRYWELL DEPTH				48" DIAMETER DRYWELL DEPTH			
	5'	10'	15'	20'	5'	10'	15'	20'
1000								
2000								
3000								
4000								
5000								
6000								
7000								
8000								
9000								
10000								

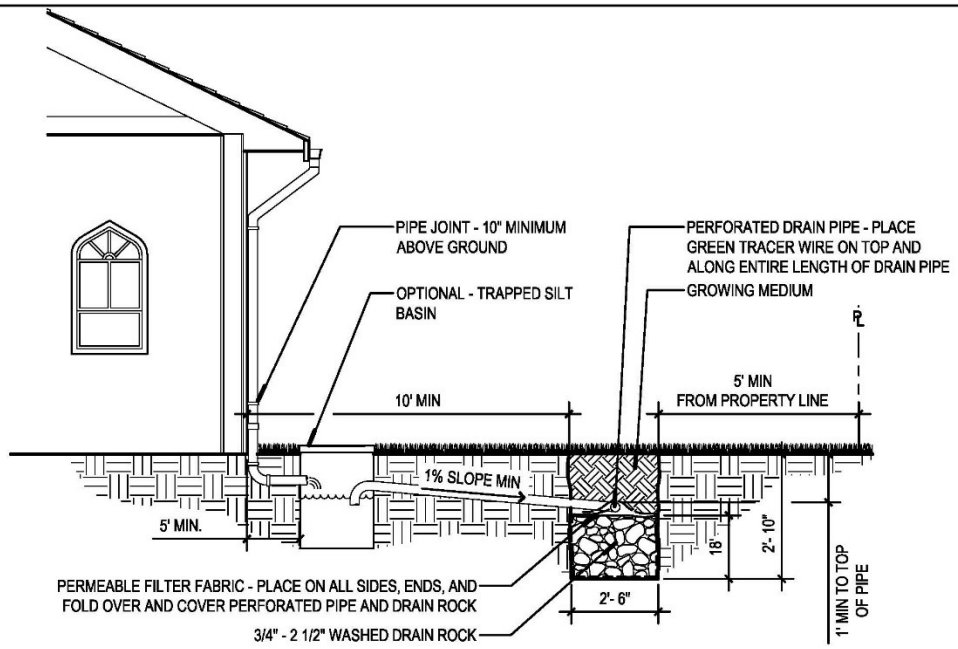
CLACKAMAS WATER ENVIRONMENT SERVICES

CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045

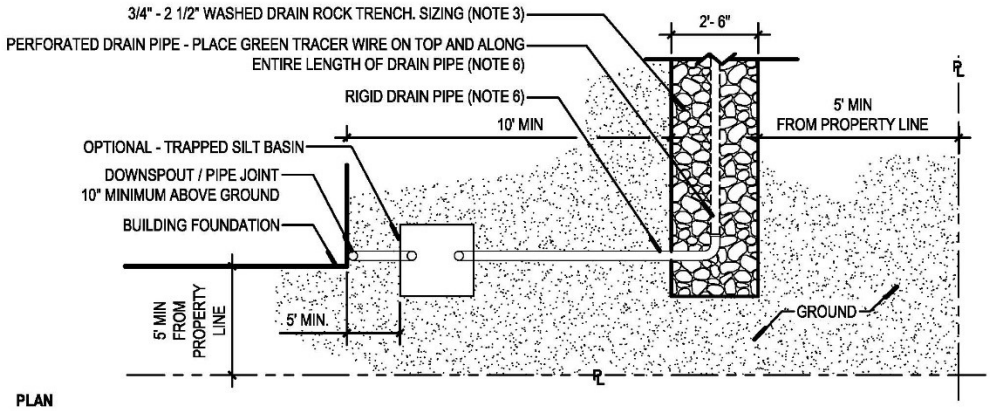
DATE: July, 2022 SCALE: NTS

SIMPLIFIED DESIGN APPROACH DRYWELL

STANDARD DRAWING
SWM -08



SECTION

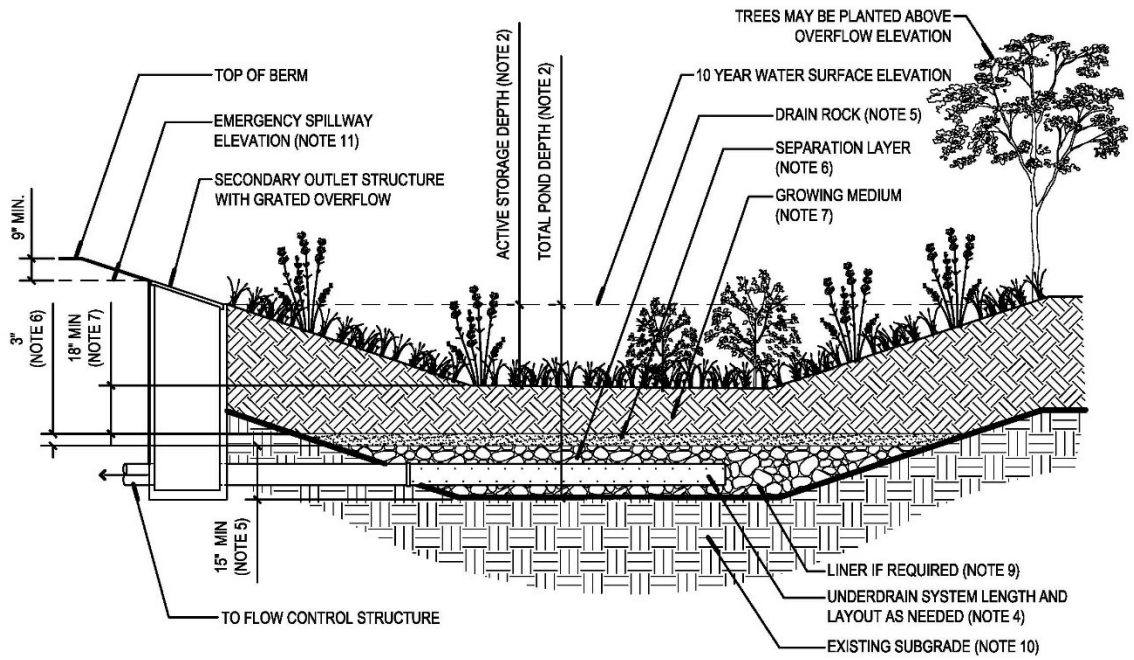


PLAN

GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. SITING CRITERIA: INFILTRATION RATE MUST BE 2" PER HOUR MINIMUM. INFILTRATION TRENCH SHALL NOT BE PLACED WHERE BASE OF FACILITY HAS LESS THAN 5' SEPARATION TO WATER TABLE.
3. SIZING: 2'-6" WIDE X 1'-6" TALL X 20' LONG PER 1000 SQUARE FEET OF IMPERVIOUS SURFACE.
4. SETBACKS: SOAKAGE TRENCH MUST BE 10' FROM FOUNDATIONS, 5' FROM PROPERTY LINES, AND 20' FROM CESSPOOLS.
6. PIPING MUST BE CAST IRON, ABS OR PVC. 3" PIPE REQUIRED FOR FACILITIES DRAINING UP TO 1500 SF, OTHERWISE 4" MINIMUM PIPE. UNIFORM PLUMBING CODE ALSO APPLIES.
7. TRAPPED SILT BASIN: OPTIONAL FOR ROOF RUNOFF OR PEDESTRIAN ONLY PAVED AREAS.

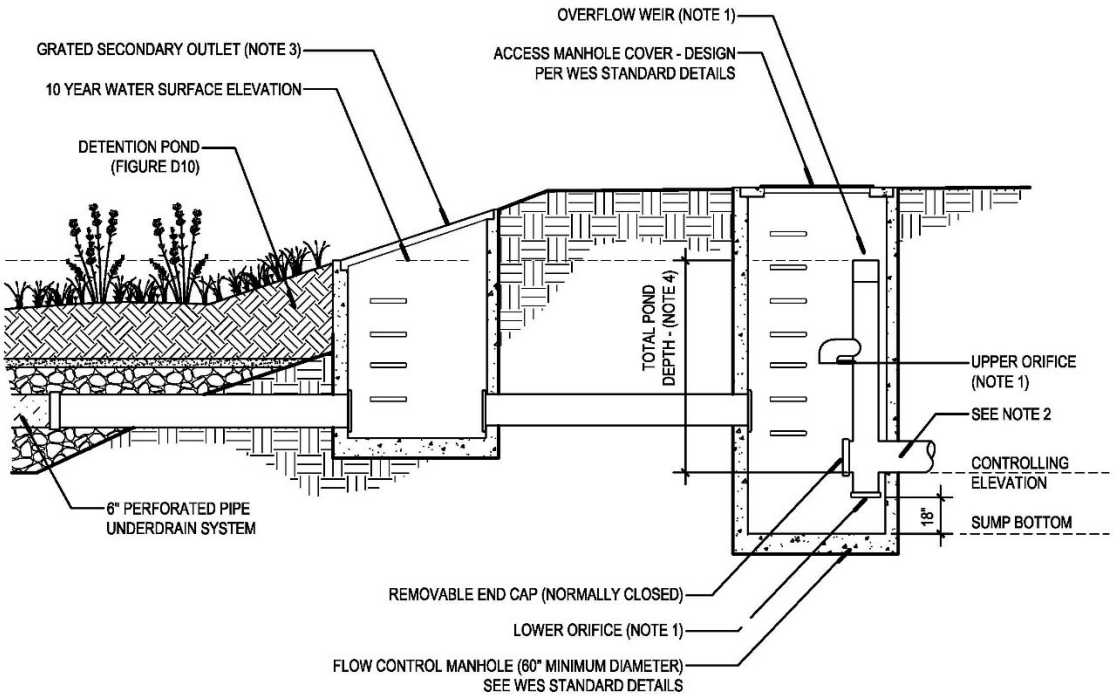
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS SIMPLIFIED DESIGN APPROACH INFILTRATION TRENCH	STANDARD DRAWING SWM -09



GENERAL NOTES:

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED PONDS ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. DIMENSIONS:
   - ACTIVE STORAGE DEPTH (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): PER FACILITY SIZING MODEL
   - TOTAL POND DEPTH: 4' MINIMUM, PER FACILITY SIZING MODEL
   - BOTTOM SLOPE: 2.0% OR LESS
   - SIDE SLOPES OF DETENTION POND: 3:1 MAXIMUM
3. SETBACKS:
   - DETENTION POND MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. PIPING:
   - PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON OR PVC SCH. 40. 6" MINIMUM DIAMETER. PIPING MUST HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
5. DRAIN ROCK:
   - SIZE: 1 1/2" - 3/4" WASHED
   - DEPTH: 15" MINIMUM
6. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. GROWING MEDIUM:
   - 18" MINIMUM
8. VEGETATION: FOLLOW LANDSCAPE PLANS
9. WATERPROOF LINER (IF REQUIRED): SHALL BE 30 MIL PVC OR EQUIVALENT FOR DETENTION POND.
10. SEASONAL HIGH GROUNDWATER SEPARATION:
    - SEPARATION DISTANCE AS REQUIRED BY WES.
11. EMERGENCY SPILLWAY SIZED TO CONVEY THE 100 - YEAR DESIGN STORM. PROVIDE 6" MINIMUM FREEBOARD ABOVE THE 100 - YEAR DESIGN STORM.

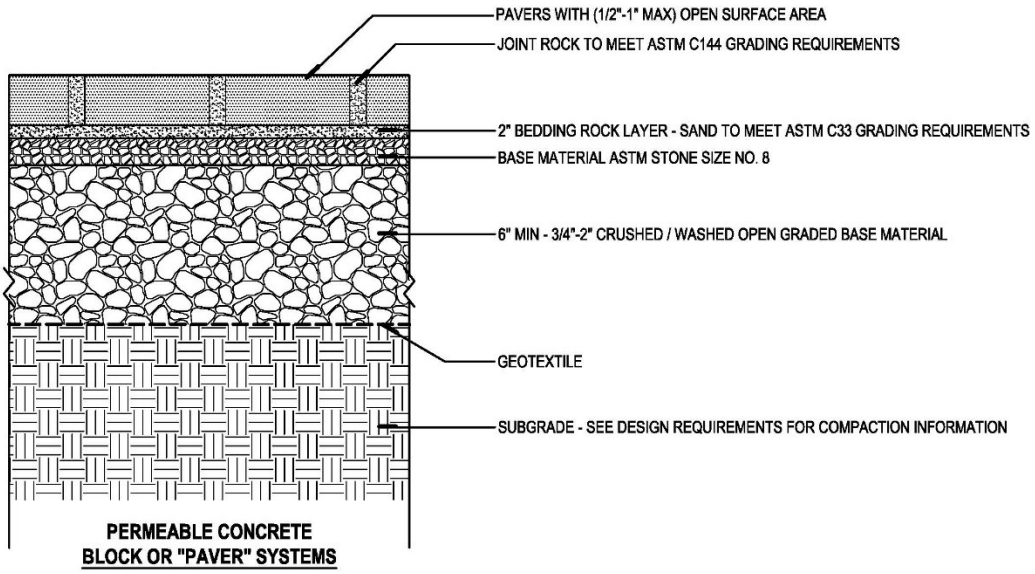
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS DETENTION POND	STANDARD DRAWING SWM -10



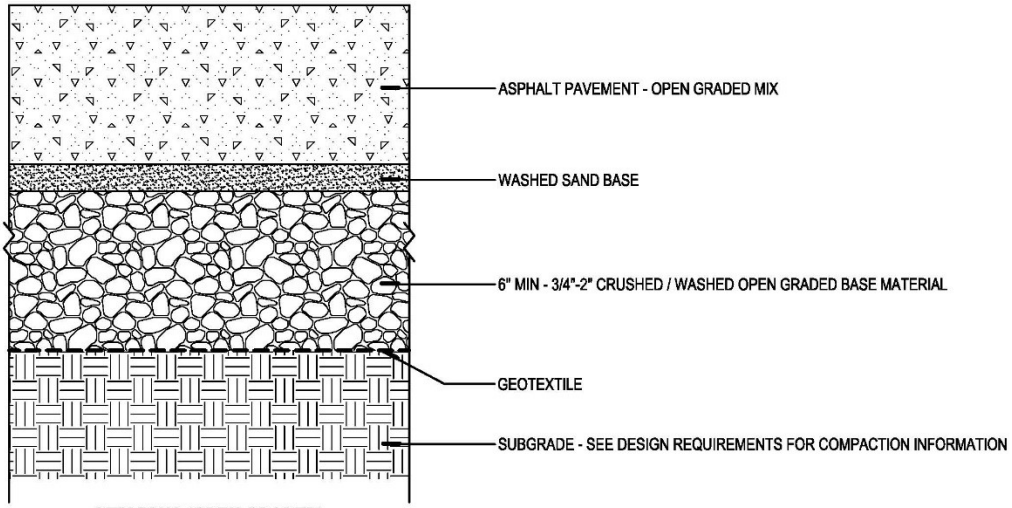
GENERAL NOTES:

1. ORIFICE AND WEIR DIMENSIONS AND ELEVATION DETERMINED THROUGH FACILITY SIZING MODEL.
2. PIPE SIZING DETERMINED BY ENGINEER.
3. SECONDARY OUTLET SIZED FOR PEAK DESIGN STORM.
4. TOTAL POND DEPTH - PER FACILITY SIZING MODEL, INCLUDES GROWING MEDIA, SEPARATION LAYER, AND DRAIN ROCK AS SHOWN ON FIGURE D1.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS DETENTION POND FLOW CONTROL STRUCTURE	STANDARD DRAWING SWM -11



PERMEABLE CONCRETE BLOCK OR "PAVER" SYSTEMS

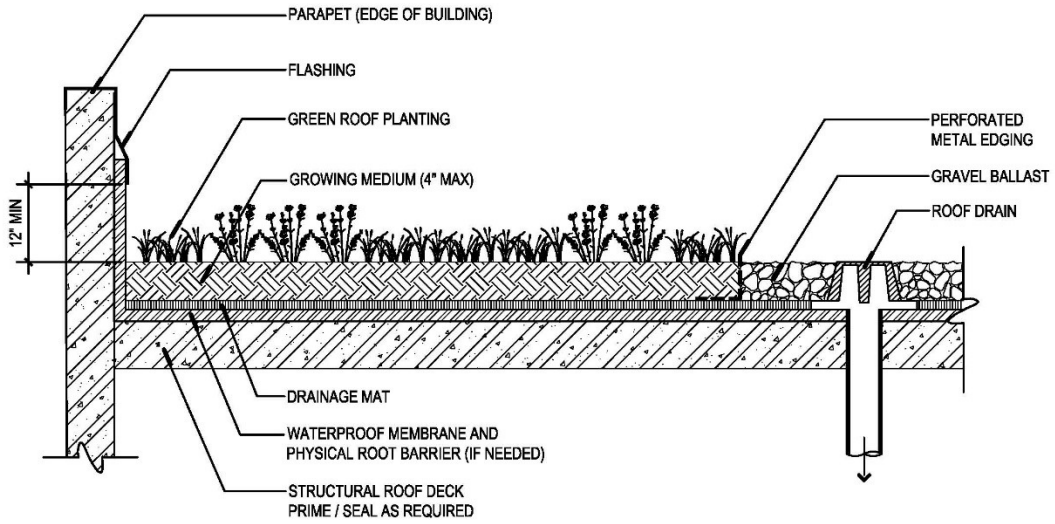


PERVIOUS (OPEN GRADED) CONCRETE SYSTEMS

GENERAL NOTES:

1. DESIGN ENGINEER SHALL SUBMIT PERVIOUS PAVEMENT DESIGN AND SPECIFICATIONS IN CONFORMANCE WITH INDUSTRY STANDARDS.
2. PAVERS SHALL HAVE AN AVERAGE COMPRESSIVE STRENGTH OF 8,000 PSI. - NO INDIVIDUAL UNIT LESS THAN 7,200 PSI. MINIMUM 80 MM THICKNESS.
3. PAVERS SHALL BE BANDED BY CONCRETE EDGE RESTRAINTS.
4. MANHOLE COLLARS PER WES STANDARD DETAIL.

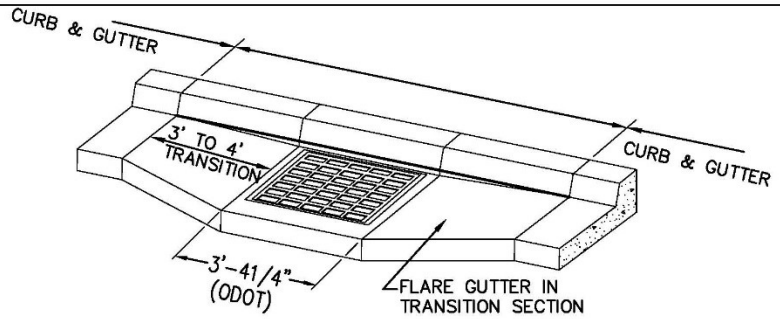
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July, 2022 SCALE: NTS PERVIOUS PAVEMENT	STANDARD DRAWING SWM -12



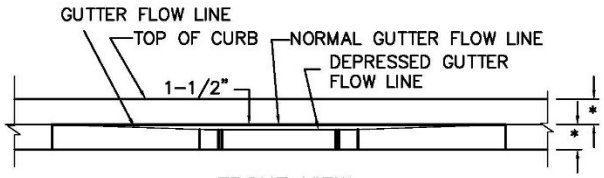
GENERAL NOTES:

1. DESIGN ENGINEER OR LANDSCAPE ARCHITECT SHALL SUBMIT GREEN ROOF DESIGN AND SPECIFICATIONS IN CONFORMANCE WITH INDUSTRY STANDARDS.

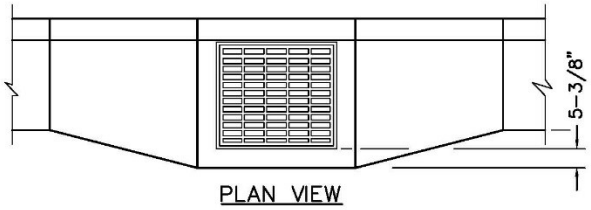
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	DATE: July 2022 SCALE: NTS GREEN ROOF	STANDARD DRAWING SWM -13



NOTE:
TOP SLAB SHOWN WITH GUTTER TRANSITION FLARE.
MATCH THE TOP FRONT EDGE OF THE FRAME AND THE TOP FRONT EDGE OF THE TOP SLAB TO THE NORMAL PAVEMENT GRADE.

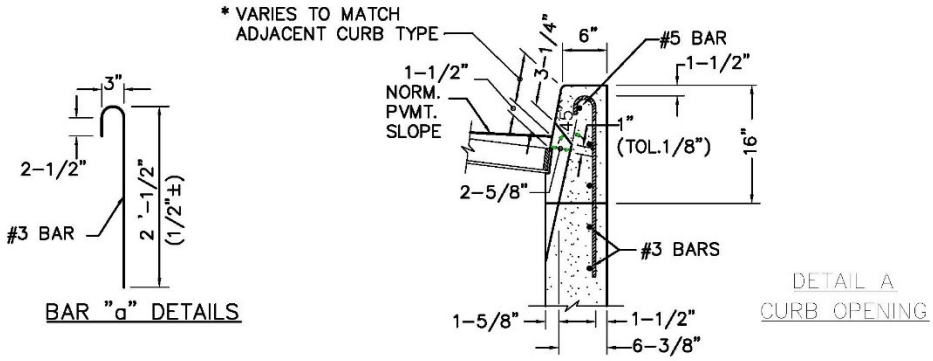


FRONT VIEW

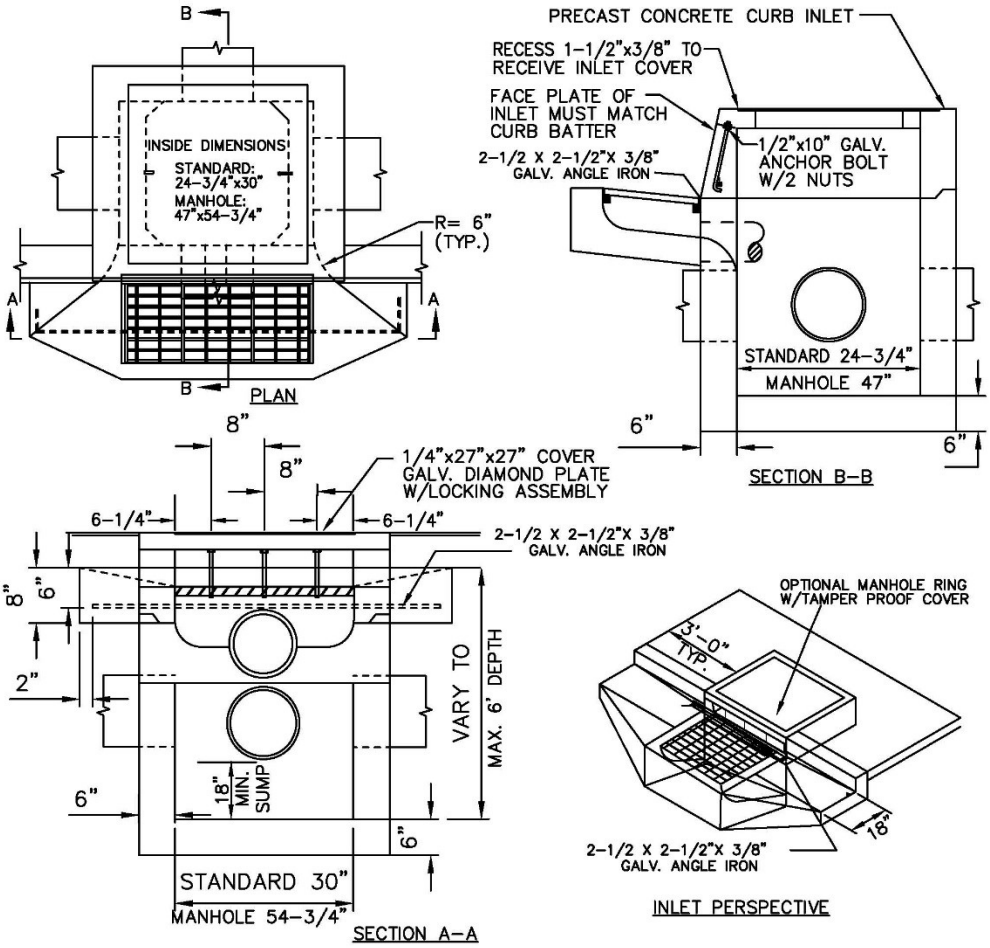


PLAN VIEW

CURB AND GUTTER TRANSITION SECTION



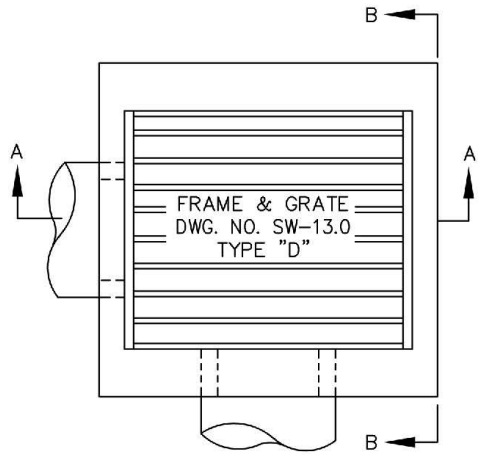
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July 2022 *SCALE:* N.T.S. **CB CURB AND GUTTER DETAIL**	*STANDARD DRAWING* **SWM -14**



NOTES

1. CURB INLET CATCH BASIN SHALL CONFORM TO CURRENT ODOT/APWA SPECIFICATION. THE INLET SHALL HAVE AN 8" CURB EXPOSURE AT THE GRATE.
2. GRATED INLET SHALL BE POURED IN PLACE, A SHALLOW PRECAST INLET, OR A COMBINATION INLET GUTTER PLATE WITH LID (NEENAH R-3335-B CURB PIECE OR APPROVED EQUAL.)
3. CONNECT THE GRATED INLET TO THE CATCH BASIN BY A MINIMUM 12" DIAMETER CONCRETE PIPE GROUTED INTO BOTH SECTONS. A SLOT MAY BE USED IF THE CURB INLET SECTION IS PRECAST AND DESIGNED TO CARRY THE LOADING. A METAL CURB PIECE MAY BE USED.
4. THE CURB INLET CATCH BASIN MAY USE A GB INLET WITH A SINGLE GRATE.
5. AN 18" SUMP IS REQUIRED.
6. ALL METAL PARTS MUST BE HOT DIPPED GALVANIZED AFTER FABRICATION.
7. THE LATCH SPRING MUST HAVE 50 LB. OF COMPRESSIVE STRENGTH.
8. SPECIFICATIONS FOR CONCRETE AND MISC. MATERIALS USED IN CONSTRUCTION SHALL CONFORM TO THE CURRENT ODOT/APWA STANDARD SPECIFICATIONS.
9. CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3300 PSI IN 28 DAYS.

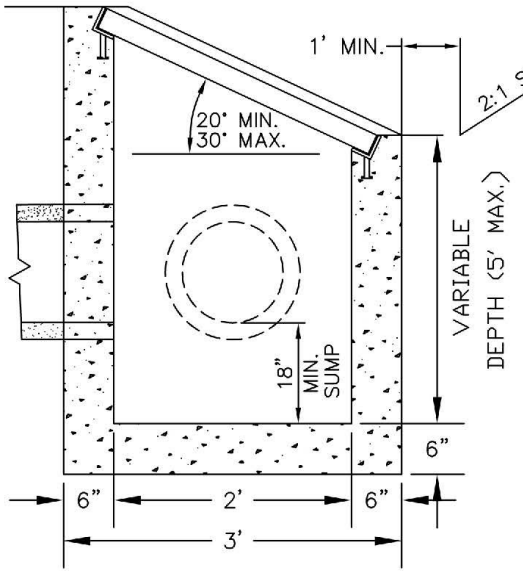
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. CB CURB INLET	*STANDARD DRAWING* SWM -15



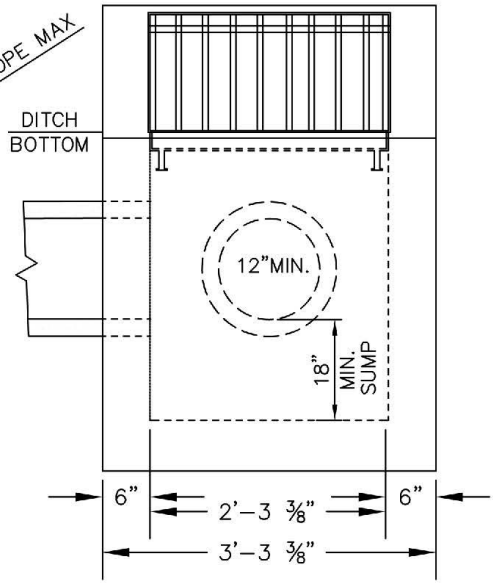
PLAN

NOTES

1. SPECIFICATIONS FOR CONCRETE AND MISC. MATERIALS USED IN CONSTRUCTION SHALL CONFORM TO THE CURRENT APWA STANDARD SPECIFICATIONS.
2. CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3300 PSI IN 28 DAYS.
3. REFER TO ODOT STANDARD DRAWING RD370 FOR MORE INFORMATION.



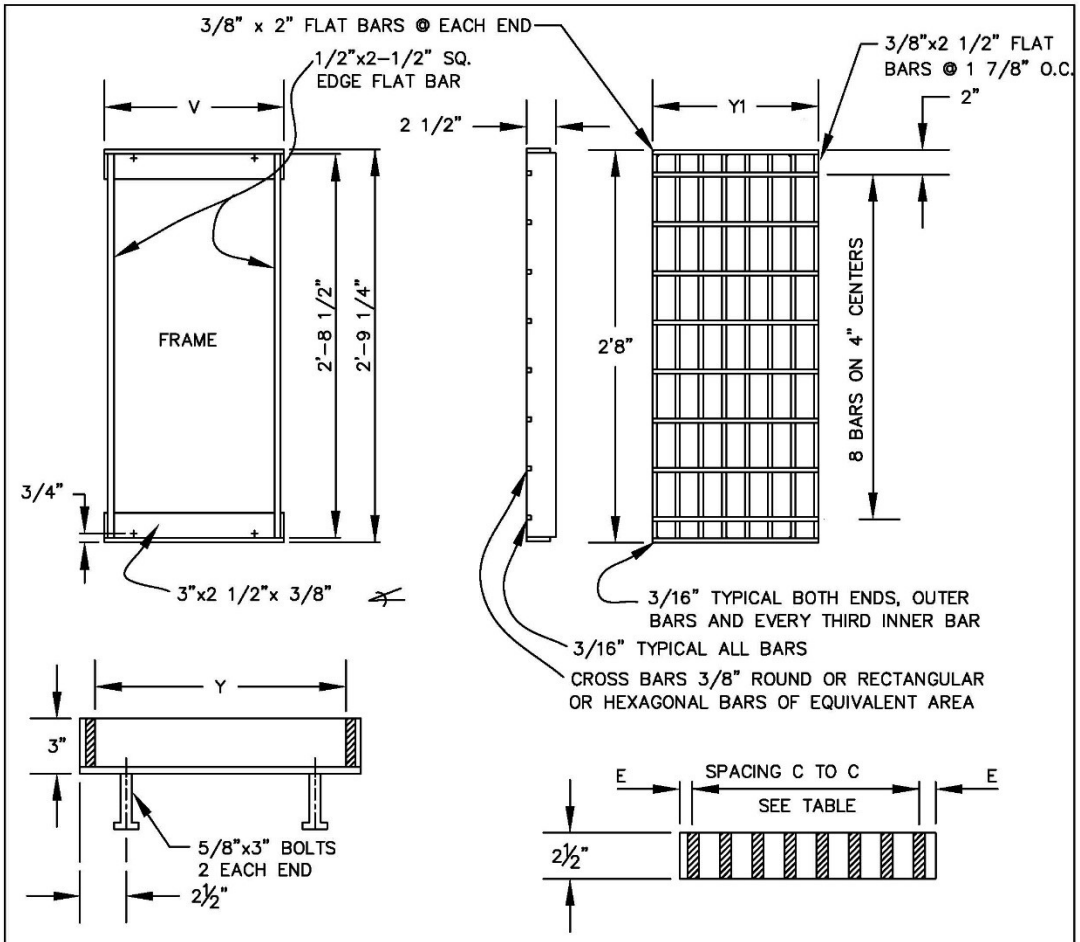
SECTION A–A



SECTION B–B

NOTE: PROVIDE 6" OF COMPACTED CRUSHED ROCK BELOW STRUCTURE

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. CB DITCH INLET	*STANDARD DRAWING* SWM -16

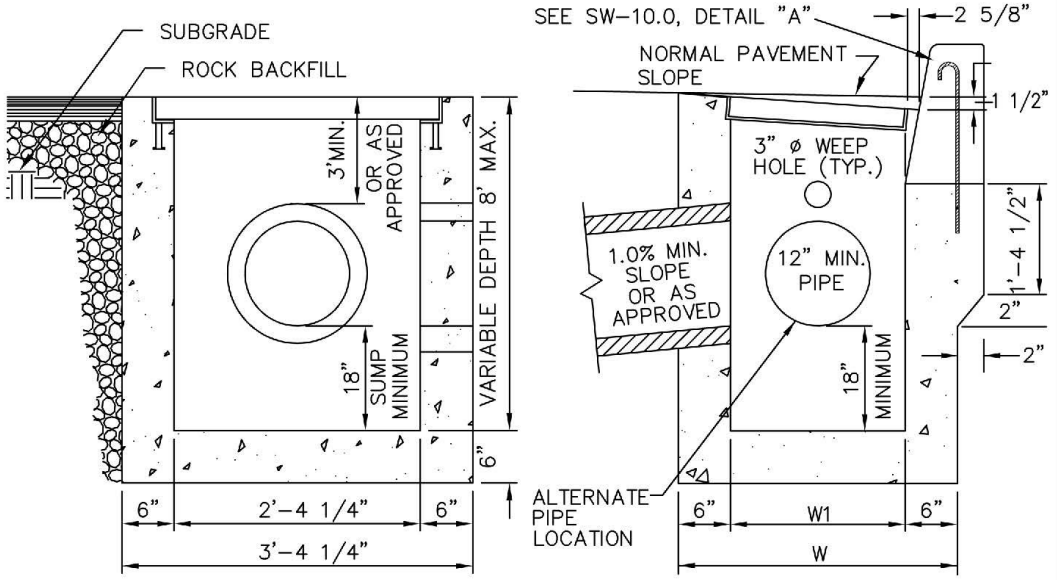


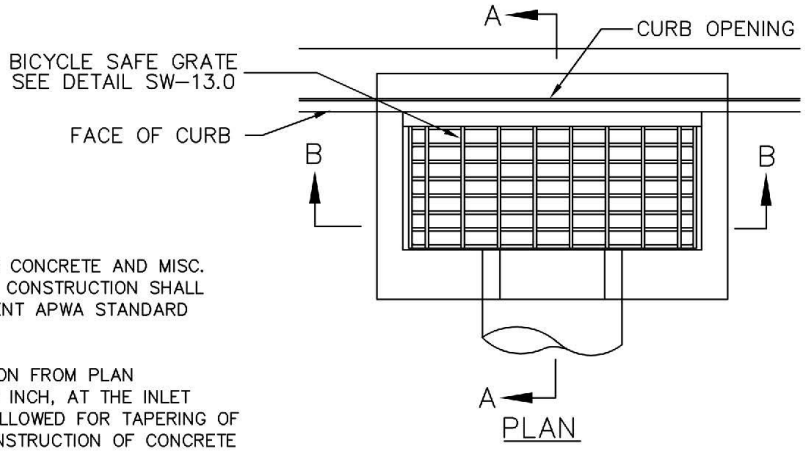
CATCH BASIN TYPE	V	Y	Y1	E	SPACING C TO C	NO. OF BARS PER GRATE	REMARKS
GB–2	2'–4 3/4"	2'–3 3/8"	1'–1 1/2"	5/8"	1 3/4"	8	2–GRATES
D	2'–4 3/4"	2'–3 3/8"	2'–3"	1 1/2"	3"	9	
GB	1'–3 1/4"	1'–1 7/8"	1'–1 1/2"	5/8"	1 3/4"	8	1–GRATE

NOTES

1. MATERIALS AND FABRICATION SHALL CONFORM TO THE CURRENT APWA STANDARD SPECIFICATIONS.
2. 3/8" CROSS BARS SHALL BE FLUSH WITH THE GRATE SURFACE AND MAY BE FILLET WELDED, RESISTANCE WELDED OR ELECTROFORGED TO BEARING BARS.
3. GB CATCH BASIN FOR USE WITH CURB INLET CATCH BASIN WITH GRATE ONLY.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. CB FRAME AND GRATE	*STANDARD DRAWING* SWM -17





NOTES

1. SPECIFICATIONS FOR CONCRETE AND MISC. MATERIALS USED IN CONSTRUCTION SHALL CONFORM TO CURRENT APWA STANDARD SPECIFICATIONS.
2. A MAXIMUM DEVIATION FROM PLAN DIMENSIONS OF ONE INCH, AT THE INLET FLOOR, SHALL BE ALLOWED FOR TAPERING OF FORMS USED IN CONSTRUCTION OF CONCRETE INLETS.
3. REFER TO CURRENT ODOT/APWA OREGON STATE CHAPTER DRAWING RD 366.
4. THE OUTSIDE DIAMETER OF THE PIPE MATERIAL SHALL NOT EXCEED 28".
5. PROVIDE 6" OF COMPACTED CRUSHED ROCK BELOW STRUCTURE.

CATCH BASIN TYPE	W	W1
GB-2	3' 3-3/8"	2' 3-3/8"

GB-1 NOT ALLOWED

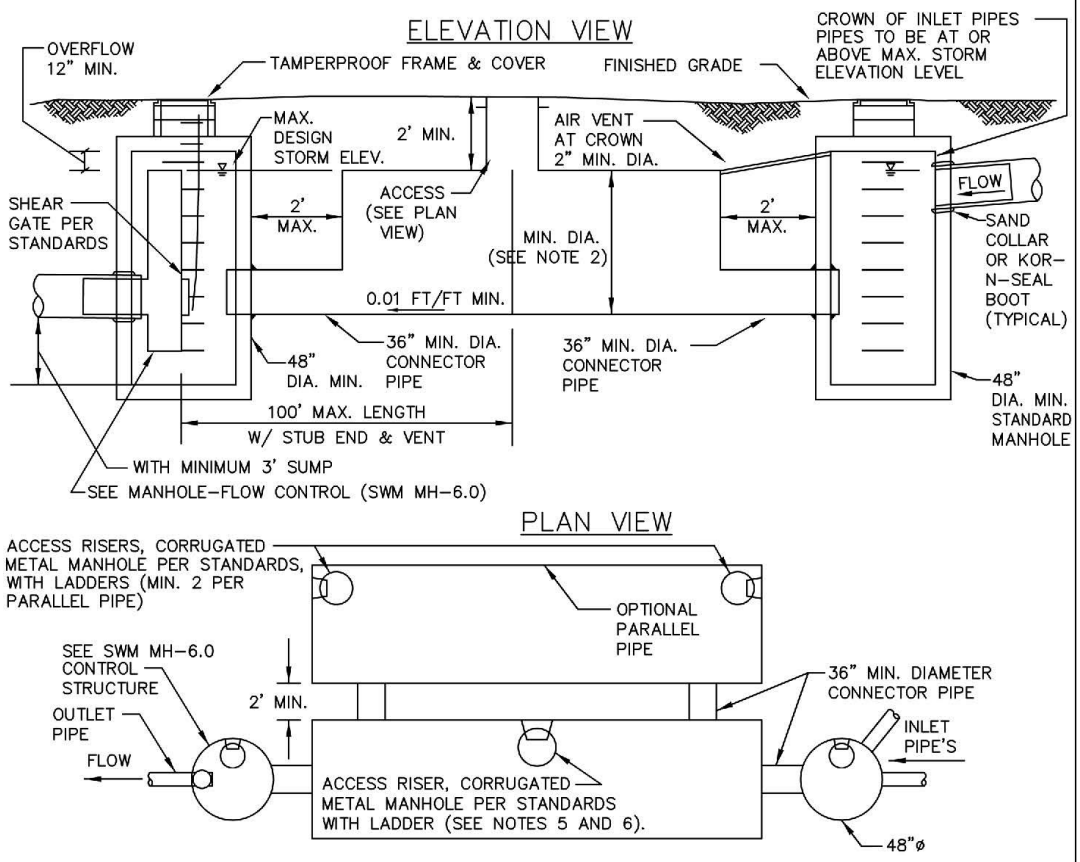
CLACKAMAS WATER ENVIRONMENT SERVICES

CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045

APPROVAL DATE: July, 2022 *SCALE:* N.T.S.

CB STANDARD GB2

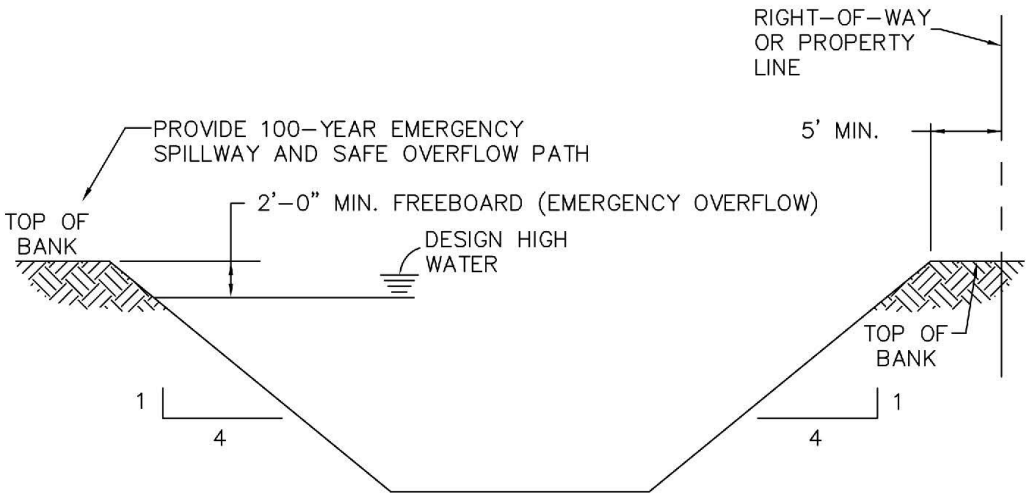
STANDARD DRAWING
SWM -18



NOTES:

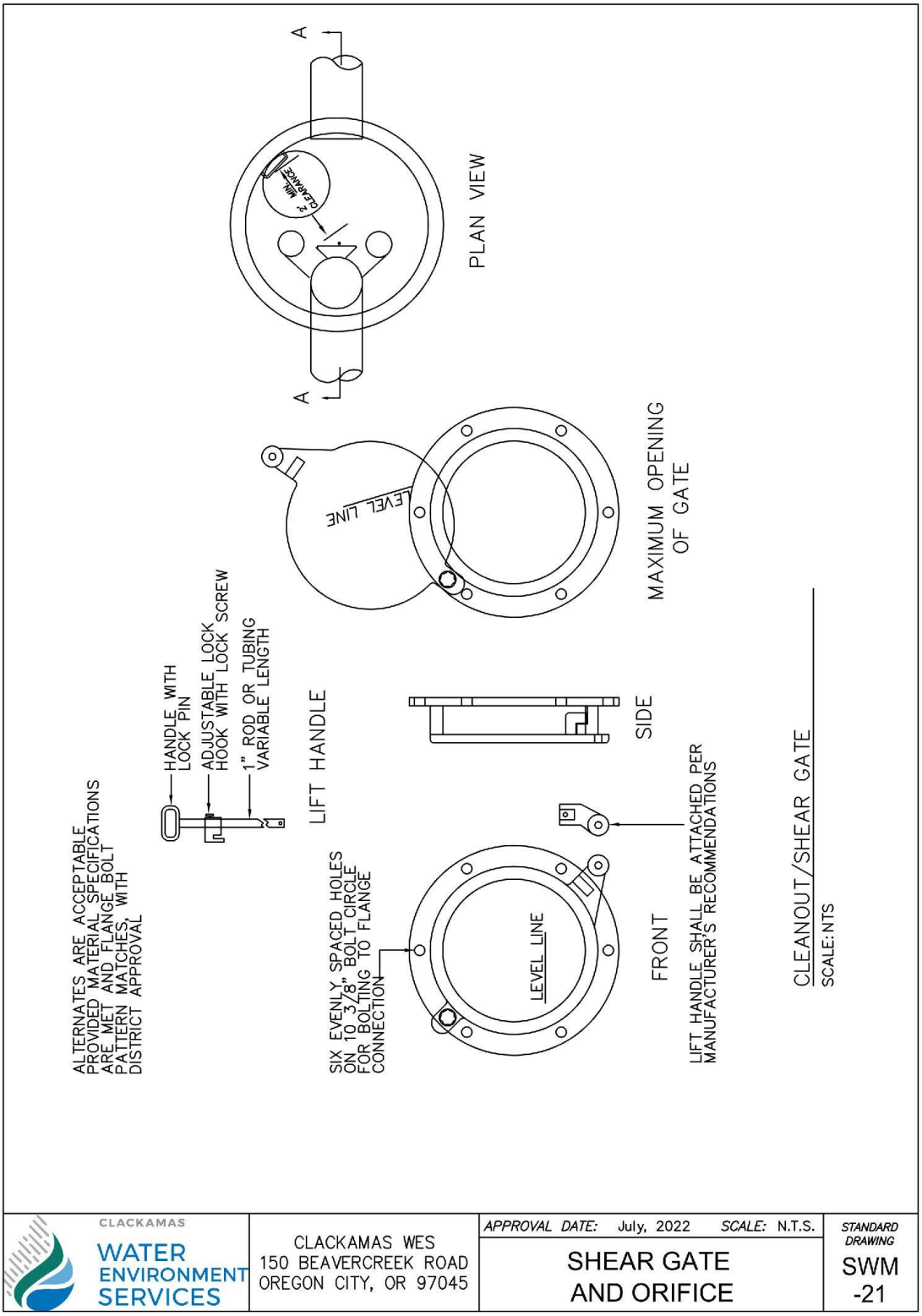
1. NEOPRENE GASKETS REQUIRED AT ALL CMP AND CPE PIPE JOINTS.
2. 36" MINIMUM PIPE DIAMETER. PROVIDE 48"ø MANHOLES AT EACH END OF PIPE (CONC. PUBLIC, CMP WITH DISTRICT APPROVAL).
3. ALL METAL PARTS AND SURFACES SHALL BE CORROSION RESISTANT. STEEL HARDWARE SHALL BE GALVANIZED. PIPE SHALL BE ALUMINIZED. COMPLETE CORROSION PROTECTION MUST BE ASSURED.
4. CAPACITY OF OUTLET PIPE MUST BE EQUAL TO OR GREATER THAN ALL INLET PIPES COMBINED.
5. ACCESS RISERS REQUIRED CENTERED OVER EVERY 100' OF DETENTION PIPE WHEN 48"ø MANHOLES ARE PROVIDED ON EACH END, OR AT EITHER END OF A 100' LONG PARALLEL PIPE AS SHOWN ABOVE.
6. IN AREAS WITH VEHICULAR TRAFFIC, PROVIDE TRAFFIC BEARING ACCESS (HS-20) OVER CORRUGATED METAL MANHOLE.
7. PENETRATE CARRIER PIPE THROUGH VAULT WALL.
8. USE APPROVED WATERTIGHT STRUCTURE ADAPTOR.
9. NO FLOW CONTROL JOINT OUTSIDE OF STRUCTURE.

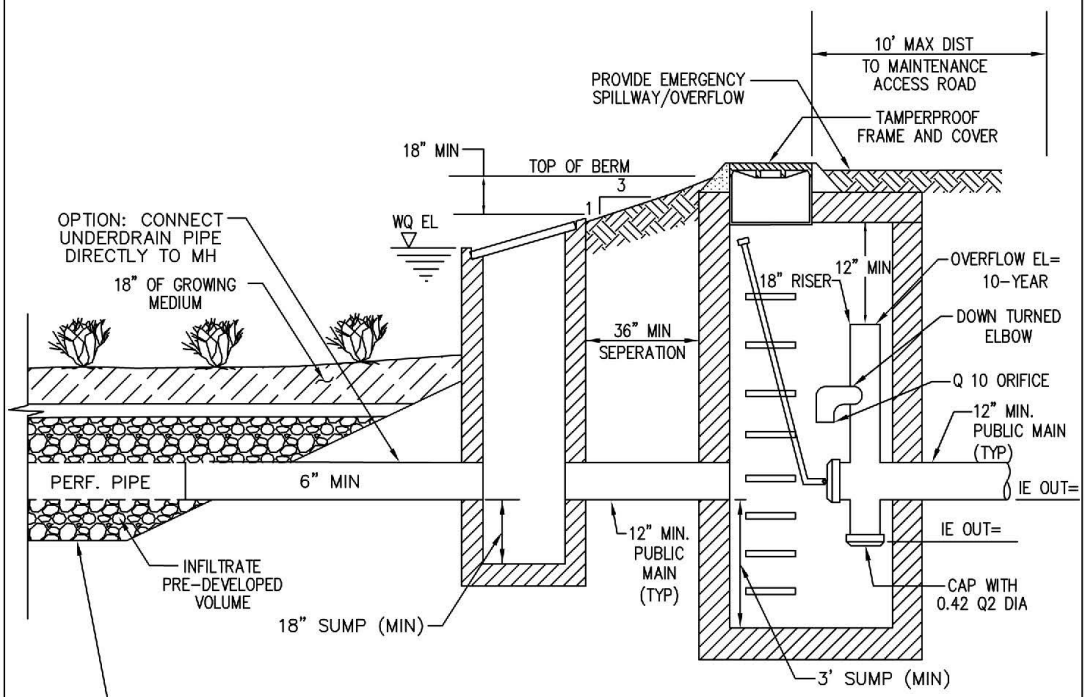
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. DETENTION TANK DIAGRAM	*STANDARD DRAWING* SWM -19



STANDARD DETENTION POND

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. POND DIAGRAM	*STANDARD DRAWING* SWM -20


A
A
2" MIN. CLEARANCE
PLAN VIEW
LEVEL LINE
MAXIMUM OPENING OF GATE
HANDLE WITH LOCK PIN
ADJUSTABLE LOCK HOOK WITH LOCK SCREW
1" ROD OR TUBING VARIABLE LENGTH
LIFT HANDLE
SIDE
ALTERNATES ARE ACCEPTABLE PROVIDED MATERIAL SPECIFICATIONS ARE MET AND FLANGE BOLT PATTERN MATCHES, WITH DISTRICT APPROVAL
SIX EVENLY SPACED HOLES ON 10 3/8" BOLT CIRCLE FOR BOLTING TO FLANGE CONNECTION
LEVEL LINE
FRONT
LIFT HANDLE SHALL BE ATTACHED PER MANUFACTURER'S RECOMMENDATIONS
CLEANOUT/SHEAR GATE
SCALE: NTS
CLACKAMAS
WATER ENVIRONMENT SERVICES
CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045
APPROVAL DATE: July, 2022
SCALE: N.T.S.
SHEAR GATE AND ORIFICE
STANDARD DRAWING
SWM -21



WATER QUALITY MEDIA UNDERDRAIN AND INFILTRATION STORAGE NOT REQUIRED IF FACILITY IS DESIGNED FOR FLOW CONTROL ONLY.
IE OUT PIPE SHALL BE SIZED TO CONVEY 25-YEAR STORM.

PIPE OUTLET STRUCTURE			
PIPE DIAMETER		STRUCTURE	
I.E. IN	I.E. OUT	TYPE	DRW
6" – 15"	6" – 15"	DI	SW-12.0
> 15"	> 15"	MH	SW-17.0

FLOW CONTROL MANHOLE			
PIPE DIAMETER		STRUCTURE	
I.E. IN	I.E. OUT	TYPE	SIZE
12" – 15"	12" – 15"	MH	48"
> 15"	> 15"	MH	60"

6"ø MIN. FOR PRIVATE MAINTAINED SYSTEMS
8"ø MIN. FOR PUBLIC MAINTAINED SYSTEMS

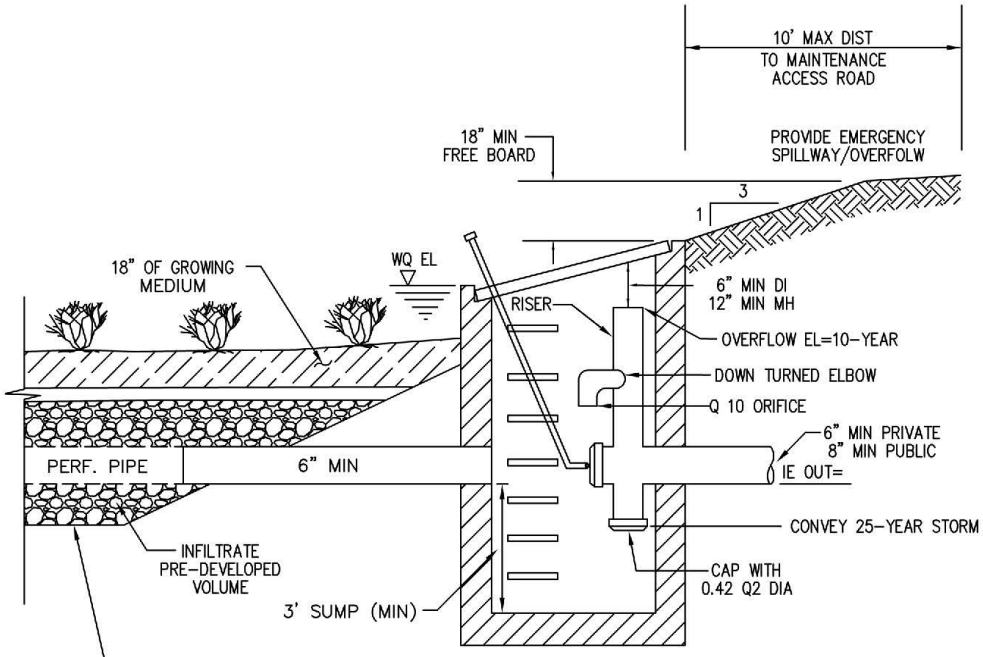
CLACKAMAS WATER ENVIRONMENT SERVICES

CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045

APPROVAL DATE: July, 2021 *SCALE:* N.T.S.

FLOW CONTROL STRUCTURE TYPE 1

STANDARD DRAWING SWM -22

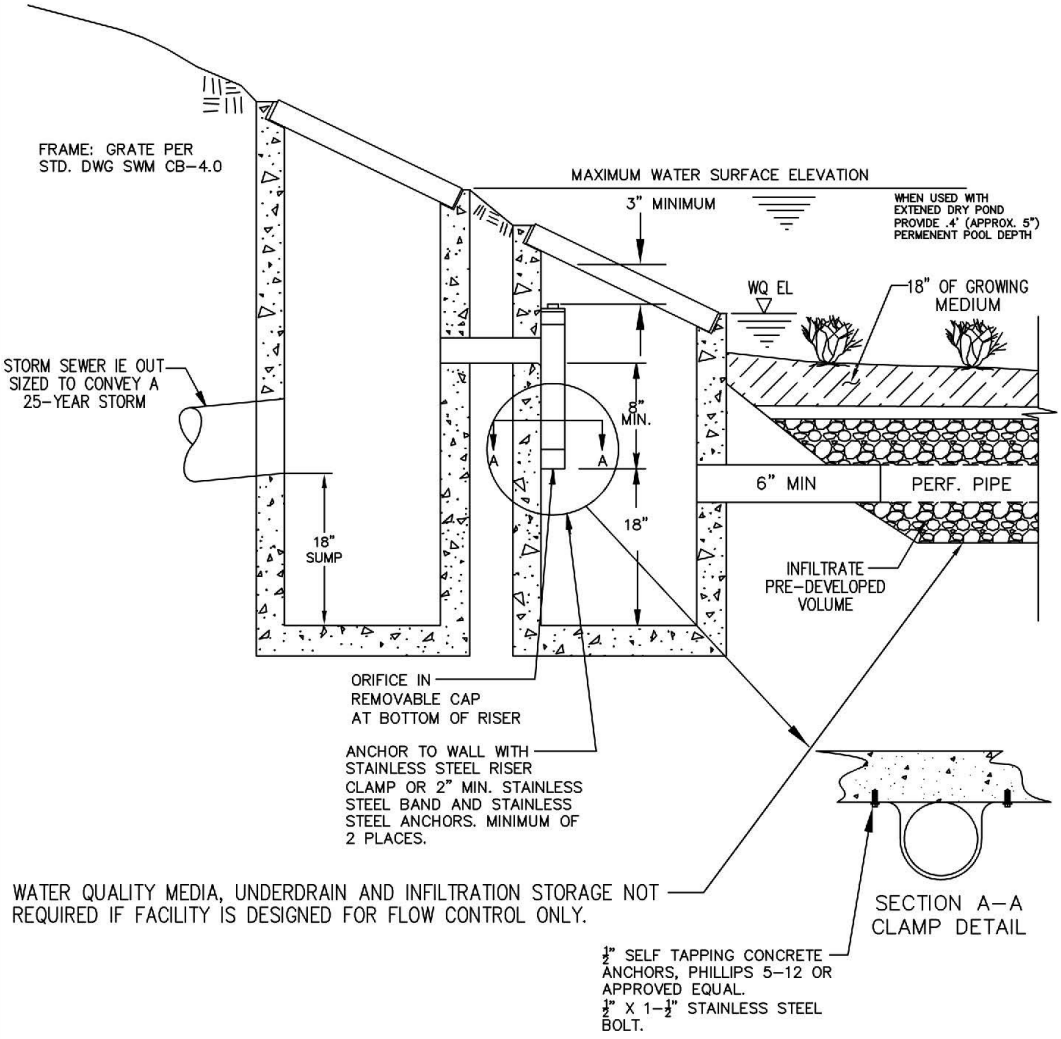


WATER QUALITY MEDIA UNDERDRAIN AND INFILTRATION STORAGE NOT REQUIRED IF FACILITY IS DESIGNED FOR FLOW CONTROL ONLY.
IE OUT PIPE SHALL BE SIZED TO CONVEY 25-YEAR STORM.

FLOW CONTROL STRUCTURE			
PIPE DIAMETER		STRUCTURE	
I.E. IN	I.E. OUT	TYPE	DRW
6" MIN	6" – 8"	DI	CB-3.0
6" MIN	> 8" MIN	MH	MH-6.0
6" MIN	> 15"	MH	MH-6.0

6"ø MIN. FOR PRIVATE MAINTAINED SYSTEMS
8"ø MIN. FOR PUBLIC MAINTAINED SYSTEMS

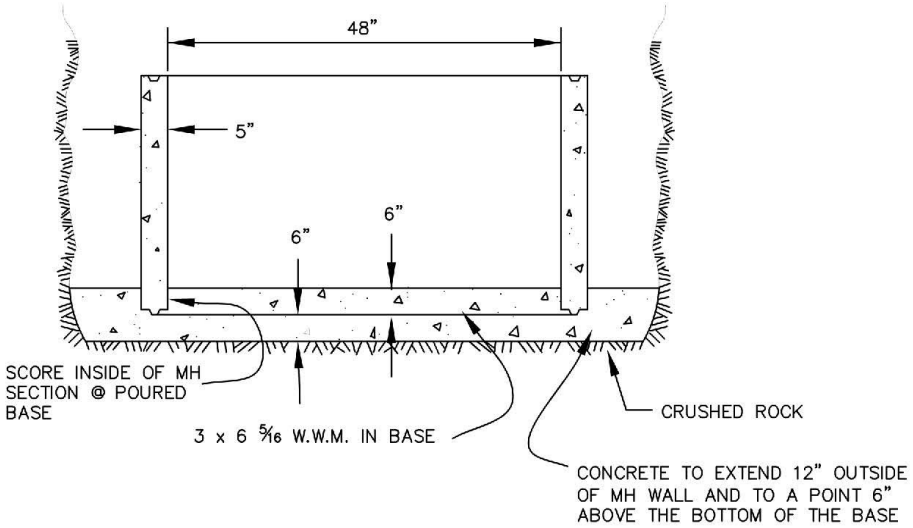
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. FLOW CONTROL STRUCTURE TYPE 2	*STANDARD DRAWING* SWM -23



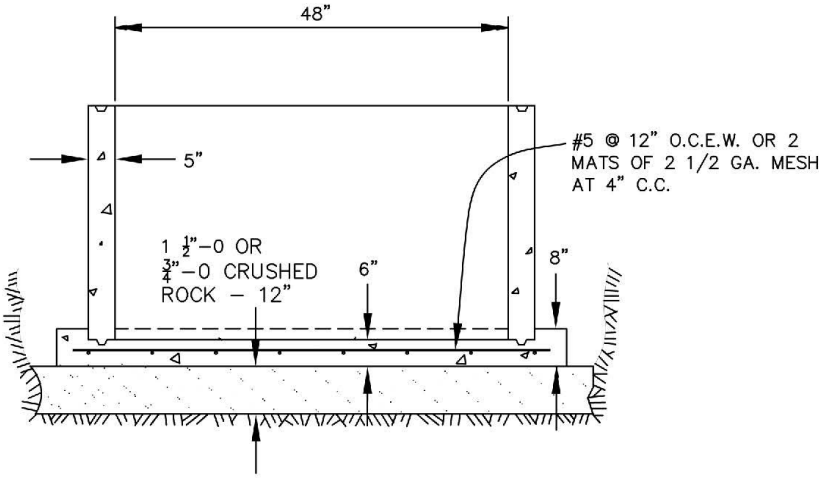
NOTES:

1. CONNECTING PIPE AND TEE SHALL BE 4", 6", OR 8" AWWA C-900 OR ASTM 3034 PVC, AND ONE SIZE LARGER THAN THE ORIFICE OPENING.
2. MAXIMUM ORIFICE OPENING SHALL BE 6" DIAMETER.
3. STRUCTURES TYPE AND SIZE SHALL CONFORM WITH DETAIL SWM FC-5.0.
4. FRAME AND GRATE SHALL CONFORM TO CATCH BASIN-FRAME AND GRATE (DETAIL SWM CB-4.0).
5. SUBMERGED ORIFICE AND RISER SHALL BE SECURED FLUSH AGAINST WALL OF STRUCTURE AS APPROVED.
6. MAINTAINANCE ACCESS REQUIRED TO WITHIN 10' OF CENTER OF BOTH STRUCTURES AND EDGE OF MAINTENANCE ACCESS ROAD.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. FLOW CONTROL STRUCTURE TYPE 3	*STANDARD DRAWING* SWM -24



POURED IN PLACE MANHOLE BASE

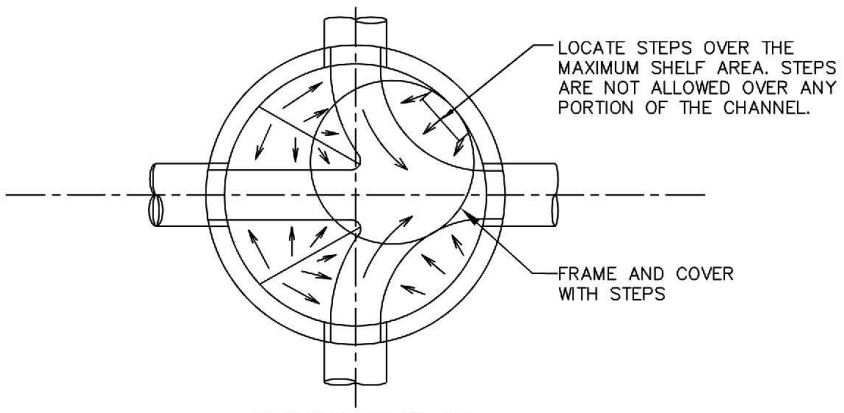


PRE-CAST MANHOLE BASE

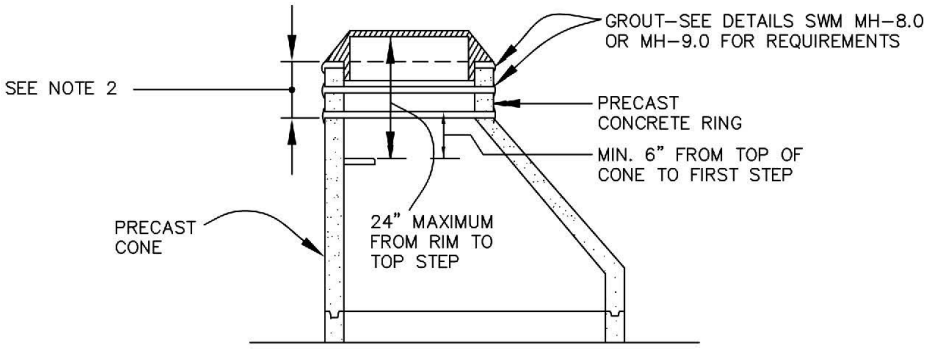
NOTES

1. SPECIFICATIONS FOR CONCRETE AND MISCELLANEOUS MATERIALS USED IN CONSTRUCTION SHALL CONFORM TO CURRENT ODOT/APWA STANDARD SPECIFICATIONS.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MANHOLE BASE	*STANDARD DRAWING* SWM -25



GENERAL PLAN OF CHANNEL INTERSECTION

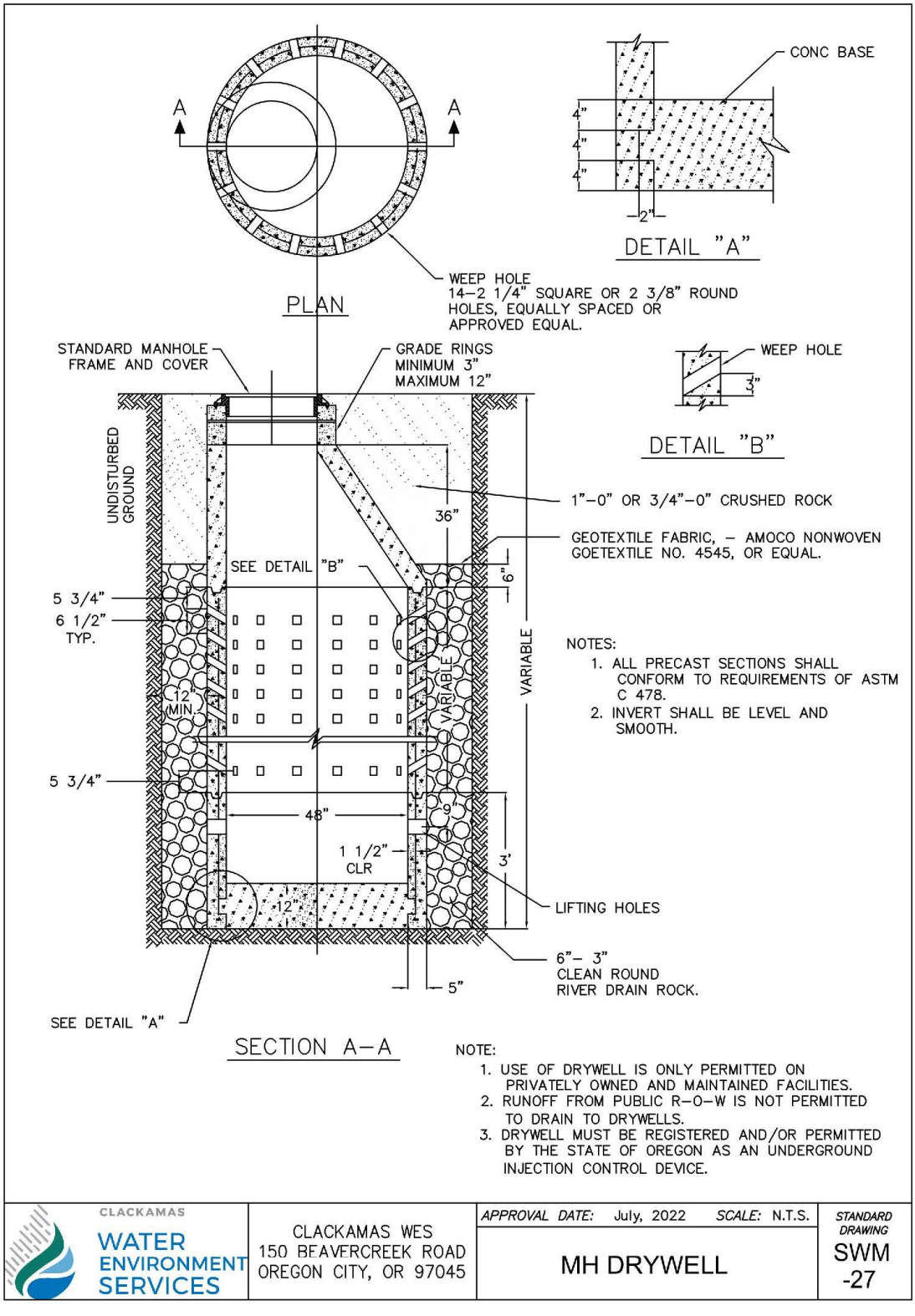


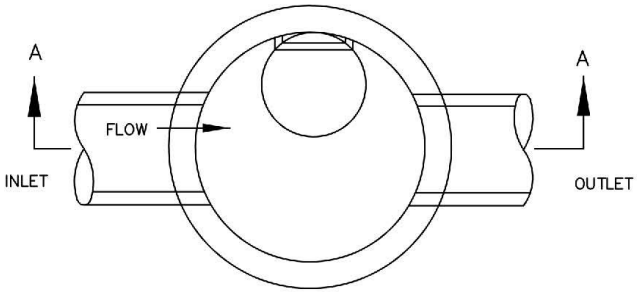
PRECAST RING EXTENSION

NOTES

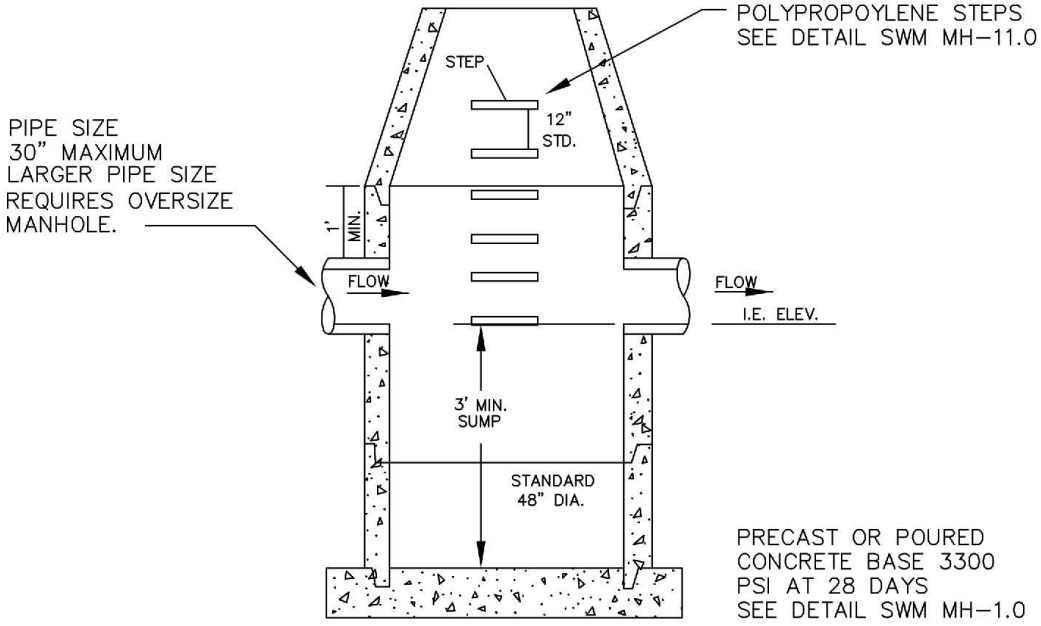
1. SPECIFICATIONS FOR CONCRETE AND MISCELLANEOUS MATERIALS USED IN CONSTRUCTION SHALL CONFORM TO CURRENT APWA STANDARD SPECIFICATIONS.
2. NUMBER OF RISER RINGS ALLOWED SHALL NOT EXCEED 12" MAXIMUM.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MH CHANNEL AND RING EXTENSION	*STANDARD DRAWING* SWM -26


A
A
PLAN
WEEP HOLE
14–2 1/4" SQUARE OR 2 3/8" ROUND
HOLES, EQUALLY SPACED OR
APPROVED EQUAL.
CONC BASE
4"
4"
4"
2"
DETAIL "A"
STANDARD MANHOLE
FRAME AND COVER
GRADE RINGS
MINIMUM 3"
MAXIMUM 12"
WEEP HOLE
3"
DETAIL "B"
UNDISTURBED
GROUND
1"–0" OR 3/4"–0" CRUSHED ROCK
36"
GEOTEXTILE FABRIC, – AMOCO NONWOVEN
GOETEXTILE NO. 4545, OR EQUAL.
SEE DETAIL "B"
6"
5 3/4"
6 1/2"
TYP.
VARIABLE
VARIABLE
12"
(MIN.)
5 3/4"
48"
9"
1 1/2"
CLR
3'
12"
LIFTING HOLES
6"– 3"
CLEAN ROUND
RIVER DRAIN ROCK.
5"
SEE DETAIL "A"
SECTION A–A
NOTES:
1. ALL PRECAST SECTIONS SHALL CONFORM TO REQUIREMENTS OF ASTM C 478.
2. INVERT SHALL BE LEVEL AND SMOOTH.
NOTE:
1. USE OF DRYWELL IS ONLY PERMITTED ON PRIVATELY OWNED AND MAINTAINED FACILITIES.
2. RUNOFF FROM PUBLIC R–O–W IS NOT PERMITTED TO DRAIN TO DRYWELLS.
3. DRYWELL MUST BE REGISTERED AND/OR PERMITTED BY THE STATE OF OREGON AS AN UNDERGROUND INJECTION CONTROL DEVICE.
CLACKAMAS
WATER ENVIRONMENT SERVICES
CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045
APPROVAL DATE: July, 2022
SCALE: N.T.S.
MH DRYWELL
STANDARD DRAWING
SWM -27



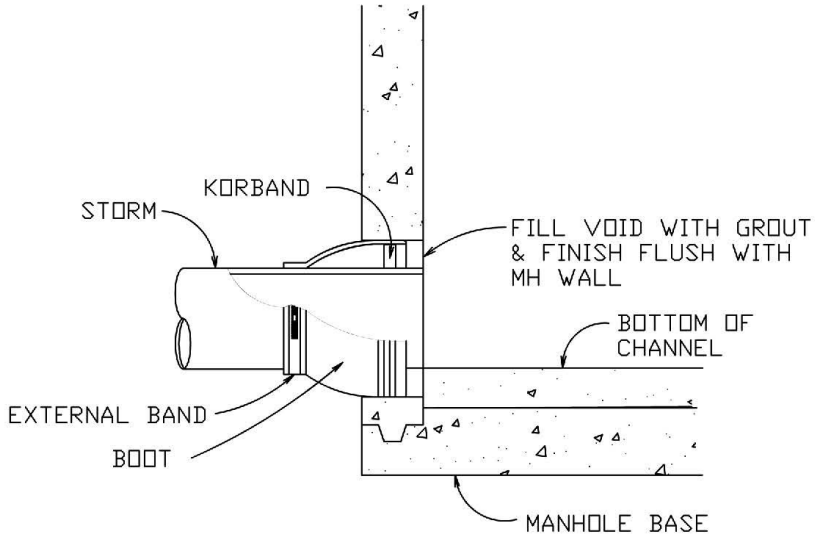
PLAN



SECTION A–A

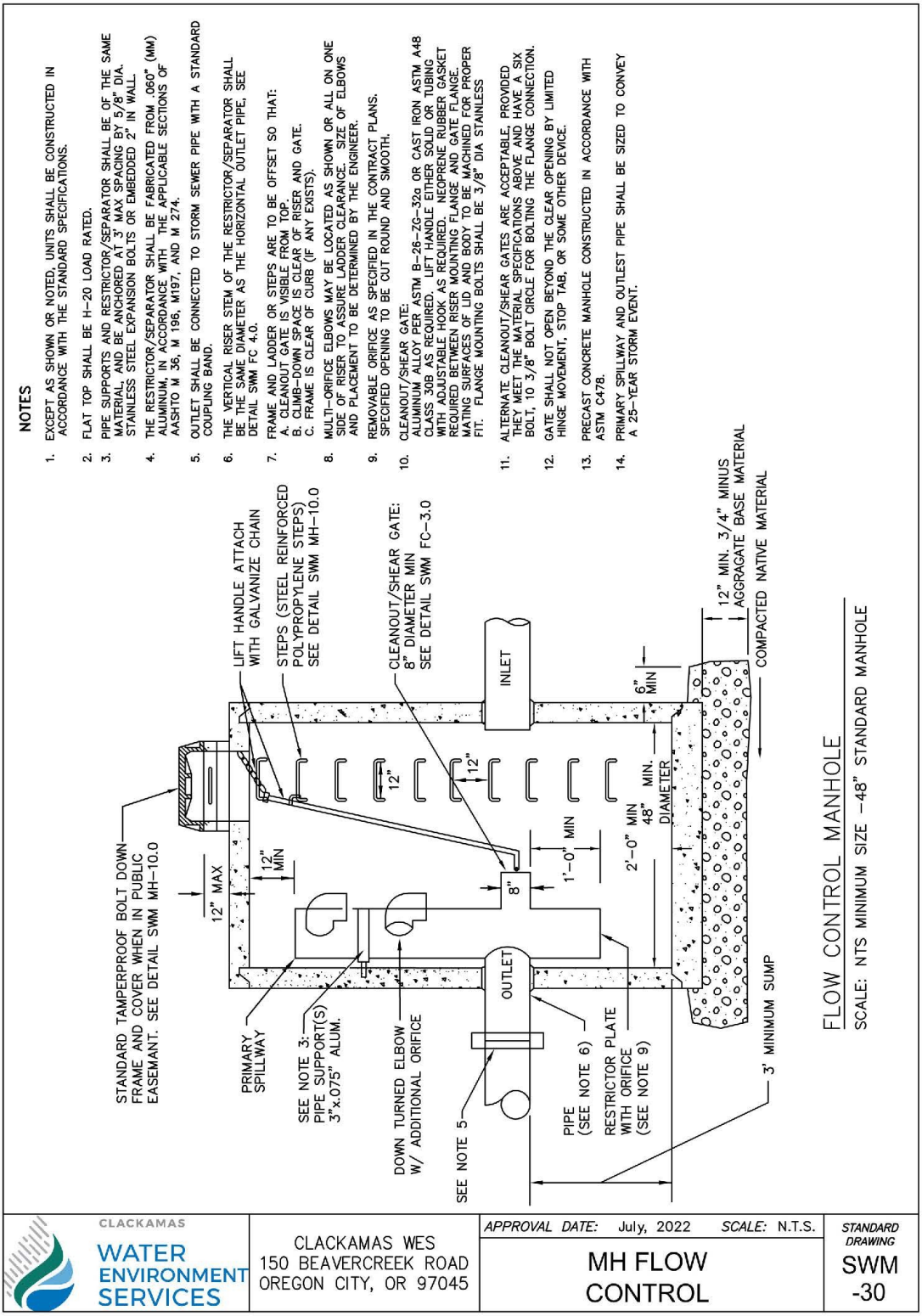
NOTE: PROVIDE 6" OF COMPACTED CRUSHED ROCK BELOW STRUCTURE

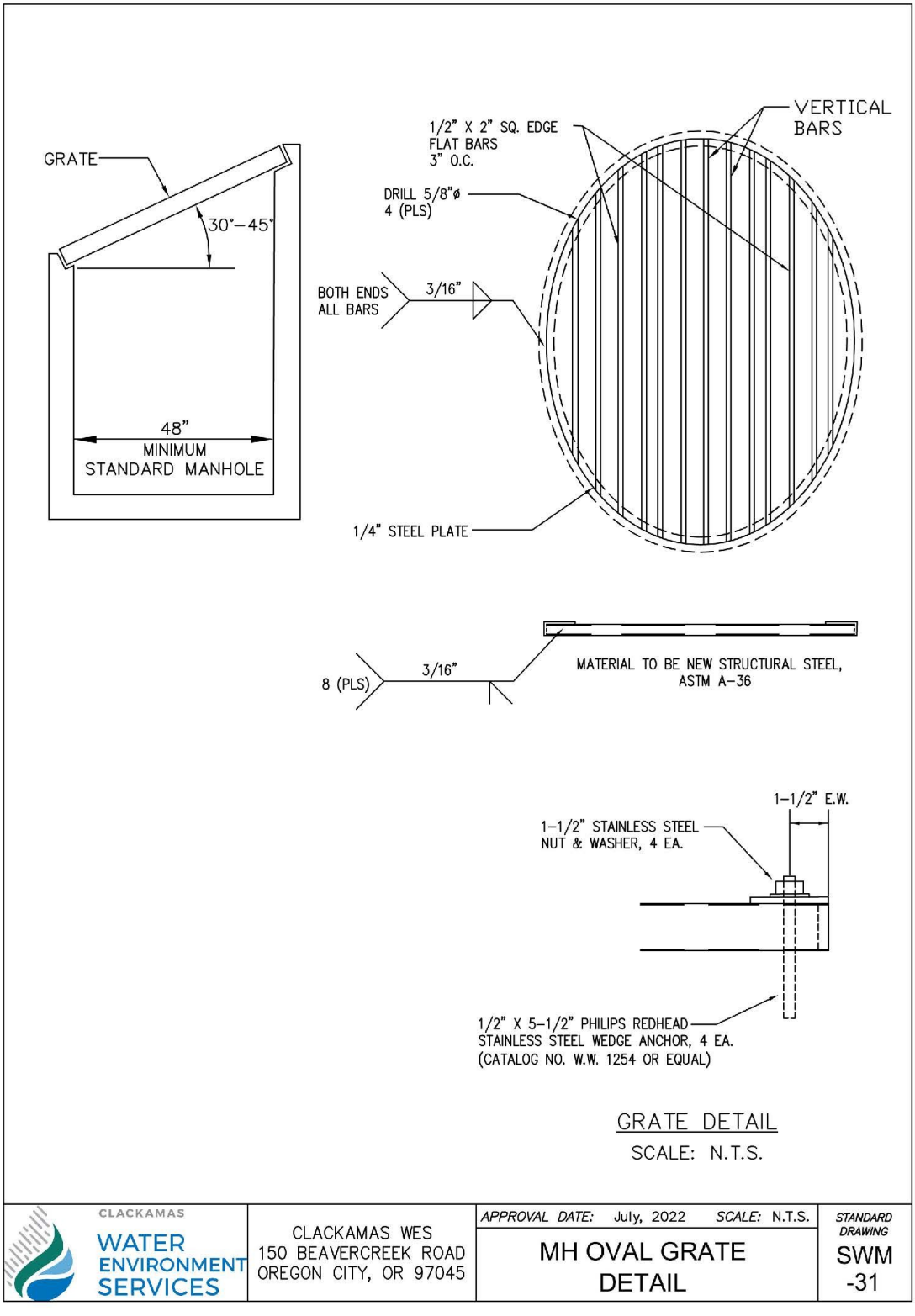
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MH ENERGY DISSIPATOR	*STANDARD DRAWING* SWM -28



FLEXIBLE MANHOLE CONNECTION
(KOR-N-SEAL OR EQUAL)

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MH FLEXIBLE CONNECTION	*STANDARD DRAWING* SWM -29

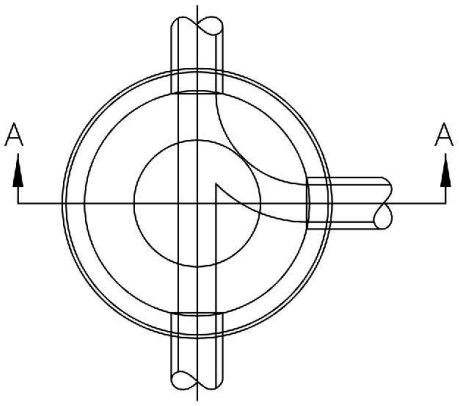

NOTES
1. EXCEPT AS SHOWN OR NOTED, UNITS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS.
2. FLAT TOP SHALL BE H-20 LOAD RATED.
3. PIPE SUPPORTS AND RESTRICTOR/SEPARATOR SHALL BE OF THE SAME MATERIAL, AND BE ANCHORED AT 3' MAX SPACING BY 5/8" DIA. STAINLESS STEEL EXPANSION BOLTS OR EMBEDDED 2" IN WALL.
4. THE RESTRICTOR/SEPARATOR SHALL BE FABRICATED FROM .060" (MM) ALUMINUM, IN ACCORDANCE WITH THE APPLICABLE SECTIONS OF AASHTO M 36, M 196, M197, AND M 274.
5. OUTLET SHALL BE CONNECTED TO STORM SEWER PIPE WITH A STANDARD COUPLING BAND.
6. THE VERTICAL RISER STEM OF THE RESTRICTOR/SEPARATOR SHALL BE THE SAME DIAMETER AS THE HORIZONTAL OUTLET PIPE, SEE DETAIL SWM FC 4.0.
7. FRAME AND LADDER OR STEPS ARE TO BE OFFSET SO THAT:
A. CLEANOUT GATE IS VISIBLE FROM TOP.
B. CLIMB-DOWN SPACE IS CLEAR OF RISER AND GATE.
C. FRAME IS CLEAR OF CURB (IF ANY EXISTS).
8. MULTI-ORIFICE ELBOWS MAY BE LOCATED AS SHOWN OR ALL ON ONE SIDE OF RISER TO ASSURE LADDER CLEARANCE. SIZE OF ELBOWS AND PLACEMENT TO BE DETERMINED BY THE ENGINEER.
9. REMOVABLE ORIFICE AS SPECIFIED IN THE CONTRACT PLANS. SPECIFIED OPENING TO BE CUT ROUND AND SMOOTH.
10. CLEANOUT/SHEAR GATE:
ALUMINUM ALLOY PER ASTM B-26-2G-32a OR CAST IRON ASTM A48 CLASS 30B AS REQUIRED. LIFT HANDLE EITHER SOLID OR TUBING WITH ADJUSTABLE HOOK AS REQUIRED. NEOPRENE RUBBER GASKET REQUIRED BETWEEN RISER MOUNTING FLANGE AND GATE FLANGE. MATING SURFACES OF LID AND BODY TO BE MACHINED FOR PROPER FIT. FLANGE MOUNTING BOLTS SHALL BE 3/8" DIA STAINLESS
11. ALTERNATE CLEANOUT/SHEAR GATES ARE ACCEPTABLE, PROVIDED THEY MEET THE MATERIAL SPECIFICATIONS ABOVE AND HAVE A SIX BOLT, 10 3/8" BOLT CIRCLE FOR BOLTING THE FLANGE CONNECTION.
12. GATE SHALL NOT OPEN BEYOND THE CLEAR OPENING BY LIMITED HINGE MOVEMENT, STOP TAB, OR SOME OTHER DEVICE.
13. PRECAST CONCRETE MANHOLE CONSTRUCTED IN ACCORDANCE WITH ASTM C478.
14. PRIMARY SPILLWAY AND OUTLEST PIPE SHALL BE SIZED TO CONVEY A 25-YEAR STORM EVENT.
STANDARD TAMPERPROOF BOLT DOWN FRAME AND COVER WHEN IN PUBLIC EASEMANT. SEE DETAIL SWM MH-10.0
12" MAX
12" MIN
LIFT HANDLE ATTACH WITH GALVANIZE CHAIN
STEPS (STEEL REINFORCED POLYPROPYLENE STEPS) SEE DETAIL SWM MH-10.0
CLEANOUT/SHEAR GATE: 8" DIAMETER MIN SEE DETAIL SWM FC-3.0
INLET
12"
12"
6" MIN
12" MIN. 3/4" MINUS AGGRAGATE BASE MATERIAL
COMPACTED NATIVE MATERIAL
8"
1'-0" MIN
2'-0" MIN 48" MIN. DIAMETER
PRIMARY SPILLWAY
SEE NOTE 3: PIPE SUPPORT(S) 3"x.075" ALUM.
DOWN TURNED ELBOW W/ ADDITIONAL ORIFICE
OUTLET
SEE NOTE 5
PIPE (SEE NOTE 6)
RESTRICTOR PLATE WITH ORIFICE (SEE NOTE 9)
3' MINIMUM SUMP
FLOW CONTROL MANHOLE
SCALE: NTS MINIMUM SIZE -48" STANDARD MANHOLE
CLACKAMAS
WATER ENVIRONMENT SERVICES
CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045
APPROVAL DATE: July, 2022
SCALE: N.T.S.
MH FLOW CONTROL
STANDARD DRAWING
SWM -30



GRATE DETAIL

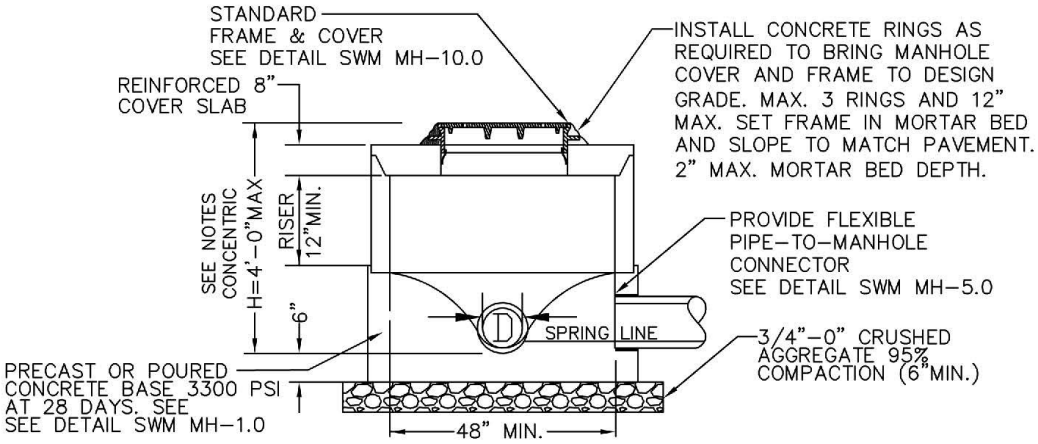
SCALE: N.T.S.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MH OVAL GRATE DETAIL	*STANDARD DRAWING* SWM -31



PLAN

(FRAME & COVER NOT SHOWN)

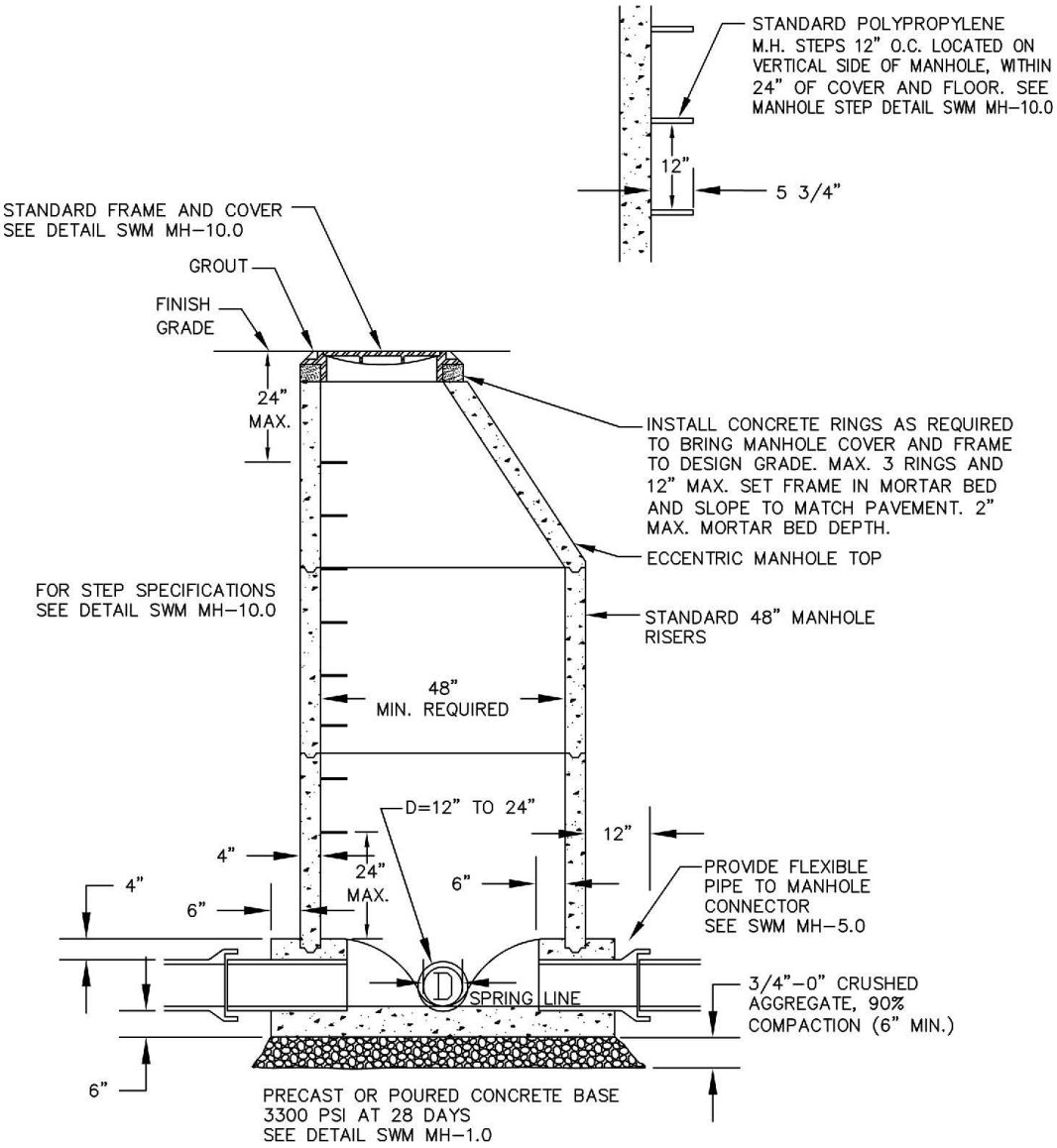


SECTION A-A

NOTES:

1. FLEXIBLE PIPE-TO-MANHOLE CONNECTIONS SHALL BE INSTALLED ACCORDING TO MANUFACTURES SPECIFICATIONS.
2. WATER TIGHT JOINTS.
3. ALL MANHOLE SECTIONS MUST MEET OR EXCEED ASTM C 478.
4. CONCENTRIC EQUAL TO OR LESS THAN 4-FEET – NO STEPS; ECCENTRIC GREATER THAN 4-FEET TO 6'-6" – REQUIRES STEPS.

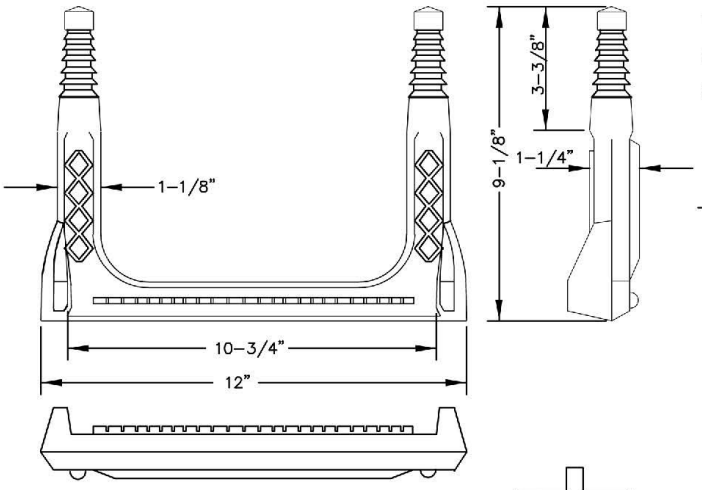
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MH SHALLOW PRECAST	*STANDARD DRAWING* SWM -32



NOTE

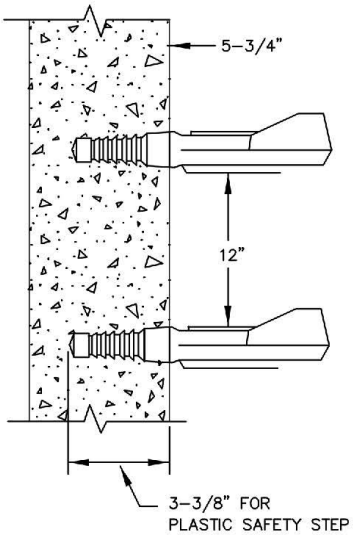
1. SPECIFICATIONS FOR CONCRETE AND MISCELLANEOUS MATERIALS USED IN CONSTRUCTION SHALL CONFORM TO CURRENT APWA STANDARD SPECIFICATIONS.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2021 *SCALE:* N.T.S. MH STANDARD	*STANDARD DRAWING* SWM -33



NOTES:

1. ALL STEPS SHALL CONFORM TO THE REQUIREMENTS OF ASTM C-478.
2. MANHOLE STEPS MUST BE TIGHT AND FIRMLY EMBEDDED.
3. ALL STEPS WITHIN A MANHOLE SHALL BE OF THE SAME DESIGN, TYPE, AND SIZE. (MIXING OF UNMATCHED STEPS IS NOT PERMITTED).



NOTES:

1. STEPS LOCATED AT 12" O.C. LOCATED ON VERTICAL SIDE OF MANHOLE.
2. STEPS A MAXIMUM OF 24" FROM RIM AND 6" FROM TOP OF CONE TO FIRST STEP.
3. REFERENCE DETAILS SWM MH-2.0, MH-8.0, AND MH-9.0.

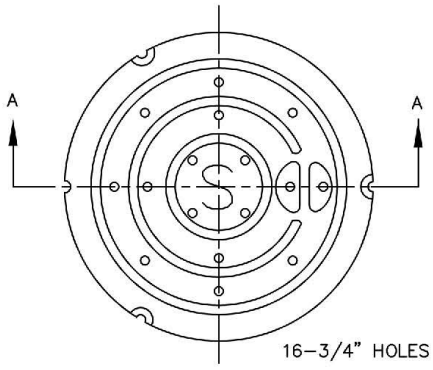
MATERIALS:

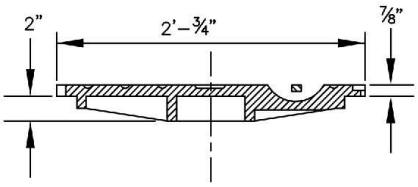
PLASTIC:

MUST CONFORM WITH ASTM C-478.
STEEL REINFORCING BAR MINIMUM 1/2" GRADE 60.
MEETING REQUIREMENTS OF ASTM A615 ENCAPSULATED
WITH INJECTION MOLDED COPOLYMER POLYPROPYLENE
WITH SERRATED SURFACES.

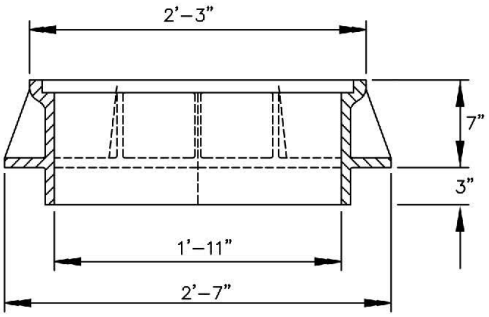
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MH STEP	*STANDARD DRAWING* SWM -34

STANDARD MANHOLE

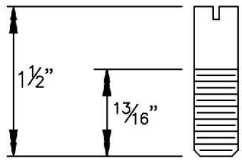




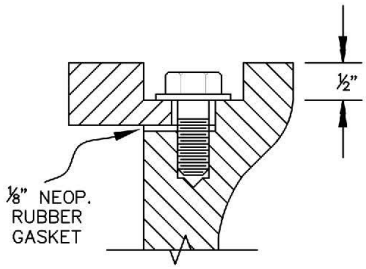
SECTION A–A

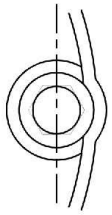


WATER TIGHT DETAILS
TAMPERPROOF



LOCATING STUD
(1) REQUIRED PER COVER





CAP SCREW
(3) REQUIRED ½" x 1¼"
PENT OR HEX HEAD
BRONZE OR CAD PL.

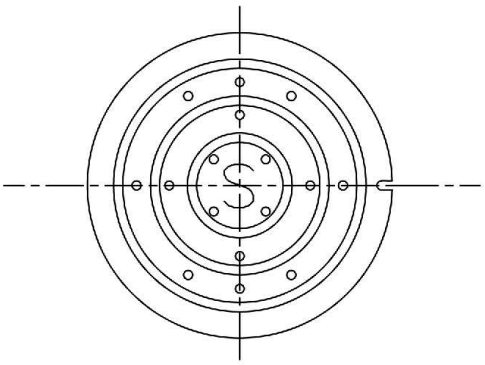
CLACKAMAS WATER ENVIRONMENT SERVICES

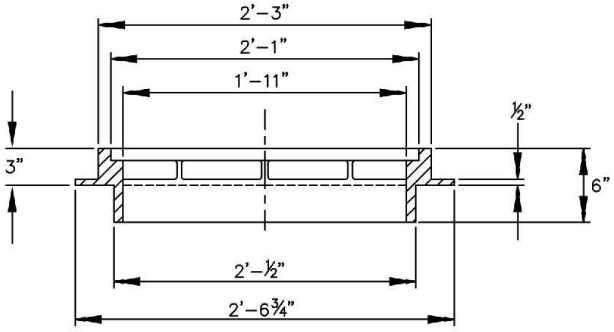
CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045

APPROVAL DATE: July, 2022 *SCALE:* N.T.S.

MH STANDARD
FRAME & COVER

STANDARD DRAWING
SWM
-35

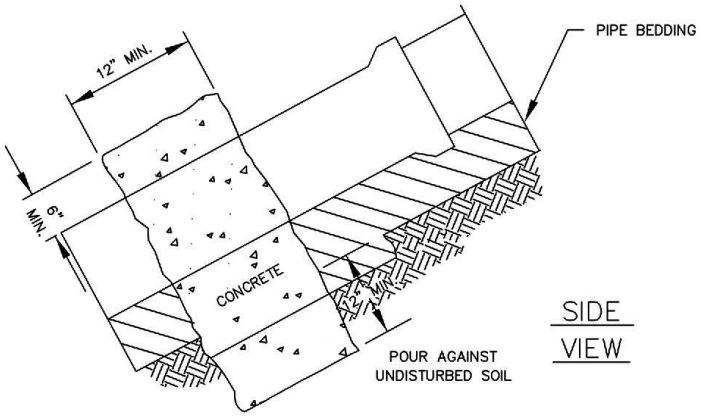




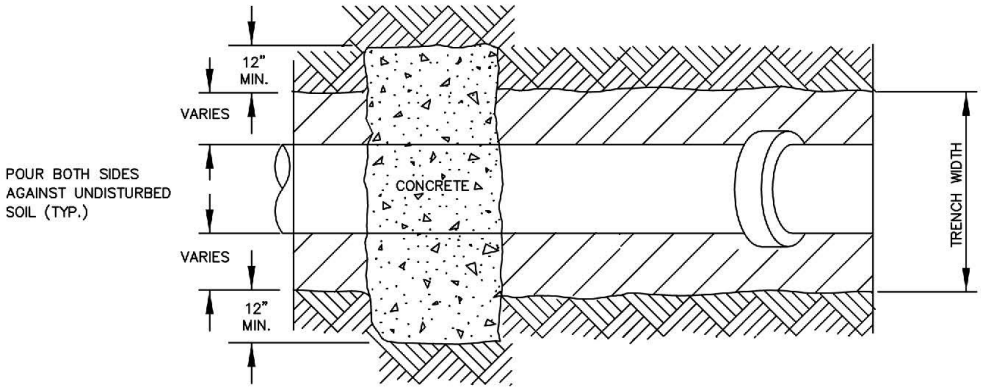
NOTES

1. SUBURBAN FRAME & COVER CAN BE USED IN EASEMENTS AND SUBDIVISION STREETS EXCEPT COLLECTOR, ARTERIAL, AND INDUSTRIAL STREETS, OR AS NOTED ON CONSTRUCTION PLANS.
2. 16, 3/4"Ø HOLES.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MH SUBURBAN FRAME & COVER	*STANDARD DRAWING* SWM -36



SIDE VIEW



PLAN

SLOPE FT/FT	MIN. ANCHOR SPACING CENTER TO CENTER
0.20 – 0.34	35'
0.35 – 0.50	25'
0.51+	15' OR CONC. ENCASEMENT

ANCHOR WALL

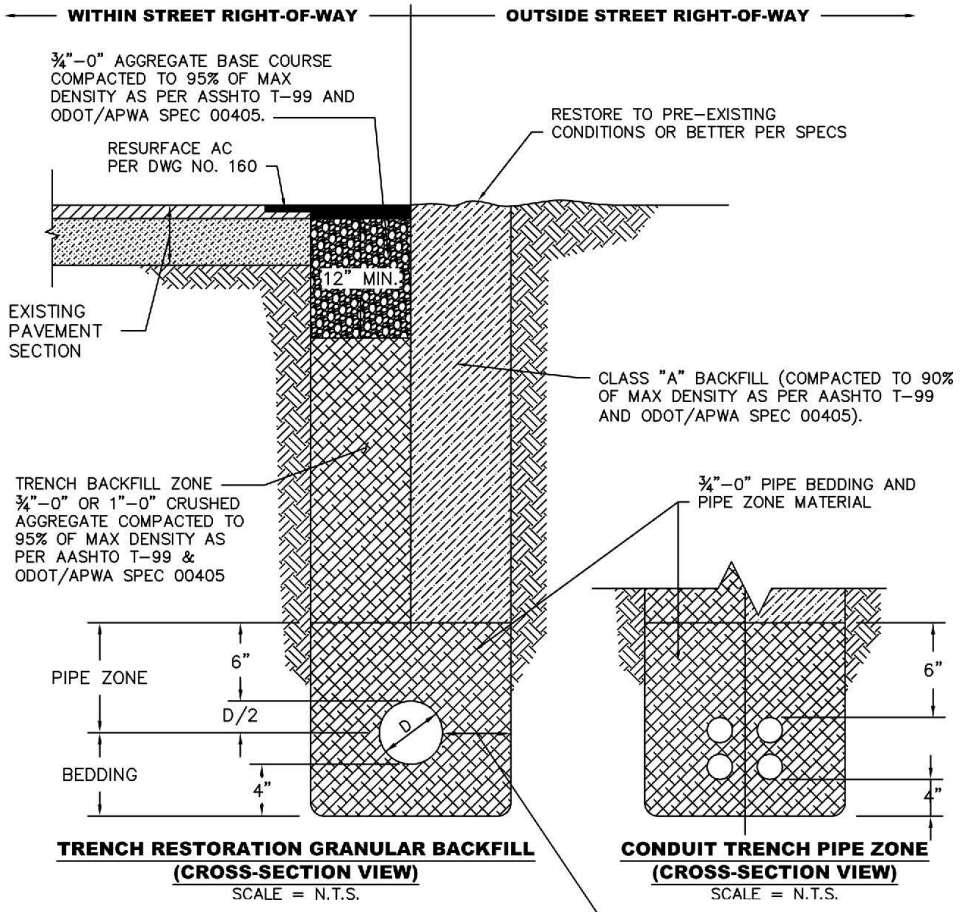
CLACKAMAS WATER ENVIRONMENT SERVICES

CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045

APPROVAL DATE: July, 2022 *SCALE:* N.T.S.

ANCHOR WALL

STANDARD DRAWING
SWM -37



TRENCH RESTORATION GRANULAR BACKFILL
(CROSS-SECTION VIEW)
SCALE = N.T.S.

CONDUIT TRENCH PIPE ZONE
(CROSS-SECTION VIEW)
SCALE = N.T.S.

NOTES:

1. PAVEMENT SHALL BE CUT PER STANDARD DRAWING 200.
2. PROVIDE COMPACT TEST RESULTS FOR TRENCH BACKFILL TO THE CITY FOR VERIFICATION.
3. CONTROL DENSITY FILL SHALL BE USED ON COLLECTOR AND ARTERIAL STREETS. REFER TO STANDARD DRAWING 210.

SHORING TRENCH CLEARANCE WIDTH	
D (IN.)	TRENCH (IN)
4–10	9
12–16	12
18–21	16
24–30	18
36–72	24

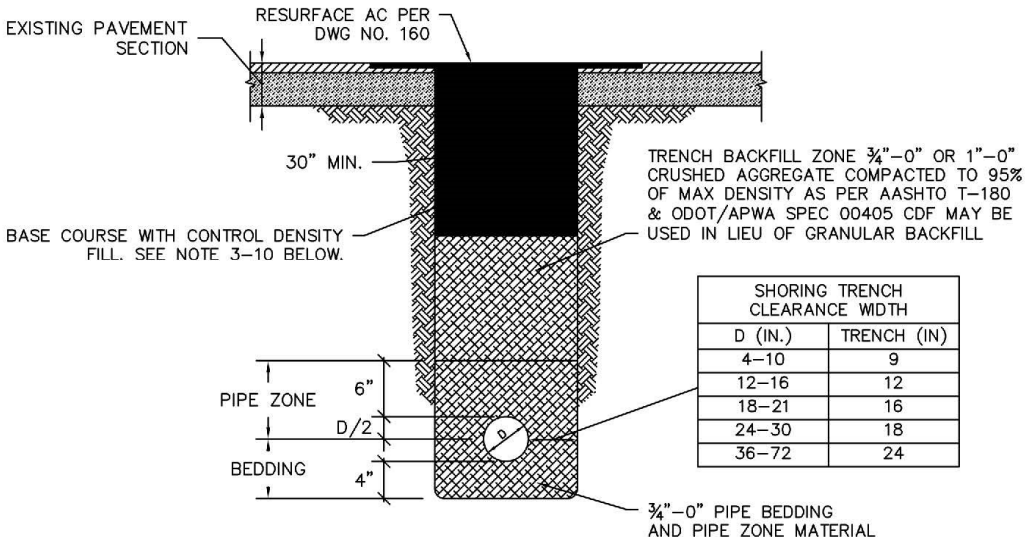
CLACKAMAS WATER ENVIRONMENT SERVICES

CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045

APPROVAL DATE: July, 2022 *SCALE:* N.T.S.

TRENCH RESTORATION

STANDARD DRAWING
SWM -38



SHORING TRENCH CLEARANCE WIDTH	
D (IN.)	TRENCH (IN)
4–10	9
12–16	12
18–21	16
24–30	18
36–72	24

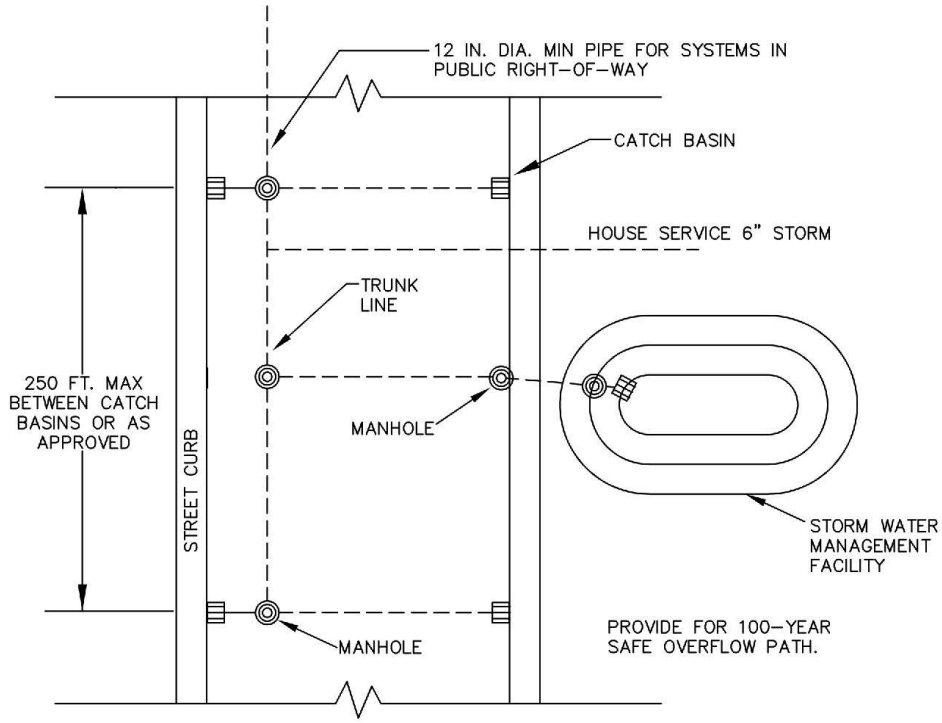
TRENCH RESTORATION W/ CDF

SCALE = N.T.S.

NOTES:

1. SAWCUT EXISTING AC PAVEMENT ACCORDING TO STANDARD DRAWING 200.
2. CONTROL DENSITY FILL (CDF) CONSISTS OF A MIXTURE OF PORTLAND CEMENT, FLY ASH, AGGREGATES, WATER AND ADMIXTURES PROPORTIONED TO PROVIDE A NON–SEGREGATING, SELF–CONSOLIDATING, FREE–FLOWING MATERIAL WHICH WILL RESULT IN A HARDENED, DENSE, NON–SETTLING FILL PRODUCING UNCONFINED COMPRESSIVE 28 DAY STRENGTH FROM 100 PSI TO A MAXIMUM OF 200 PSI.
3. CONTRACTOR WILL PROVIDE BATCH WEIGHTS SHOWING THE AMOUNTS OF ALL INGREDIENTS IN THE MIX, BATCH TIME, AND THE TOTAL AMOUNT OF THE BATCH.
4. CDF SHALL BE PERFORMANCE BASED AND MEET THE FOLLOWING CRITERIA:
   - TYPE F FLY ASH: 200 LB MIN, TYPE I OR II CEMENT: 50 LB MIN
   - SETTLING SHALL BE LESS THAN ⅛" PER FT DEPTH
   - FINE AGGREGATE (LESS THAN ⅜") SHALL BE USED
   - CONCRETE UNIT WEIGHT SHALL BE 100 PCF MIN
5. CDF SHALL NOT BE PLACED ON FROZEN GROUND. DURING PLACEMENT TEMPERATURE MUST BE AT LEAST **34 DEGREES F. AND RISING.** CDF PLACING SHALL STOP WHEN TEMPERATURE IS 38 DEGREES F OR LESS AND FALLING.
6. TRENCH SECTIONS TO BE FILLED WITH CDF SHALL BE CONTAINED AT EITHER END OF THE TRENCH SECTION BY BULKHEADS OR EARTH FILL.
7. DURING CDF CURE TIME (TYP. 48 HOURS) THE CONTRACTOR SHALL INSTALL STEEL SHEETS OR OTHER PROTECTIVE DEVICES TO ALLOW FOR THE PASSAGE AND SAFETY OF TRAFFIC AND SO NO LOAD IS TRANSFERRED TO THE CDF.
8. CONTRACTOR SHALL ALLOW FOR A MINIMUM 48 HOUR CURE TIME FOR CDF PRIOR TO PLACING ASPHALT. STEEL PLATES ARE NOT ALLOWED IN THE ROADWAY JANUARY THRU MARCH, NOVEMBER AND DECEMBER WITHOUT PRIOR APPROVAL FROM THE CITY.
9. 30 INCH DEPTH OF CDF MAY BE REDUCED IF CONFLICTING WITH PIPE ZONE BACKFILL.
10. COPIES OF CDF MATERIAL DELIVERY SLIPS SHALL BE SUBMITTED TO CITY ENGINEERING WITHIN 48–HOURS OF PLACEMENT.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. TRENCH RESTORATION WITH CDF	*STANDARD DRAWING* SWM -39

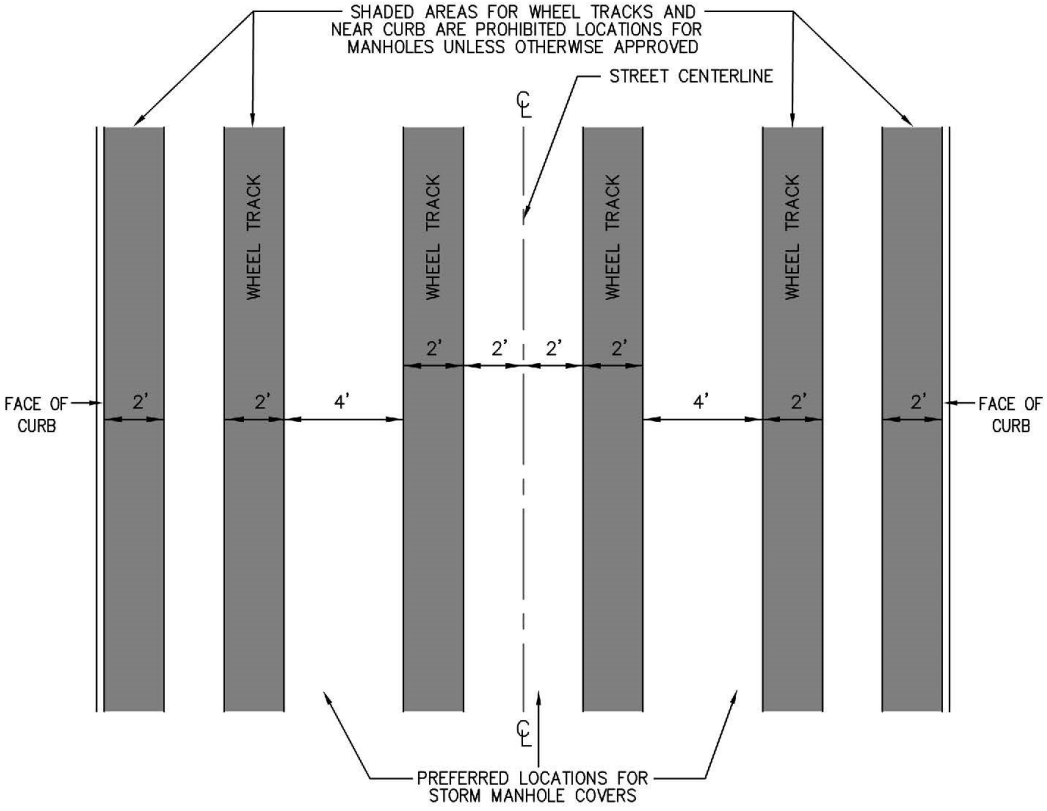


STORM COLLECTION			
STORM COLLECTION	MAX. DISTANCE BETWEEN M.H.	MIN. VELOCITY	MIN. GRADE
12-INCH PIPE	250-400 FEET 0-250 FEET	4 FT/SEC 3 FT/SEC	.01 SLOPE .005 SLOPE
15-INCH PIPE	250-400 FEET 0-250 FEET	4 FT/SEC 3 FT/SEC	.006 SLOPE .004 SLOPE
18-INCH PIPE	250-400 FEET 0-250 FEET	4 FT/SEC 3 FT/SEC	.005 SLOPE .003 SLOPE
24-INCH PIPE	300 FEET	3 FT/SEC	.002 SLOPE
30-INCH PIPE	300 FEET	3 FT/SEC	.002 SLOPE
36-INCH PIPE	300 FEET	3 FT/SEC	.002 SLOPE

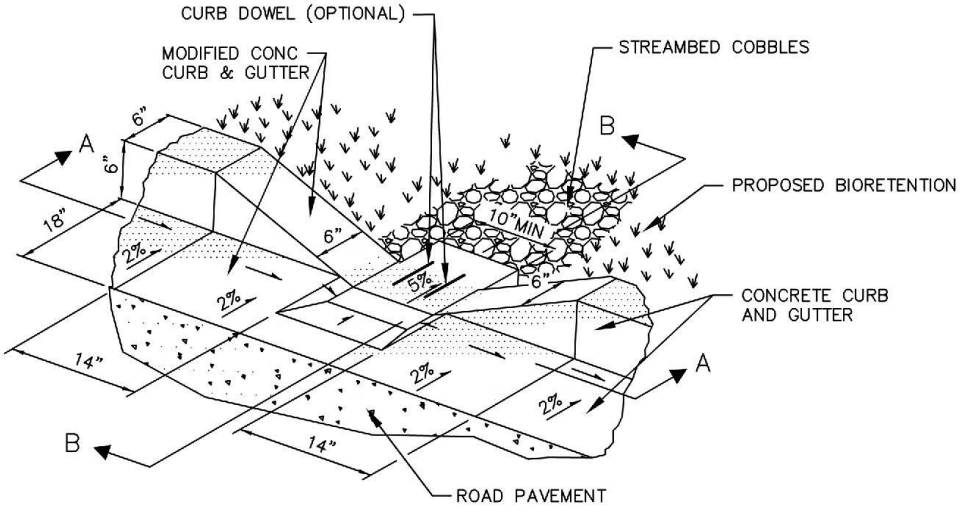
NOTES

1. A MAXIMUM OF THREE CATCH BASINS MAY BE ALLOWED TO BE CONNECTED TOGETHER WITHOUT A MANHOLE AS APPROVED BY THE DISTRICT.
2. DETENTION/WATER QUALITY FACILITIES SHALL CONNECT TO A STRUCTURE.
3. MINIMUM VELOCITY IS 3 FT/SEC.

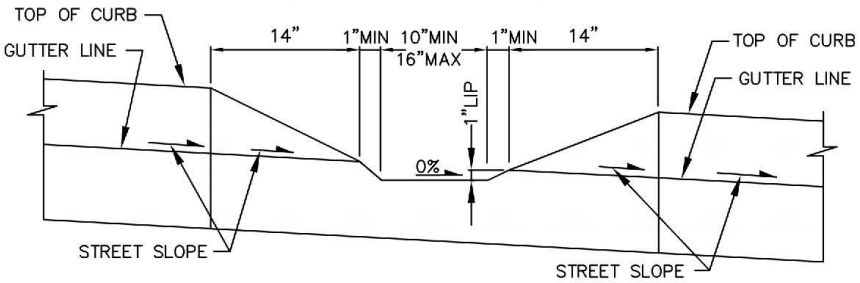
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. COLLECTION SYSTEM DIAGRAM	*STANDARD DRAWING* SWM -40



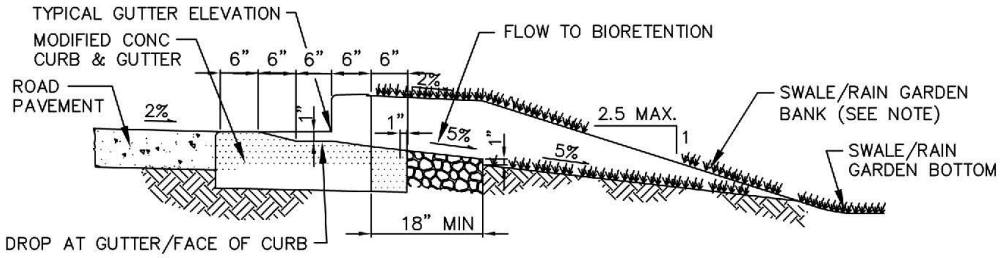
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. MH LOCATION DIAGRAM	*STANDARD DRAWING* SWM -41



SECTION A–A



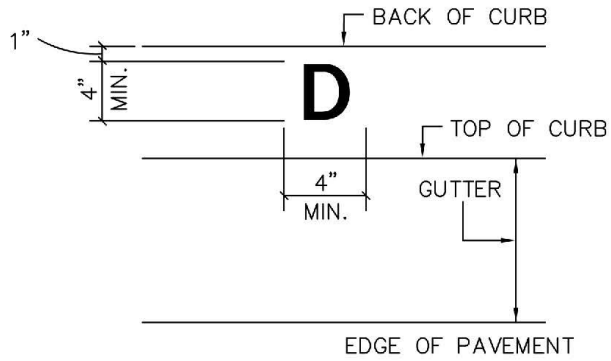
SECTION B–B



NOTE:

MODIFY INLET TO BIORETENTION PLANTER AS NEEDED TO PREVENT EROSION.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2021 *SCALE:* N.T.S. CURB CUT OPENING	*STANDARD DRAWING* SWM -42



PLAN VIEW
(TYPICAL)

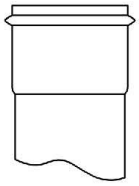
NOTES:

1. ALL STORM AND SANITARY SERVICE LATERALS SHALL BE MARKED APPROXIMATELY AS FOLLOWS:

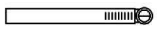
STORM DRAIN LATERAL	"D"	TOP OF CURB
SANITARY SEWER LATERAL	"S"	TOP OF CURB

2. LETTERS SHALL HAVE A 1/2" MAX. WIDTH.

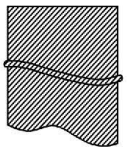
CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. CURB STAMP DETAIL	*STANDARD DRAWING* SWM -43



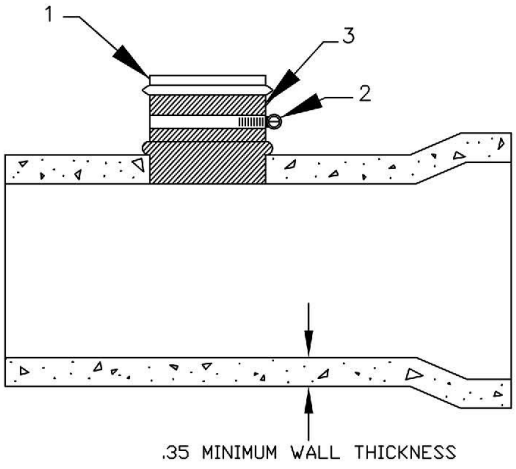
1. PVC HUB SHALL CONFORM TO ASTM 3034, SDR 35 DRIVE INTO CENTER OF RUBBER SLEEVE AFTER SLEEVE IS PLACED IN HOLE.



2. STAINLESS STEEL BAND SECURES UPPER HALF OF RUBBER SLEEVE TO THE PVC HUB. STAINLESS STEEL BAND SHALL BE 300 SERIES, $\frac{9}{16}$" BAND WIDTH, CADMIUM PLATED CARBON STEEL, AND ATTACHED WITH HEX HEAD SLOTTED SCREW.

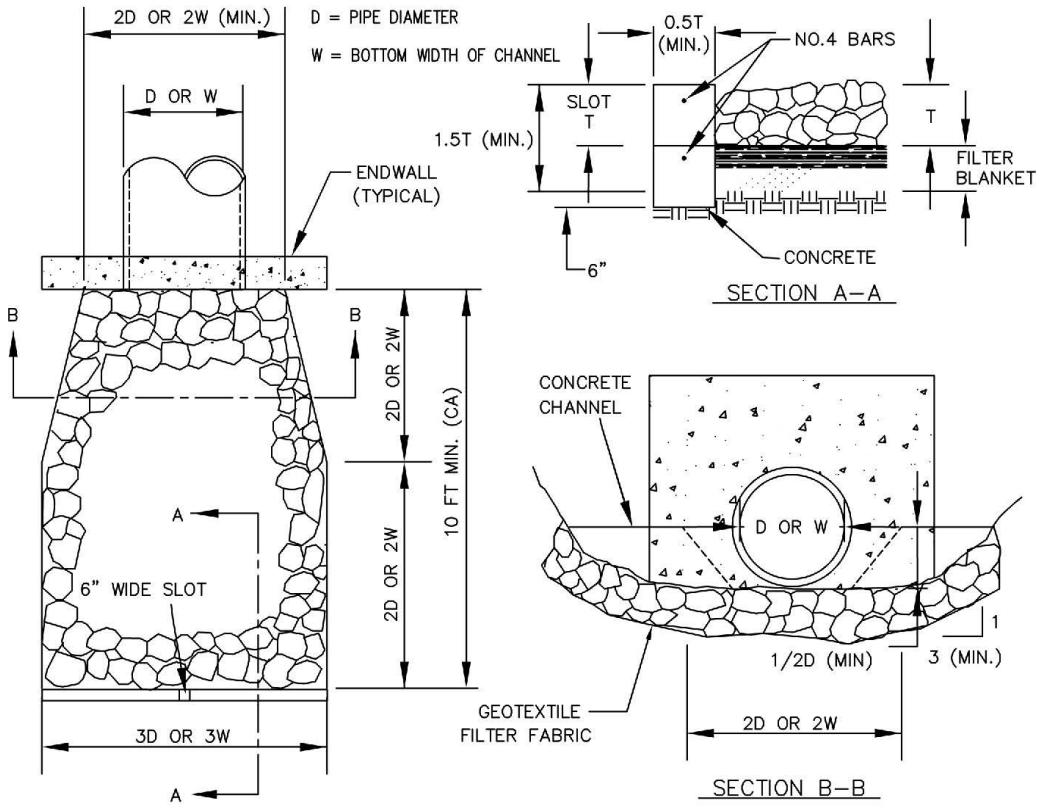


3. COMPLETE RUBBER SLEEVE INCLUDES A MOLDED SEGMENT THAT HOLDS IT IN PLACE.



NOTE:
1. ALL INSERTA–TEE HOLES SHALL BE MACHINE DRILLED AND CORED.
2. INSERTA–TEE ARE ALLOWED IN NEWLY CONSTRUCTED SEWER MAINS 12" AND LARGER INSIDE DIAMETER (I.D.).
3. SEWER MAIN SHALL BE TWO SIZES (NOMINAL I.D.) LARGER THAN THE INSERTA –TEE.
4. HOST PIPE SHALL BE MINIMUM .35" WALL THICKNESS.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. INSERTA TEE	*STANDARD DRAWING* SWM -44



NOTES
1. PLANS SHALL SPECIFY:
   A) ROCK CLASS AND THICKNESS (T)
   B) FILTER MATERIAL, NUMBER OF LAYERS AND THICKNESS.
2. RIP RAP SHALL BE EITHER QUARRY STONE OR BROKEN CONCRETE (IF SHOWN ON THE PLANS). COBBLES ARE NOT ACCEPTABLE. SEE DETAIL SWM ST–10.1 FOR SIZING.
3. RAP RAP SHALL BE PLACED OVER FILTER BLANKET WHICH MAY BE EITHER GRANULAR MATERIAL OR PLASTIC FILTER CLOTH.
4. PLACEMENT
   A) MINIMUM DEPTH = 1–1/2 TIMES AVERAGE STONE SIZE.
   B) ROCKS SHALL BE PLACED TO PROVIDE A MINIMUM OF VOIDS.
   C) SURFACE ROCKS SHALL PROTRUDE AT LEAST 1/2 THEIR VERTICAL DIMENSION.
   D) RIPRAP IS TO BE PLACED OVER A GEOTEXTILE FABRIC ON A NATURAL BEDDING, OR IT MAY BE GROUTED OR PLACED OVER A GRAVEL BEDDING AS REQUIRED BY THE DISTRICT.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2021 *SCALE:* N.T.S. OUTFALL RIP RAP	*STANDARD DRAWING* SWM -45

RIP RAP SIZING AT OUTFALLS FOR PIPES GREATER THAN 6 INCHES IN DIAMETER

DISCHARGE VELOCITY AT DESIGN FLOW (FPS)	REQUIRED PROTECTION MINIMUM DIMENSIONS				
	TYPE	DEPTH*	WIDTH	LENGTH**	WIDTH
0 – 5	RIPRAP*	2 X (MAX STONE SIZE)	DIAMETER +6 FEET	10' MIN. OR AS CALCULATED IF LONGER	CROWN +1 FOOT
6 – 10	RIPRAP*	2 X (MAX STONE SIZE)	DIAMETER +6 FEET OR 3 X DIA. WHICH–EVER IS GREATER	AS CALCULATED	CROWN +1 FOOT
11 – 20	GABION OR RIPRAP*	2 X (MAX STONE SIZE)	DIAMETER +6 FEET OR 4 X DIA. WHICH–EVER IS GREATER	AS CALCULATED	CROWN +1 FOOT
OVER 20	ENGINEERED ENERGY DISSIPATER REQUIRED				

* RIPRAP SIZE SHALL BE DETERMINED USING THE FOLLOWING FORMULAE***

V = AVERAGE VELOCITY (FT/S)
Do = PIPE DIAMETER (FT)
ds = RIPRAP DIAMETER (FT)
Lsp = APRON LENGTH (FT)
depth = THICKNESS (FT)
Fo = $V/(g*DO)^{0.5}$

*RIPRAP SIZE ds=0.25*Do*Fo (6" MINIMUM)
DEPTH=2*ds (1–FOOT MINIMUM)
**APRON LENGTH Lsp=Do(8+17*Log Fo)

g= 32.2 FT/S^2

*** US ARMY CORPS OF ENGINEERE DESIGN FORMULAS FROM EROSION AND RIPRAP REQUIREMENTS AT CULVERT AND STORM OUTLETS, JANUARY 1970.

CLACKAMAS WATER ENVIRONMENT SERVICES

CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045

APPROVAL DATE: July, 2022 *SCALE:* N.T.S.

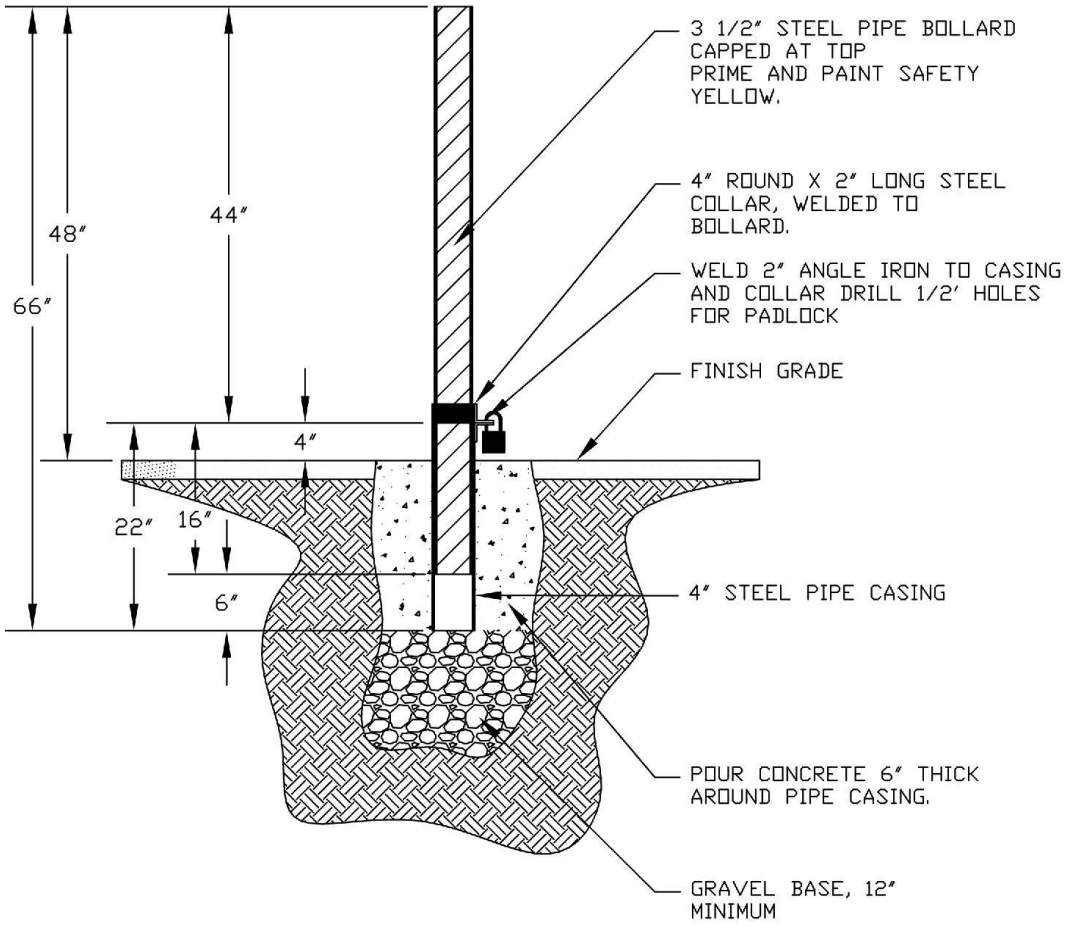
OUTFALL RIP RAP SIZING

STANDARD DRAWING SWM -46

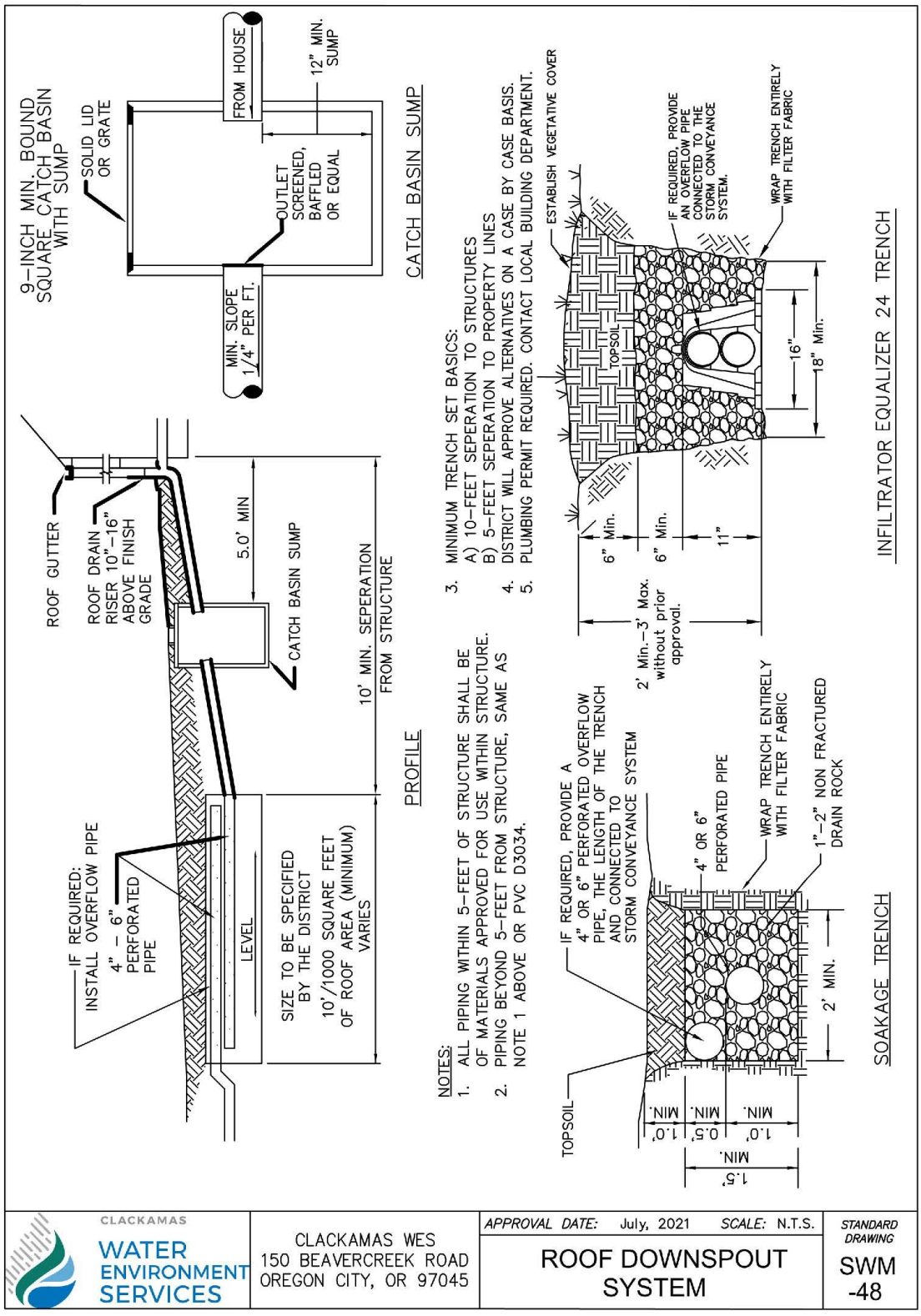
STEEL PIPE SPECIFICATIONS

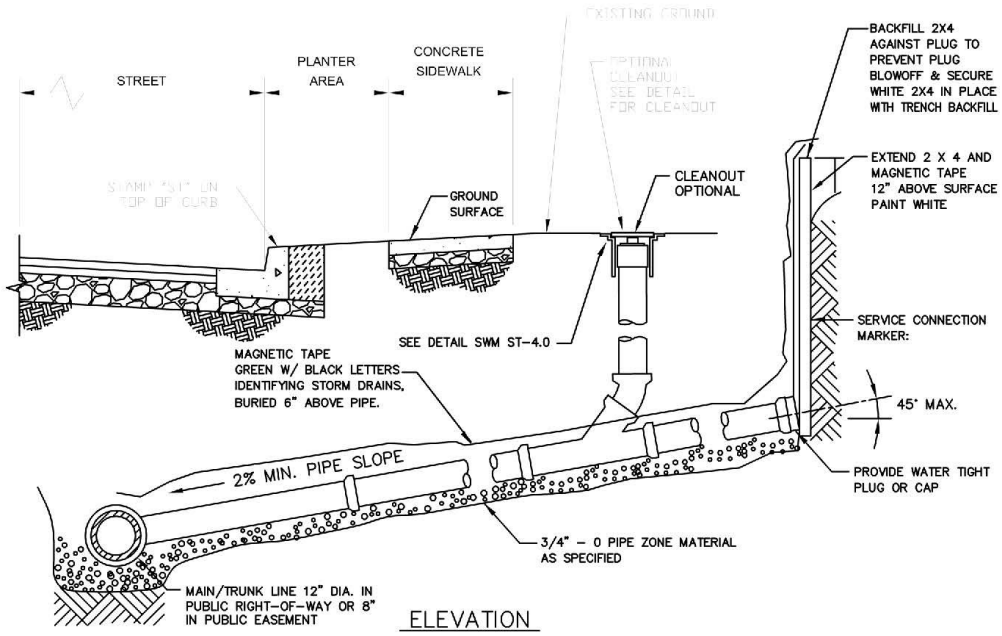
ASTM A-53 STEEL, SCHEDULE 40, BLACK, HOT DIPPED, ZINC-COATED, WELDED, SEAMLESS

4-INCH STEEL PIPE	O.D. = 4.500″	I.D. = 4.026	THICKNESS = 0.237
3 1/2-INCH STEEL PIPE	O.D. = 4.000″	I.D. = 3.549″	THICKNESS = 0.226″



CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. REMOVABLE BOLLARD	*STANDARD DRAWING* SWM -47


9-INCH MIN. BOUND SQUARE CATCH BASIN WITH SUMP
SOLID LID OR GRATE
FROM HOUSE
12" MIN. SUMP
OUTLET SCREENED, BAFFLED OR EQUAL
MIN. SLOPE 1/4" PER FT.
CATCH BASIN SUMP
ROOF GUTTER
ROOF DRAIN RISER 10"-16" ABOVE FINISH GRADE
5.0' MIN
CATCH BASIN SUMP
10' MIN. SEPERATION FROM STRUCTURE
IF REQUIRED: INSTALL OVERFLOW PIPE 4" - 6" PERFORATED PIPE
LEVEL
SIZE TO BE SPECIFIED BY THE DISTRICT 10'/1000 SQUARE FEET OF ROOF AREA (MINIMUM) VARIES
PROFILE
NOTES:
1. ALL PIPING WITHIN 5-FEET OF STRUCTURE SHALL BE OF MATERIALS APPROVED FOR USE WITHIN STRUCTURE.
2. PIPING BEYOND 5-FEET FROM STRUCTURE, SAME AS NOTE 1 ABOVE OR PVC D3034.
3. MINIMUM TRENCH SET BASICS:
A) 10-FEET SEPERATION TO STRUCTURES
B) 5-FEET SEPERATION TO PROPERTY LINES
4. DISTRICT WILL APPROVE ALTERNATIVES ON A CASE BY CASE BASIS.
5. PLUMBING PERMIT REQUIRED. CONTACT LOCAL BUILDING DEPARTMENT.
ESTABLISH VEGETATIVE COVER
TOPSOIL
IF REQUIRED, PROVIDE AN OVERFLOW PIPE CONNECTED TO THE STORM CONVEYANCE SYSTEM.
WRAP TRENCH ENTIRELY WITH FILTER FABRIC
6" Min.
6" Min.
11"
16"
18" Min.
2' Min.-3' Max. without prior approval.
INFILTRATOR EQUALIZER 24 TRENCH
IF REQUIRED, PROVIDE A 4" OR 6" PERFORATED OVERFLOW PIPE, THE LENGTH OF THE TRENCH AND, CONNECTED TO STORM CONVEYANCE SYSTEM
4" OR 6" PERFORATED PIPE
WRAP TRENCH ENTIRELY WITH FILTER FABRIC
1"-2" NON FRACTURED DRAIN ROCK
2' MIN.
TOPSOIL
1.0' MIN.
0.5' MIN.
1.0' MIN.
1.5' MIN.
SOAKAGE TRENCH
CLACKAMAS WATER ENVIRONMENT SERVICES
CLACKAMAS WES
150 BEAVERCREEK ROAD
OREGON CITY, OR 97045
APPROVAL DATE: July, 2021
SCALE: N.T.S.
ROOF DOWNSPOUT SYSTEM
STANDARD DRAWING
SWM -48



STORM SEWER LATERAL SERVICE CONNECTION

NOTE: EVERY PROPERTY SHALL HAVE A SEPARATE SERVICE CONNECTION CONNECTED DIRECTLY TO THE MAINLINE, UNLESS OTHERWISE APPROVED BY THE DISTRICT. SHARED SERVICES ARE NOT ALLOWED.

CLACKAMAS WATER ENVIRONMENT SERVICES	CLACKAMAS WES 150 BEAVERCREEK ROAD OREGON CITY, OR 97045	*APPROVAL DATE:* July, 2022 *SCALE:* N.T.S. SERVICE CONNECTION	*STANDARD DRAWING* SWM -49

Appendix D: Facility Sizing Methodology and Resources

1. Santa Barbara Urban Hydrograph Method

The Santa Barbara Urban Hydrograph (SBUH) method is a single-event model that estimates a flow hydrograph for a representative rainfall event. The SBUH method was developed by the Santa Barbara County Flood Control and Water Conservation District. Applicable to urban areas, it converts design storm incremental rainfall depths into instantaneous unit hydrographs.

Elements of the SBUH Method

The SBUH method depends on several variables:

- Pervious (A_p) and impervious (A_{imp}) land areas
- Time of concentration (Tc) calculations
- Runoff curve numbers (CN) applicable to the site
- Design storms

Assumptions for these variables must be explained and justified in the design report.

Land Area

The total area, including the pervious and impervious areas within a drainage basin, shall be quantified in order to evaluate critical contributing areas and the resulting site runoff. Each area with a basin shall be analyzed separately and their hydrographs combined to determine the total basin hydrograph. Areas shall be selected to represent homogenous land use/development units.

Time of Concentration

Time of concentration, Tc, is the time for a theoretical drop of water to travel from the furthest point in the drainage basin to the facility being designed. In this case, Tc is derived by calculating the overland flow time of concentration and the channelized flow time of concentration. Tc depends on several factors, including ground slope, ground roughness, and distance of flow. The formula for determining Tc is found on 3. Standard Equations.

When calculating Tc, the following limitations apply:

- Overland sheet flow (flow across a flat area that does not form into channels or rivulets) shall not extend for more than 300 feet.
- For flow paths through closed conveyance facilities such as pipes and culverts, standard hydraulic formulas shall be used for establishing velocity and travel time
- Flow paths through lakes or wetlands may be assumed to be zero (i.e., $T_c = 0$).

Runoff Curve Numbers

Runoff curve numbers were developed by the NRCS after studying the runoff characteristics of various types of land. Curve numbers (CN) were developed to reduce diverse characteristics such as soil type, land usage, and vegetation into a single variable for use in runoff calculations. The runoff curve numbers approved by the District for water quantity/quality calculations are included in **Table 28**.

The curve numbers presented in **Table 28** are for wet antecedent moisture conditions. Wet conditions assume previous rainstorms have reduced the capacity of soil to absorb water. Given the frequency of storms in Clackamas County, wet conditions are most likely, and result in conservative hydrographic values.

Design Storm

The SBUH method also requires a design storm to perform the runoff calculations. For flow control calculations, the District uses an NRCS Type 1A 24-hour storm distribution. The rainfall depths for 2-year through 100-year storm events are shown in **Table 26**.

Table 26. WES Design Storms

Design Storm/Recurrence Interval (years)	24-Hour Rainfall Depth (inches)
Water Quality	1.0
2-year	2.4
5-year	2.85
10-year	3.2
25-year	4.0
50-year	4.13
100-year	4.8

2. Soils Information

Soils information can be found in the current NRCS Soil Survey for Clackamas County, Oregon. Soils information may be obtained electronically from the NRCS Soil Survey at https://websoilsurvey.nrcs.usda.gov/app/.

1. Select “Start WSS”.
2. Under the “Area of Interest”, use the State and County drop down menus to select Oregon and Clackamas and select “View” and the Area of Interest Interactive Map will show Clackamas County.
3. Use the Area of Interest Interactive Map to navigate to the project site location.
4. Determine the areas of the site that fall under each of the four hydrologic soil groups in **Table 27**.

Table 27. Hydrologic Soil Groups

Group A	Soils having a high infiltration rate (low runoff potential) when thoroughly wet (deep, well drained to excessively drained sands or gravelly sands)
Group B	Soils having a moderate infiltration rate when thoroughly wet (moderately deep or deep, moderately well drained, or well drained soils that have moderately fine texture to moderately coarse texture)
Group C	Soils having a slow infiltration rate when thoroughly wet (soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture)
Group D	Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet (clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material)

3. Standard Equations

MANNING'S EQUATION: (Open Channel Flow}

$$Q = \left(\frac{1.486}{n}\right) AR^{2/3} S^{1/2}$$

Manning's Equation for circular pipe flowing full

$$Q = \frac{0.463}{n} D^{2/3} S^{1/2}$$

$$V = \frac{0.590}{n} D^{2/3} S^{1/2}$$

$$V = \left(\frac{1.486}{n}\right) R^{2/3} S^{1/2}$$

Q *Quantity of flow*, cubic feet per second
V Velocity of flow, feet per second
n Manning's coefficient of roughness (see Table 29 and Table 30 of these Standards)
A Cross-sectional area, square feet
R Hydraulic radius (area of flow divided by wetted perimeter), feet
S Slope of the pipe or energy line, feet per foot
0 Diameter of pipe, feet

RATIONAL METHOD: (Stormwater Design Flows)

Q = CIA (Max. drainage area=100 acres-- Max. time: *60 minutes*)

Q Quantity of runoff, cubic feet per second
C Coefficient of runoff (ratio of runoff to rainfall), percent (See Table 29)
I Intensity of rainfall, inches per hour
A Area of tributary drainage basin, acres

GUTTER FLOW CAPACITY: (Manning's Equation Modified)

$$Q = 0.56 \frac{\frac{1}{Sx}}{n} S^{0.5} d^{2.67} \quad \text{or} \quad Q = \frac{0.56}{n} Sx^{1.67} S^{0.5} T^{2.67} \qquad V = \frac{1.12}{n} S^{0.5} Sx^{0.67} T^{2.67}$$

Q Quantity of flow, cubic feet per second
Sx Street cross slope, feet per loot
S Street longitudinal slope, feet per foot
n Manning's coefficient of roughness for the gutter, (normally 0.018)
D Depth of flow at the curb, test
T Total width of flow in the gutter, feet

TIME OF CONCENTRATION: (Overland Stormwater Flow)

Tt = L/60V (for conversion of velocity to travel time)

Tc = $T_{11} + T_{12} + \ldots . T_{1m}$

Tt = $\frac{0.42\ (nL)^{0.8}}{1.58\ (S)^{0.4}}$ (Manning's kinematic solution for sheet flow less than 300 feet)

V = 16.1345 $(S)^{0.5}$ (Unpaved surfaces)

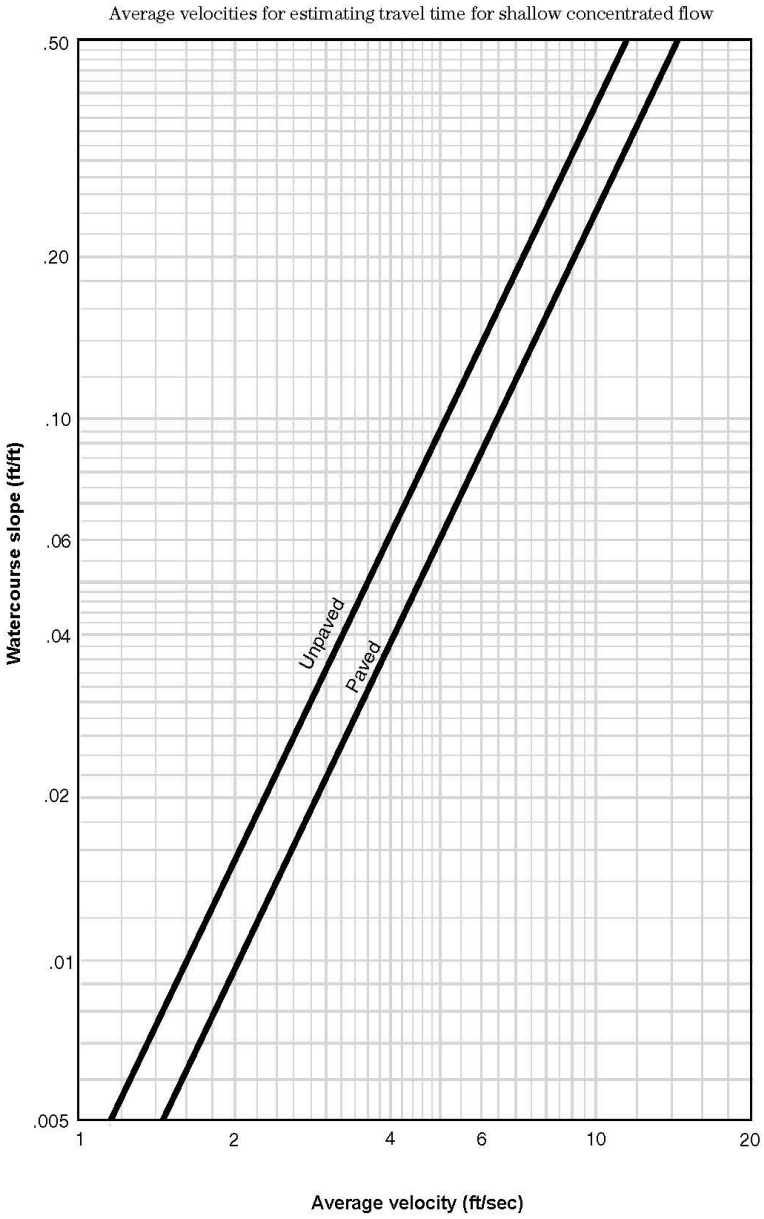
V = 20.3282 $(S)^{0.5}$ (Paved surfaces)

Shallow concentrated flow for slopes less than 0.005 ft/ft. For steeper slopes, see Figure 13.

Tt Travel time, minutes
L Flow length, feet
V Average veracity of flow, *feet per second*
60 Conversion factor from seconds to minutes
Tc *Total time of concentration, minutes* {minimum Tc = 5.0 minutes)
n Manning's roughness coefficient for various surfaces, (see Table 29 and Table 30)
S Slope of the hydraulic grade line (land or watercourse slope), feet per foot
1.58 A factor derived from Ref. No. 8 (P2, from 2-year, 24-hr precipitation chart, for the Portland, Oregon area [P 2°·5 = 2.5°·5=1.58])

Figure 13. Average Velocities for Shallow Concentrated Flow

Figure from Technical Release 55: Urban Hydrology for Small Watersheds, published by the United States Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division (1986, updated 1999).



[1] Figure from Technical Release 55: Urban Hydrology for Small Watersheds, published by the United States Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division (1986, updated 1999).

Table 28. Runoff Curve Numbers[2]

Description	Curve Numbers for Hydrological Soil Groups			
	A	**B**	**C**	**D**
Open space (lawns, parks, golf courses, cemeteries)				
Poor condition (< 50% grass coverage)	68	79	86	89
Fair condition (50 to 75% grass coverage)	49	69	79	84
Good condition (>75% grass coverage)	39	61	74	80
Impervious Areas				
Paved areas (parking lots, roofs, driveways)	98	98	98	98
Streets and roads				
Paved with curbs	98	98	98	98
Paved with open ditches	83	89	92	93
Gravel	76	85	89	91
Dirt	72	82	87	89
Urban Districts				
Commercial and business (85% impervious)	89	92	94	95
Industrial (72% impervious)	81	88	91	93
Residential districts by average lot size				
1/8 acre or less (65% impervious)	77	85	90	92
1/4 acre (38% impervious)	61	75	83	87
1/3 acre (30% impervious)	57	72	81	86
1/2 acre (25% impervious)	54	70	80	85
Woods (Good Hydrologic Condition)		70*		

** CN for Predeveloped Forest Condition is assumed to be equivalent to Woods condition with Hydrologic Soil Group C.*

[2] Urban Hydrology for Small Watersheds (TR-55), USDA Soil Conservation Service Engineering Division (1986).

Table 29. Runoff Coefficients for Developed Areas (Average Impervious Area Percent for Typical Land Uses, Ground Slopes, and Hydrological Soil Groups)

% Impervious	Soil Type	Drainage Area Slope			Typical Land Use
		Under <5%	5% to 10%	Over 10%	
0-10	A	0.19	0.24	0.29	Open Spaces, Parks, Cemeteries, Playgrounds
	B	0.24	0.30	0.36	
	C	0.29	0.36	0.44	
	D	0.33	0.43	0.52	
11-20	A	0.26	0.31	0.36	Residential (1 unit/20,000 square feet or greater)
	B	0.30	0.37	0.43	
	C	0.35	0.42	0.50	
	D	0.39	0.48	0.57	
21-30	A	0.34	0.39	0.44	Residential (1 unit/10,000 square feet)
	B	0.37	0.44	0.50	
	C	0.41	0.49	0.56	
	D	0.45	0.54	0.62	
31-40	A	0.41	0.46	0.51	Residential (1 unit/5,000 – 7,000 square feet)
	B	0.44	0.50	0.56	
	C	0.47	0.55	0.61	
	D	0.51	0.59	0.67	
41-50	A	0.49	0.54	0.59	Residential (1 unit/less than 5,000 square feet)
	B	0.52	0.57	0.63	
	C	0.55	0.61	0.67	
	D	0.57	0.65	0.72	
51-60	A	0.56	0.61	0.66	Mixed-Use Residential
	B	0.58	0.64	0.70	Residential Streets
	C	0.61	0.67	0.74	Schools/Campuses
	D	0.63	0.70	0.77	
61-70	A	0.64	0.69	0.74	Mixed Use Residential
	B	0.66	0.72	0.77	Mixed-Use Commercial
	C	0.67	0.74	0.80	Collector Streets
	D	0.69	0.76	0.82	
71-80	A	0.71	0.76	0.81	Mixed Use Residential
	B	0.72	0.78	0.83	Mixed-Use Commercial
	C	0.73	0.80	0.85	Arterial Streets
	D	0.75	0.81	0.87	Hospitals
81-90	A	0.79	0.84	0.89	Commercial Centers
	B	0.80	0.85	0.90	High Density Residential
	C	0.81	0.86	0.91	
	D	0.81	0.87	0.92	
91-100	A	0.86	0.91	0.96	Commercial Centers
	B	0.87	0.92	0.97	High Density Residential
	C	0.87	0.92	0.97	Arterial Streets
	D	0.88	0.92	0.97	

❶ Any of the runoff coefficients may be adjusted to the nearest 0.05 to reflect any departure from these typical values. Any adjustment must be applied uniformly throughout a drainage area.

❷ Soil Types: A = gravel and sandy loam; B = light clay and silt loam; C = tight clay.

❸ The land uses are typical for a given percent of impervious surface. Where there is or will be any significant variation from typical conditions, another percentage range should be used.

Source: City of Portland, 2020 Sewer and Drainage Facilities Manual

Table 30. Runoff Coefficients for Undeveloped Areas (General Surface Characteristics, Ground Slope, and Hydrologic Soil Groups)

Surface Characteristics	Soil Type	Drainage Area Slope		
		Under 5%	**5% to 10 %**	**Over 10%**
Woodland	A	0.10	0.15	0.20
	B	0.15	0.25	0.30
	C	0.30	0.35	0.40
Lawn, Pasture, and Meadow	A	0.15	0.20	0.25
	B	0.25	0.30	0.35
	C	0.30	0.40	0.50
Cultivated Land	A	0.25	0.35	0.50
	B	0.40	0.55	0.70
	C	0.50	0.65	0.80
Gravel Areas and Walks				
Loose		0.30	0.40	0.50
Packed		0.70	0.75	0.80
Pavement and Roof		0.90	0.95	1.00

4. Hydraulics

The following figures are from the Oregon Department of Transportation Hydraulics Design Manual (2014), Chapter 7, Appendix A.

Figure 14. Rainfall I-D-R Curve Zone Map

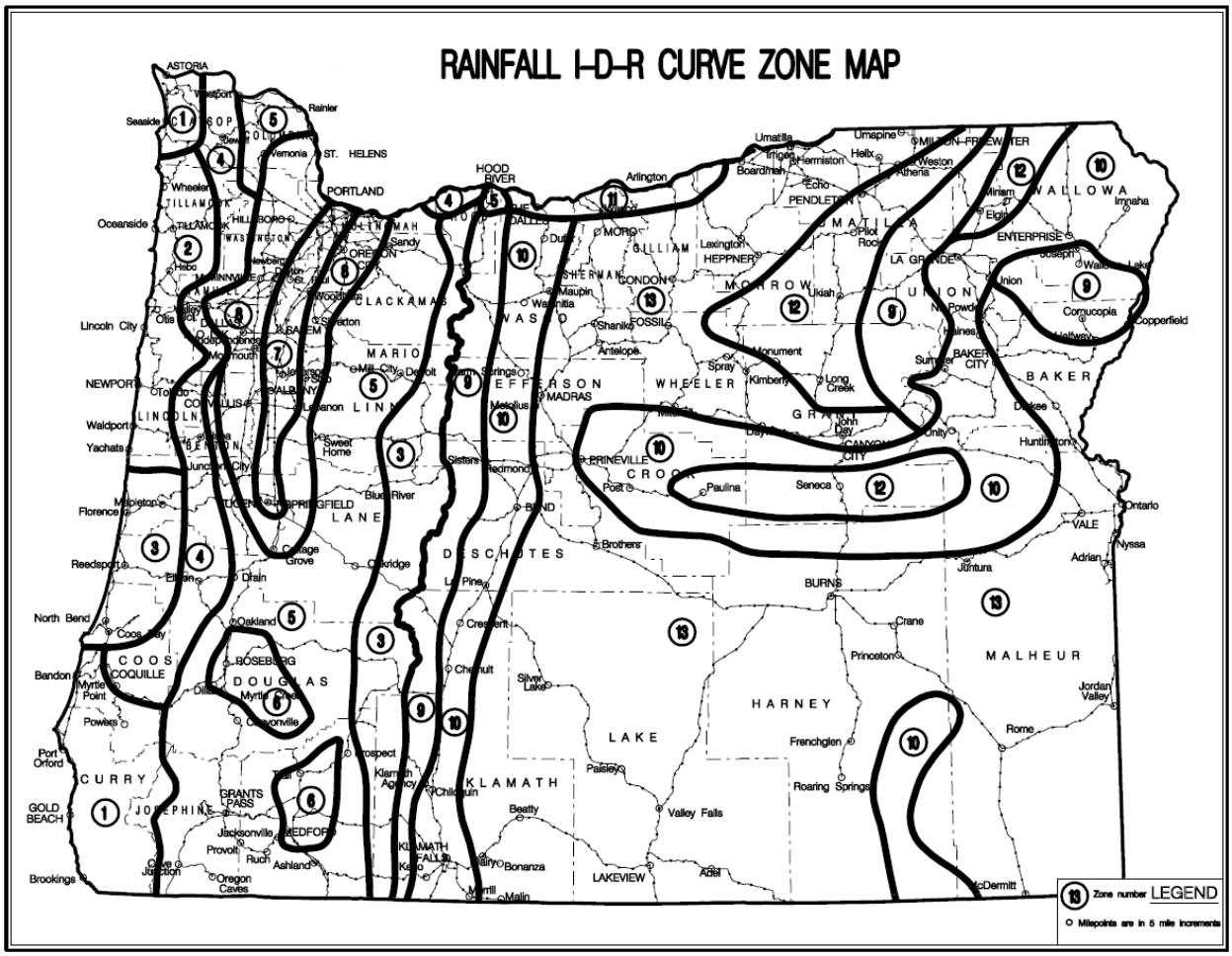


Figure 15. Rainfall Intensity Recurrence Curves (Zone 5)

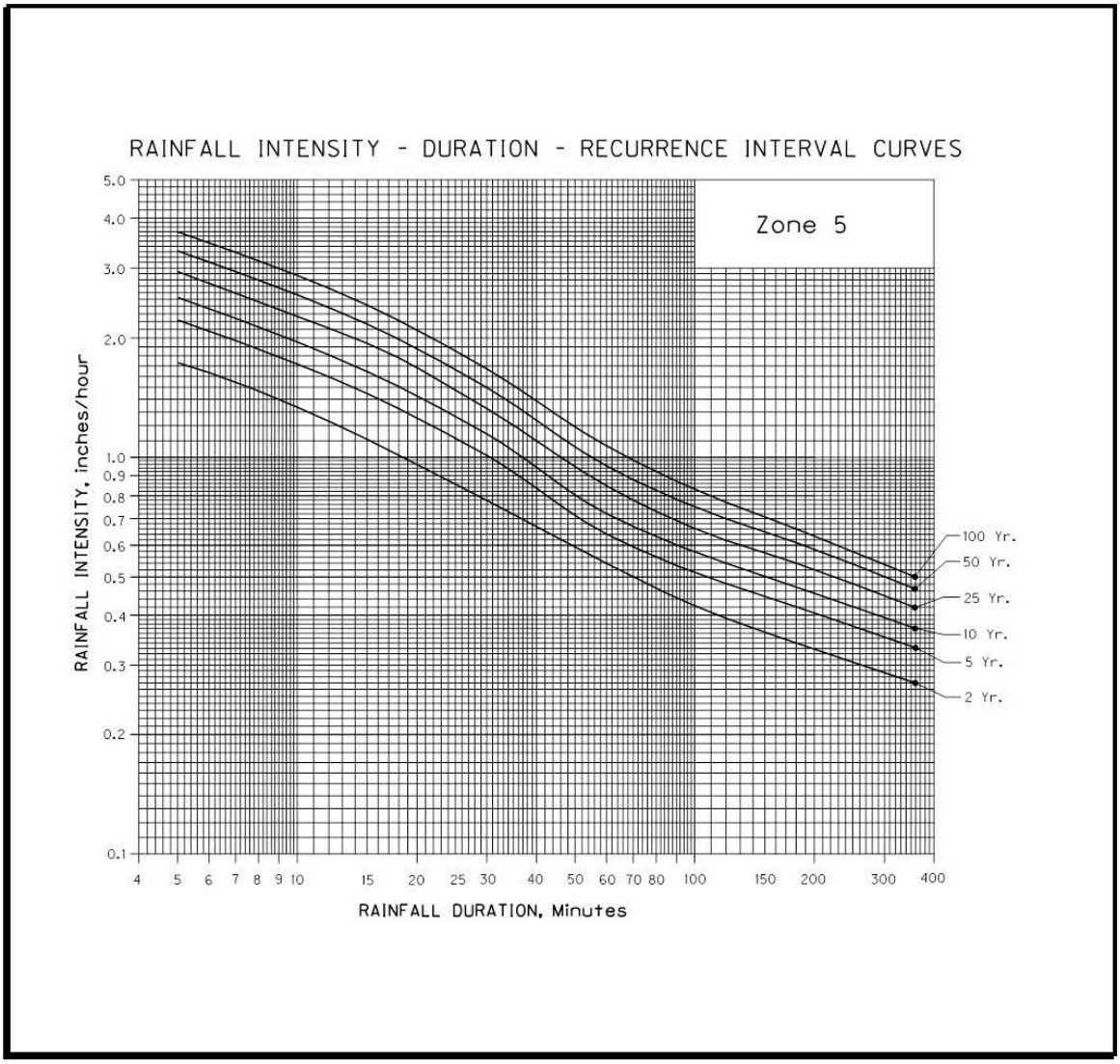


Figure 16. Rainfall Intensity Recurrence Curves (Zone 7)

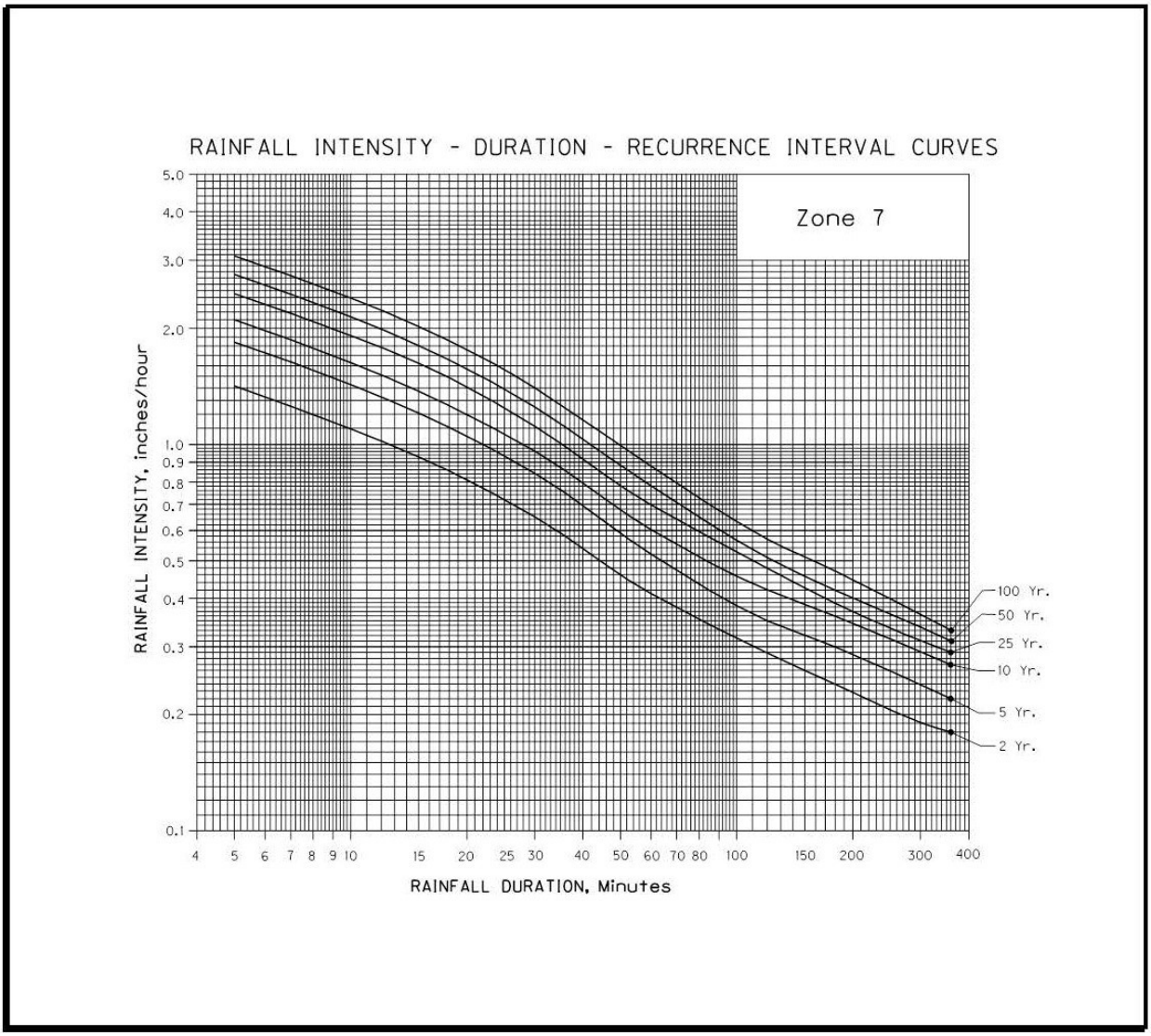
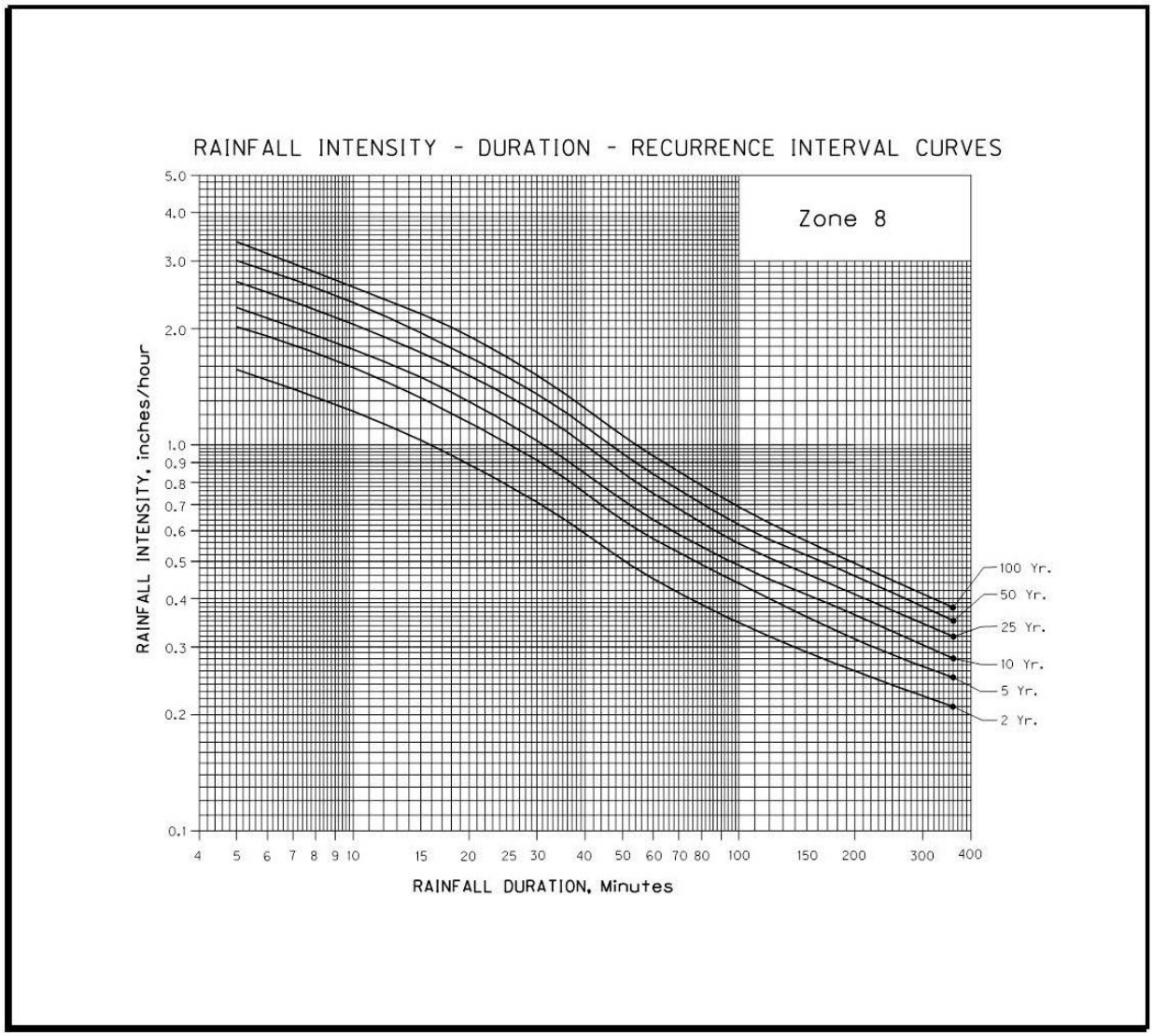


Figure 17. Rainfall Intensity Recurrence Curves (Zone 8)



5. NOAA Isopluvial Maps

The following figures are from the Precipitation-Frequency Atlas of the Western United States (Volume X – Oregon), published by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service (1973).

Figure 18. Isopluvials of 2-YR, 24-HR Precipitation in Tenths of an Inch

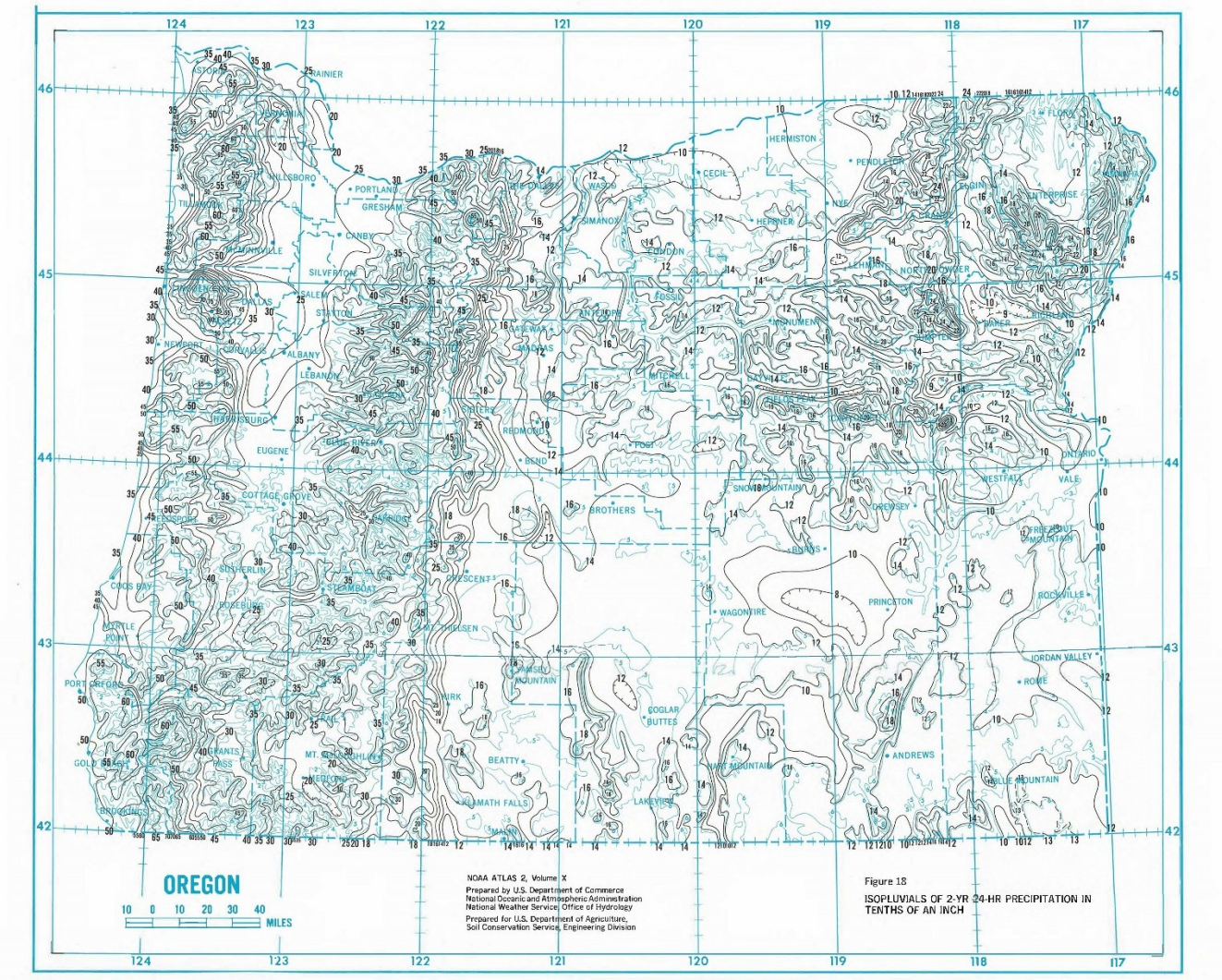


Figure 19. Isopluvials of 5-yr, 24-hr Precipitation in Tenths of an Inch

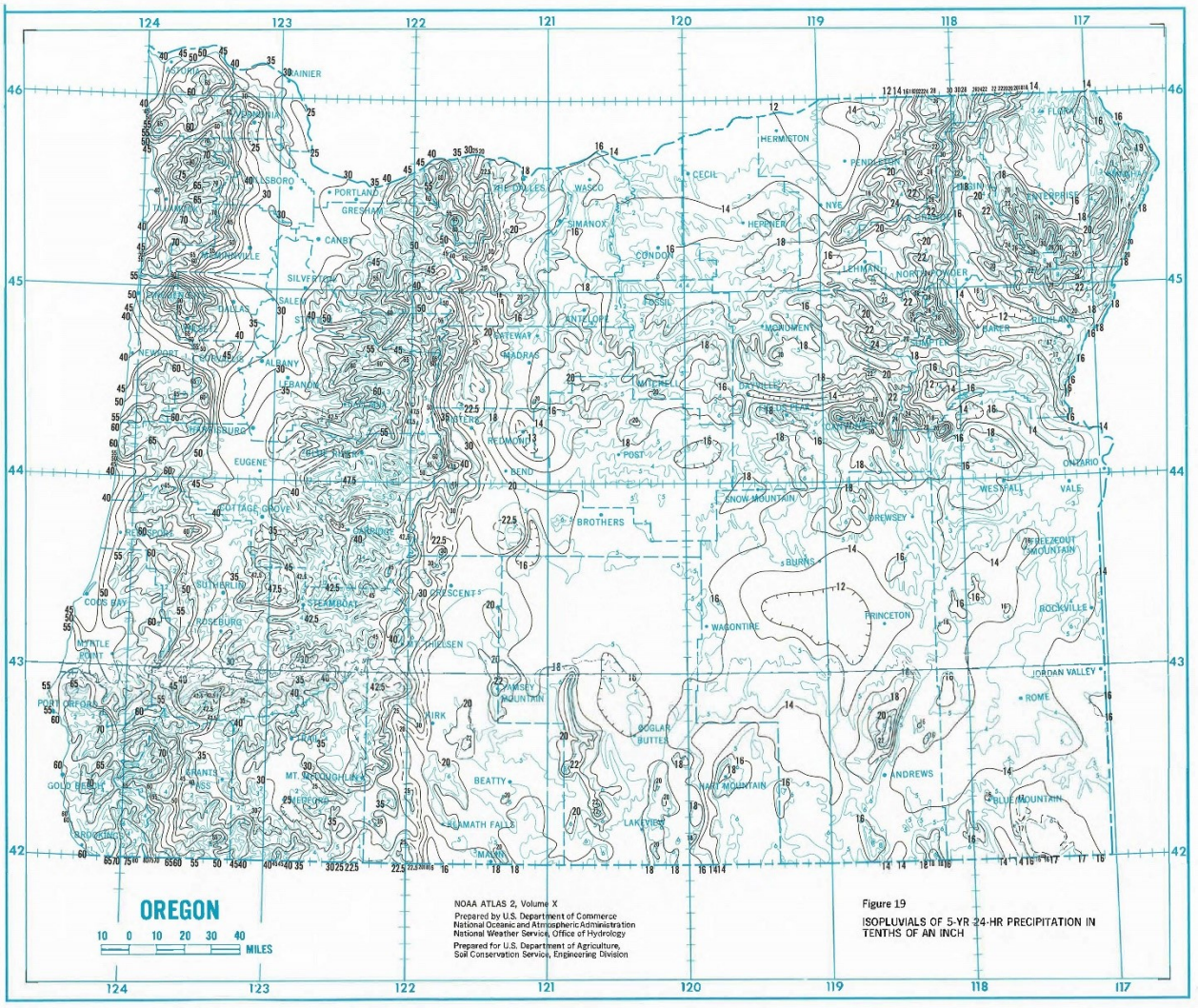


Figure 20. Isopluvials of 10-yr, 24-hr Precipitation in Tenths of an Inch

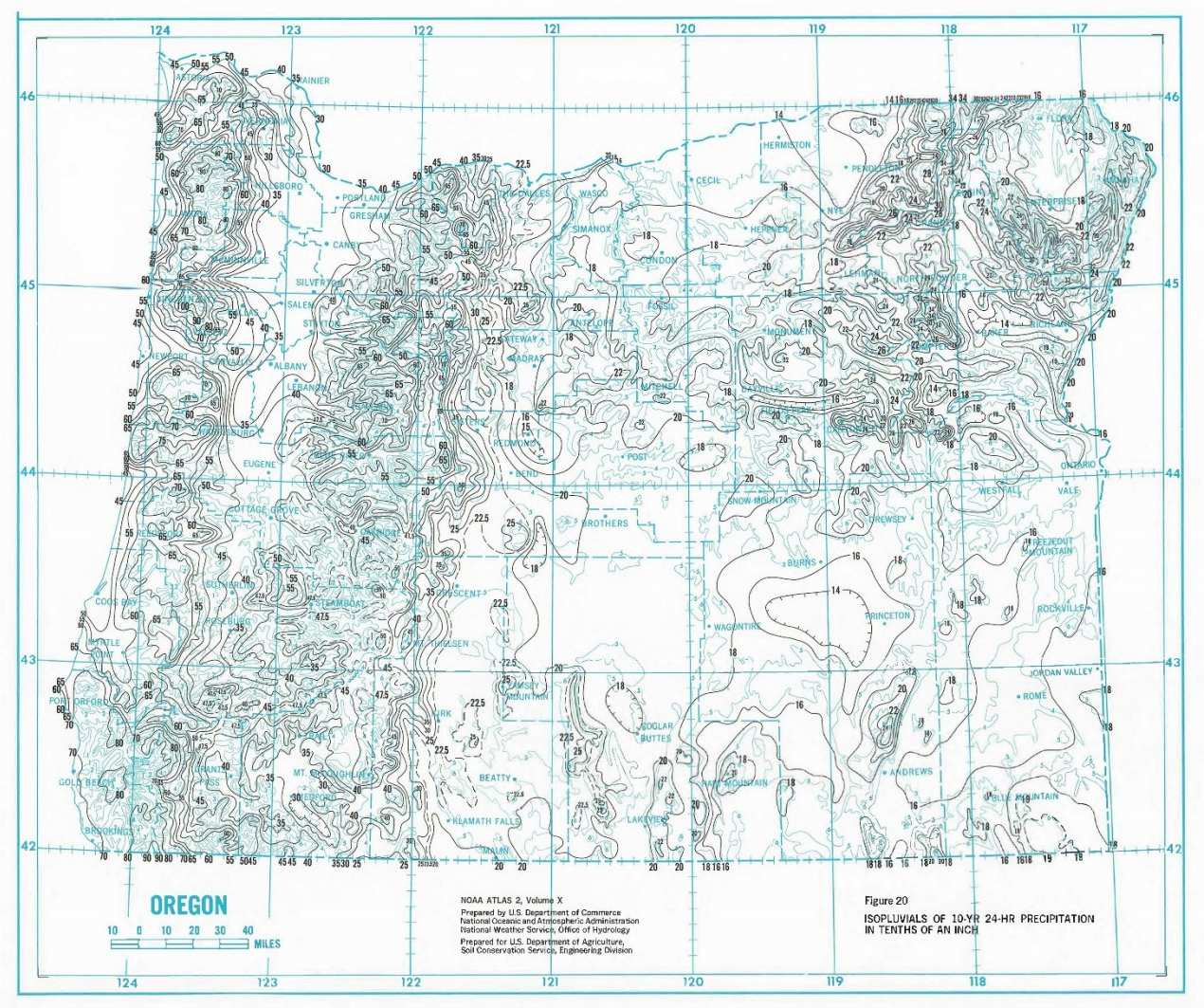


Figure 21. Isopluvials of 25-yr, 24-hr Precipitation in Tenths of an Inch

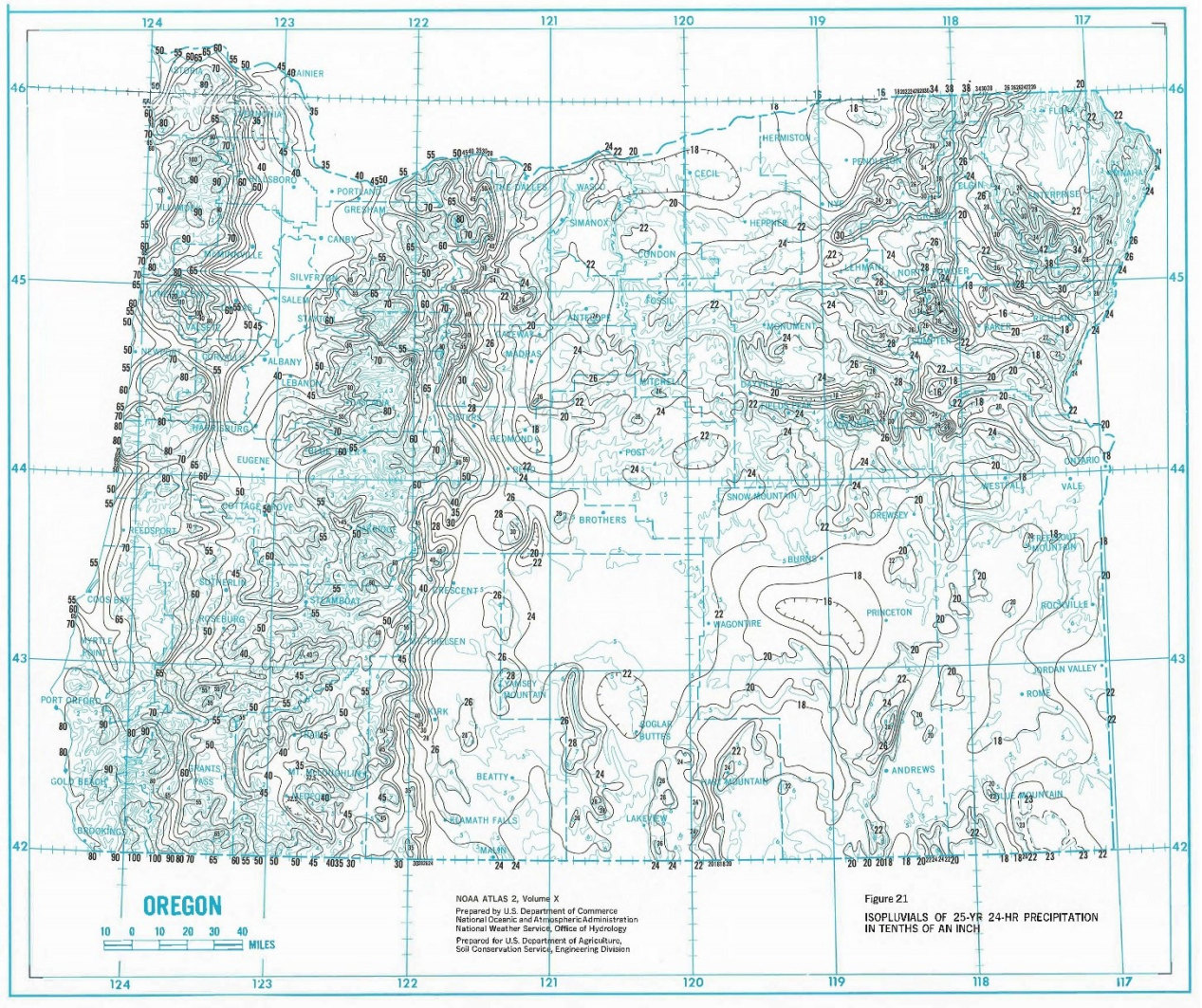


Figure 22. Isopluvials of 50-yr, 24-hr Precipitation in Tenths of an Inch

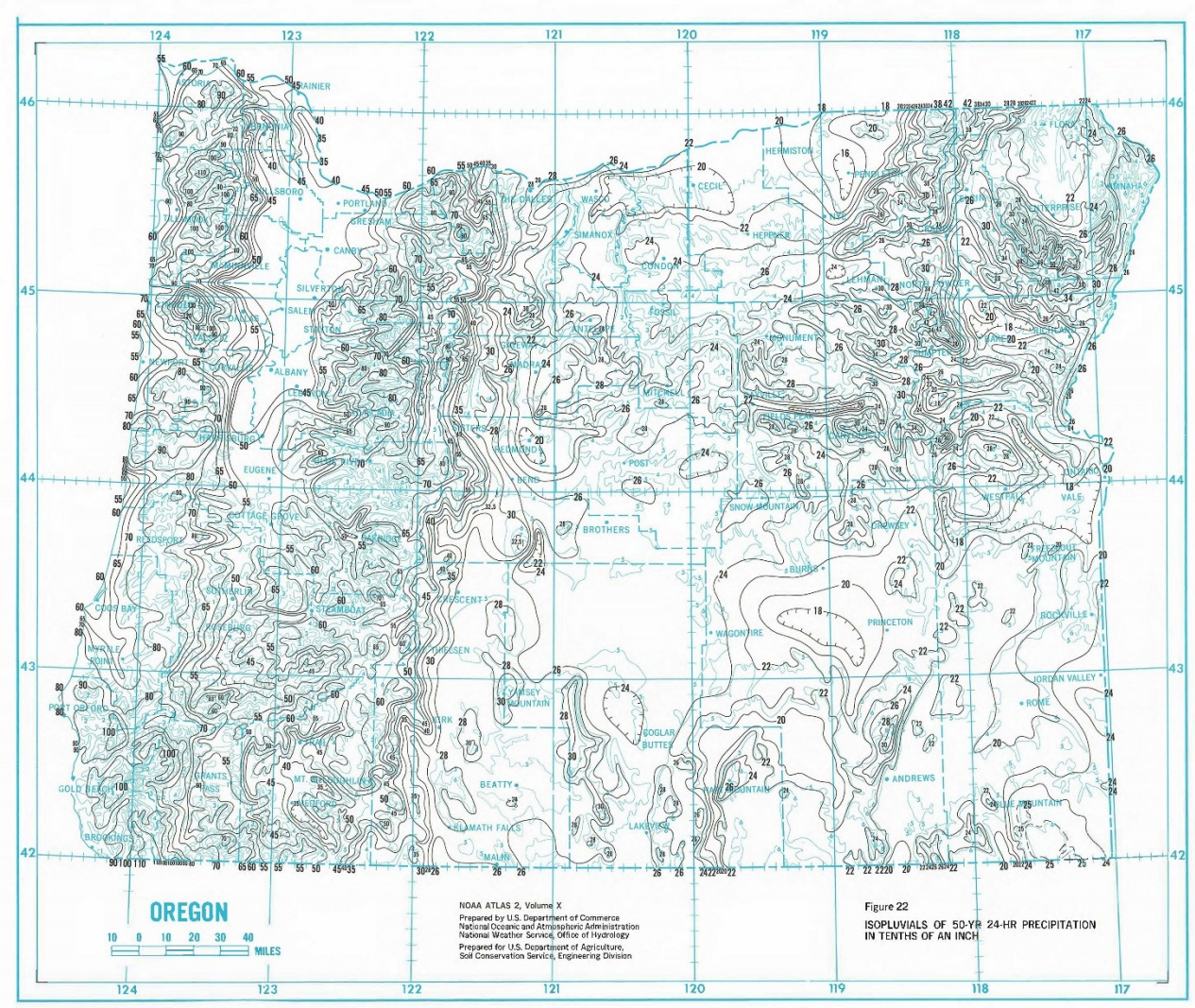


Figure 23. Isopluvials of 100-yr, 24-hr Precipitation in Tenths of an Inch